

*International Symposium on Computer
Science, Computer Engineering and
Educational Technology*

Prof. Dr. Wolfram Hardt

TUD*press*

IBS Scientific Workshop Proceedings

Herausgegeben von Stiftung IBS, Wolfram Hardt

Band 10

***International Symposium on
Computer Science, Computer
Engineering and Educational
Technology***

Prof. Dr. Wolfram Hardt (Hrsg.)

TUD*press*
2020

Bibliografische Information der Deutschen Nationalbibliothek
Die Deutsche Nationalbibliothek verzeichnet diese Publikation in der
Deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im
Internet über <http://dnb.d-nb.de> abrufbar.

Bibliographic information published by the Deutsche Nationalbibliothek
The Deutsche Nationalbibliothek lists this publication in the Deutsche Na-
tionalbibliografie; detailed bibliographic data are available in the Internet
at <http://dnb.d-nb.de>.

ISBN 978-3-95908-223-5

© 2020 TUDpress
THELEM Universitätsverlag
GmbH und Co. KG
<http://www.tudpress.de>

Alle Rechte vorbehalten. All rights reserved.
Gesetzt von den Herausgebern.
Printed in Germany.

IBS Scientific Workshop Proceedings

The “International Symposium on Computer Science, Computer Engineering and Educational Technologies” (ISCSET-2020) is the latest edition of the annual international symposium on computer science funded by the “Internationales Informatik- und Begegnungszentrum Sachsen (IBS)” fund and organized since 2012. It was our distinct pleasure for this year’s symposium to organize by the Mongolian Institute for Educational Research of the Ministry of Education and Science in cooperation with IBS.

The successful organization of ISCSET-2020 allowed us to provide an opportunity for leading international researchers to exchange ideas and research outcomes, facilitating knowledge exchange among the research community.

While this year’s symposium took place at a time of a new normal brought by the COVID-19 pandemic that has ravaged the world, it brought together leading researchers in the fields of Computer Science and Educational Technologies in order to discuss theories, practices, exchange ideas and introduce outcomes of innovative research.

It is my strong belief that the issues discussed in this symposium will not only allow us to overcome unprecedented challenges but in turn will make a contribution to opening the door for citizens of the world to access high quality education in their field of interest from anywhere in the world.

Even though the symposium took place in an online manner this year due to the COVID-19 pandemic, we would like to extend our appreciation to the researchers that took part in the symposium and presented innovative ideas. From the bottom of our hearts, we would like to wish you endless success in your future works.

We will always be eager to further cooperate with you.

Dr. Lkhagvasuren Purev

Director, Mongolian Institute for Educational Research

Prof. Dr. Dr. h. c. Uranchimeg Tudevdaya

Mongolian University of Science and Technology,

Chemnitz University of Technology

October 2020

Table of Contents

International Symposium on Computer Science, Computer Engineering and Educational Technology

Deep Learning for Personal Protective Equipment Detection	9
<i>Artem Soroka, German Magay, Bukhamer Egor</i>	
Incorporating Continuity between Professional Subjects into the English Curriculum	14
<i>Batbaatar Dashdemberel</i>	
Education in Pandemic Crisis Implementation via ICT Online Technologies	21
<i>Cyryl Koshyk</i>	
Risks in the Educational Sector: Theory and Practice	25
<i>Enkhtuvshin Jambaldorj</i>	
Sample Model for Selecting State Examination Test Item	29
<i>Gan-Erdene Jigjid, Ganbat Tsend</i>	
Perception of Lane Curvature Detection for Situational Awareness	32
<i>Julkar Nine, Shanmugapriyan Manoharan, Mohammad Didar Hossain Sagar, Shadi Saleh, Wolfram Hardt</i>	
MRI Rendering with EEG Sensors Projection	36
<i>Klementev Dmitrii</i>	
Analyses on Physics Textbooks for Secondary Schools	40
<i>Munkhbold Mangalsuren, Purevdorj Dondovsambu, Sodov Tsedendamba</i>	
Autonomous Unmanned Aerial Vehicle Development: MAVLink Abstraction Layer	45
<i>Marco Stephan, Batbayar Battseren, Uranchimeg Tudevdagva</i>	
Comprehensive Professional Competence Study of Legal University Professors	50
<i>Narantuya Lkhundev, Sodov Tsedendamba</i>	
Assessing the Progress of Children’s Competencies	53
<i>Narantuya Jamyandorj, Ganbat Tsend</i>	
Analysis of User Interface Design Methods	57
<i>Nikolai Gervas</i>	
Developing an Information Culture for Teachers	61
<i>Nyamsuren Amsarvaa, Tsedendamba Sodov</i>	

“Mathshop” E-Learning Mathematics Program - Experiments and Opportunities for Future Development	65
<i>Otgontugs Bayarrintsen, Erdenebat Dashtseren, Lkhagvasuren Purev, Bilguunbaatar Tumurkhuyag</i>	
Collision Warning Based on Multi-Object Detection and Distance Estimation	68
<i>Shadi Saleh, Chirag Rellan, Shubham Pareshkumar Surana, Julkar Nine, Wolfram Hardt</i>	
The Study to Determine the Required Product Identification System	73
<i>Sod-Od Batzorig, Gundsambu Bold</i>	
Comparison of Photogrammetric Approaches for Estimating Motion Parameters from a Monocular Sequence	77
<i>Tserennadmid Tumurbaatar</i>	
Studying the Students Information Technology Use	81
<i>Tuvshinjargal Radnaa, Tserengavaa Tserenpurev</i>	
Blended Mentoring in Academic Internship Program	84
<i>Ummay Ubaida Shegupta, René Schmidt, Martin Springwald, Wolfram Hardt</i>	
The Evaluation of Distance Teaching During COVID Quarantine at MUST	90
<i>Uranchimeg Tudevdagva, Tsooj Shambaljants, Delgermaa Senden</i>	

Deep Learning for Personal Protective Equipment Detection

Artem Soroka
Novosibirsk State Technical University
Novosibirsk, Russia
40aaa@mail.ru

German Magay
Novosibirsk State Technical University
Novosibirsk, Russia
gera303813_96@mail.ru

Bukhamer Egor
Novosibirsk State Technical University
Novosibirsk, Russia
bukhamer.egor92@yandex.ru

Abstract—*To prevent the consequences of emergencies at the workplace, it is necessary to use personal protective equipment (PPE). There is an important problem of automating personal protective equipment detection. In this paper, the problem of automating PPE detection is solved by using the modern architecture of RetinaNet to detect and classify objects in the image.*

Keywords—*deep learning; detecting; classification; safety; loss function.*

I. INTRODUCTION

There are many hazards at workplaces that can harm the worker, such as high voltage, falling objects, sparks, etc. For example, wearing a hardhat is an effective protective measure for minimizing the risk of traumatic brain injury. Moreover, a survey conducted by the US Bureau of Labor Statistics (BLS) suggests that 84% of workers who had suffered from protection injuries to the head were not wearing head protection equipment [1].

To ensure the safety of employees at work, there is a need to use personal protective equipment (PPE) to prevent situations that threaten the health and life of the employee. As a result, there is an urgent task of automation of PPE detection.

As the field of deep learning and computer vision evolves, more and more advanced image processing techniques are emerging.

In this paper, the task of PPE detecting is solved by using modern neural network architectures to detect objects in the image and classify instances.

II. OVERVIEW OF ADVANCED DEEP LEARNING SOLUTIONS

When solving computer vision problems, two types of approaches to detection (localization, object detection) and recognition are used. One-stage approach: this approach uses one convolutional neural network to detect an object and assign it to a class. These detectors include SSD [2] and YoloV3 [3].

On the contrary, two-stage involves 2 stages of object detection. First, the model proposes a set of regions of interests (ROI) by select search or regional proposal network. The proposed regions are sparse as the potential bounding box candidates can be infinite. Second, a classifier only processes the region candidates. Examples of architectures based on this approach are Faster R-CNN [4] or Mask-RCNN [5].

In this work, neural networks with the architecture RetinaNet [6], YoloV3 [3] and MobilenetV3 [7] based on the

one-stage approach were used to implement the detection and recognition of personal protective equipment instances in images.

A. MobilenetV3

The mobilenetV3 model is a representative of a new generation of neural networks, which is based on a modern architecture designed for low computing resources. Searching for MobileNetV3 [7] describes implementations of the latest version of mobile net: MobileNetV3-Large and MobileNetV3-Small. The model is intended for semantic image segmentation and object detection.

MobileNetV3, shows better results compared to MobileNetV2 [8]: on the MobileNetV3-Large modification it is more accurate in the classification problem on the ImageNet dataset, and objects are detected more than 25% faster and with approximately the same accuracy as on MobileNetV2, the experiment was carried out on the COCO dataset [9].

Compared to the previous implementation, MobileNetV3 has a set of fundamental innovations: changing the structure of the bottleneck layer, adding a new activation function, as well as moving the expanding layer (bottleneck) beyond the merge level.

B. YOLOv3

YOLO or «You Only Look Once» is CNN (convolutional neural network) very popular architecture, which is used to recognize multiple objects in an image. The main feature of this architecture compared to others is that most systems apply CNN several times to different regions of the image; in YOLO, CNN is applied once to the entire image at once. The network divides the image into a kind of grid and predicts bounding boxes and assigns it to certain object class.

YOLOv3 is an improved version of the YOLO architecture. It consists of 106 convolutional layers and better detects small objects compared to its predecessor YOLOv2.

The main feature of YOLOv3 is that there are three layers at the output, each of which is designed to detect objects of different sizes.

C. RetinaNet

The RetinaNet [6] neural network differs from other algorithms in a set of fundamental features that allow it to show good results and outperform competitors in terms of accuracy, the innovations proposed by RetinaNet authors will be described below. Focal loss function with hyper parameter. In the paper [6], the authors consider a modification of the loss function (1) for classification problems - Cross-entropy (CE).

$$CE(p_t) = -\log(p_t) \quad (1)$$

The authors pay attention to the fact that in the classical cross-entropy function the influence of wrong examples is poorly controlled and propose to supplement the function with a multiplier-regulator "penalty", the coefficients of which are hyperparameters.

$$FL(p_t) = -(1 - p_t)^\gamma \log(p_t) \quad (2)$$

γ – loss function hyperparameter, p_t – probability of ground truth class.

There is also a modification of Focal loss with an additional balance coefficient α , within the limits of this article the parameter α will be selected by experiment.

$$FL(p_t) = -\alpha_t(1 - p_t)^\gamma \log(p_t) \quad (3)$$

In the article, the authors have chosen the best hyperparameter value $\gamma = 2$. Fig. 1 shows the graph from work [6], showing the dependence of losses on the accuracy of prediction at different values of hyper parameter γ . As can be seen, the transition from the value of the loss indicator p_t to a high probability of belonging to the class, with the growth of hyperparameter γ becomes more complicated, i.e. high probability of belonging to the class is achievable at sufficiently low values p_t .

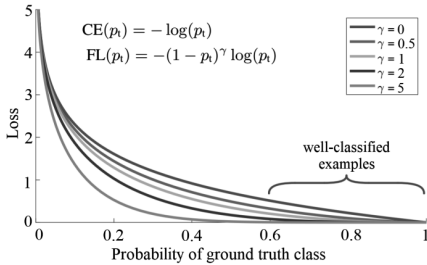


Fig. 1. Dependence of the probability of belonging to a class on the loss function at different values of hyper parameter γ .

In our work further we will consider an experiment with the selection of hyper parameters and γ , the purpose of which is to achieve the best possible neural network performance on its own data set.

Moreover, RetinaNet architecture is based on a pyramidal structure. The backbone (basic model) for RetinaNet feature map extraction is FPN (Feature Pyramid Network) [10], a modification of ResNet architecture [11].

Also RetinaNet includes two sub networks, the first sub network performs a concurrent classification of objects at the backbone outputs, the second, regression of the boundaries of the detected object. The activation function of each convolution layer is ReLu, the sigmoidal activation function is set at the classifier output. Fig. 2 shows structural scheme of RetinaNet.

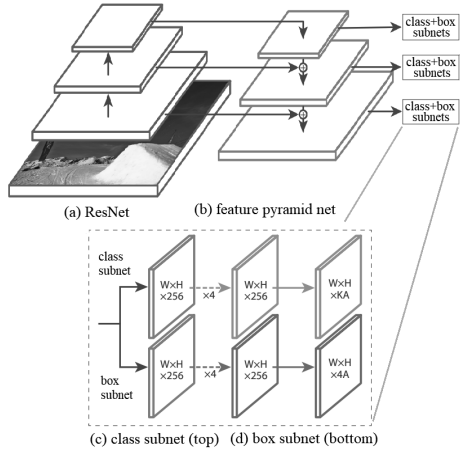


Fig. 2. RetinaNet network architecture.

The specific feature of the pyramidal structure of the artificial neural network is that the features extracted by the convolution layers of the map at different levels of the convolution layers of the neural network are considered as a hierarchical pyramid. Maps at the lower levels have a high resolution, and the upper levels have a high semantic component. Maps of the upper level are up sampled to the size of the lower layer map, and then combined into a single set of maps, a similar operation is performed for all layers.

This algorithm structure provides sufficiently high quality performance against the other modern detector architectures. Table I shows a comparison table of neural networks and their mAP (mean Average Precision) indicators at different IoU (Intersection over Union) - the overlap between the areas of prediction and validation example.

TABLE I. MAP VALUES FOR THE DIFFERENT ARCHITECTURES

Methods	Backbone	Indicators		
		AP	AP ₅₀	AP ₇₅
Two-stage methods				
Faster R-CNN+++	ResNet-101-C4	34.9	55.7	37.4
Faster R-CNN w FPN	ResNet-101-FPN	36.2	59.1	39.0
Faster R-CNN by G-PMI	Inception-ResNet-v2	34.7	55.5	36.7
Faster R-CNN w TDM	Inception-ResNet-v2-TDM	36.8	57.7	39.2
One-stage methods				
YOLOv2	DarkNet-19	21.6	44.0	19.2
SSD513	ResNet-101-SSD	31.2	50.4	33.3
DSSD513	ResNet-101-DSSD	33.2	53.3	35.2
RetinaNet	ResNet-101-FPN	39.1	59.1	42.3
RetinaNet	ResNeXt-101-FPN	40.8	61.1	44.1
YOLOv3 608x 608[3]	Darknet-53	33.0	57.9	34.4

In the article [3] the authors compare indicators of the approach used in RetinaNet and other modern neural networks with a one-stage YOLOv3 detector. From the Table I, we can see that RetinaNet shows the best results exactly, but loses in frame processing speed. As for the task set in this

article, the focus is on object detection accuracy, sacrificing speed.

III. TRAINING RETINANET, MOBILENETV3, YOLOV3

When implementing a system of recognition of PPE, training is provided on its own dataset: video from production and images of employees with and without PPE. On the images were marked areas of PPE, the detector is trained on 13 classes: the presence / absence of PPE (positive and negative examples), as well as the presence of a person. The data set was marked using the Visual Object Tagging Tool.

The dataset was randomly split into a test dataset and a learning dataset at a ratio of 800 examples – learning data, 200 - testing data. The total number of instances in all images is more than 4800

The trained neural network model makes a prediction of finding a specific class of PPE in a certain zone.

The process of training of detectors requires certain hyperparameters to be set in advance, such as the number of epochs, learning rate, the size of the batch, the optimization method.

Number of epochs increasing leads to an increase in accuracy, but large number of epochs significantly increases the training time without a noticeable improvement in the quality of prediction. If the loss values decreased slightly over several epochs in a row training was stopped. The size of the batch is the number of images at the input of the neural network in one pass, was set equal to 2. All hyperparameters were initialized on the basis of experiments in order to achieve the optimal ratio between high quality training and the least time spent.

To minimize the Focal loss quality functional, one of the effective methods of stochastic optimization was used – Adam [12], learning rate – 3×10^{-4} , the model was trained in 30 pcochs.

A. Hardware and Software

The personal protective equipment detection system was implemented in the Python 3 programming language using the Pytorch deep learning library, training visualization tools, the TensorboardX package, plotly, OpenCV library for computer vision and image processing algorithms and Nvidia CUDA technology.

Often, training and testing deep learning models requires significant computational resources. The use of graphic process units, the advantage of which is parallel computing, can reduce the training time, so the model was trained on the Nvidia GeForce GTX 2060 GPU.

In addition to the GPU, the hardware characteristics of the PC: Intel Core i7-7900f processor; RAM 16.0 GB; GPU frequency 1710 MHz, 8192 MB GDDR6 video memory.

B. Experimental results for RetinaNet, MobilenetV3, YOLOv3

To assess the quality of the trained model, the following indicators were chosen: recall, precision, the main criteria for the quality of training are their generalization - F-measure (f1 score) and Average precision (AP). Recall is an indicator of the sensitivity of the algorithm to type II errors (false negative). Precision is an indicator of the sensitivity of the learning algorithm to type I errors (false positives). F-measure can be interpreted as the integral assessment of accuracy and recal. mAP calculates the average precision for recall in the

range [0;1]. mAP is calculated for a specific IoU, in this paper IoU will be taken more or equal to 0.5.

$$F_1 = 2 \times (\text{Precision} \times \text{Recall}) / (\text{Precision} + \text{Recall}) \quad (4)$$

In this paper, due to the Focal Loss functions of the RetinaNet neural network, we will also initialised hyperparameters of loss functions, the coefficients α and γ . To select the optimal value of the hyper parameters of the loss function, a search on lattice was performed. The domain of definition of hyper parameters was established based on the best combinations of parameters in the article [6]: $\alpha_t = 0.25$, $\gamma = 2.0$:

$$\alpha_t = \{0.05, 0.15, 0.25, 0.35\}$$

$$\gamma = \{0.5, 1.0, 2.0, 3.0, 4.0\}$$

A search was performed for each pair (α, γ) . A series of experiments was performed with the initialisation of different parameters α_t and γ of the loss function in order to increase the mAP₅₀ values. Table II shows the dependence of the quality indicators of neural network learning with initialised hyper parameters, in Fig. 3 shows a graph of dependence. As can be seen from the table, the best combination of parameters $\alpha_t = 0.15$, $\gamma = 2$ gives AP₅₀ = 58.92.

TABLE II. TABLE OF THE DEPENDENCE OF THE INDICATORS OF THE QUALITY OF LEARNING A NEURAL NETWORK WITH INITIALISED HYPER PARAMETERS.

Hyperparameters		Indicators			
α_t	γ	AP ₅₀	Recall	precision	F-score
0.05	2.0	48.60	0.520	0.394	0.449
0.15	1.0	53.92	0.510	0.554	0.531
0.15	2.0	58.92	0.691	0.387	0.496
0.15	3.0	54.00	0.688	0.230	0.344
0.25	0.5	51.25	0.495	0.515	0.505
0.25	1.0	55.02	0.561	0.509	0.534
0.25	2.0	58.44	0.706	0.424	0.530
0.25	3.0	55.14	0.748	0.233	0.355
0.25	4.0	54.76	0.775	0.206	0.325
0.35	1.0	50.47	0.605	0.425	0.499
0.35	2.0	57.09	0.690	0.377	0.488
0.35	3.0	54.78	0.773	0.214	0.335

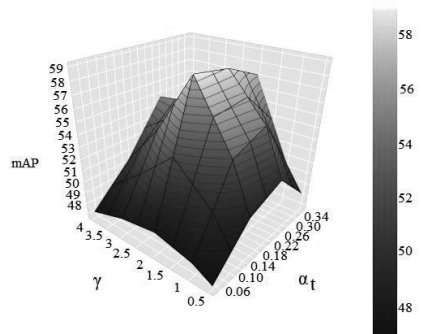


Fig. 3. Graph of mAP versus hyper parameters of the loss function.

We trained the RetinaNet model at 100 epochs with the best parameters and got the value mAP₅₀ = 60.08, which is comparable to the value mAP₅₀ presented in the original work [6]. The models of neural networks YOLOv3 and MobileNetV3 were also trained. The indicators of the quality

of neural networks learning is presented in Table III, the results of the learning algorithm are presented in Fig. 4, 5.

TABLE III. CNN METHODS COMPARISON.

Model architecture	Indicators			
	<i>mAP₅₀</i>	<i>Recall</i>	<i>Precision</i>	<i>F1-score</i>
MobileNetV3	43.81	0.523	0.371	0.449
YOLOv3	56.35	0.717	0.252	0.355
RetinaNet	60.08	0.691	0.387	0.496



Fig. 4. The result of the neural network



Fig. 5. The result of the neural network

Recently, methods based on the neural network approach for solving the problems of detecting PPE are gaining more and more popularity. A number of methods can be cited as examples. Based on Faster R-CNN architecture, to detect the

absence of hardhat on workers [13], a method for detecting the presence of hardhat using the SSD neural network architecture [14], one of the most recent approaches based on YOLOv3 [16]. Table 4 shows comparison between previous papers and ours.

TABLE IV. PREVIOUS STUDIES COMPARISON. THE PERFORMANCE OF THE PROPOSED METHODS IN TERMS OF AVERAGE PRECISION (AP₅₀) AND DETECTION SPEED.

Criteria	Hat		Vest/Uniform		FPS
	Hat	No hat	Vest	No vest	
Detection					
previous studies					
Fang et al. [13]	>90,00 ^p		×	×	10
Xie et al. [15] (CAHD)	54,60		×	×	11
Wu et al. [14] (Peleer-RPA)	74,76	62,67	×	×	3,22
Nath et al. [16] (Approach-1)	74,29	63,84	74,32	73,18	13
Ours	79,90	76,67	80,48	79,98	7

× - Not applicable
p - Precision.

As seen at Table IV approach presented by us is better in some criteria to the existing approaches. However, it should be noted that our approach covers more categories. Besides, it is necessary to note the knock-out values to determine the position of the helmet visor. The supposed problem is its transparency, for which it was decided to add few stickers to the visor, which increased the AP value for determining the position by several points. However, making changes to such objects is prohibited by regulatory documentation, and in case of making it requires a long-term approval, therefore, at this stage of development, we are forced to discard that decision. Table V shows the average precision value for each class for our method.

TABLE V. THE PERFORMANCE OF OUR METHOD IN TERMS OF AVERAGE PRECISION (AP₅₀).

Detected object class	AP ₅₀
helmet	79,90
no helmet	76,67
gloves on	66,31
gloves removed	71,32
work uniform	80,48
no uniform	79,98
work pants	78,31
no work pants	77,89
work boots	29,41
no work boots	27,47
visor risen	17,12 (42,78 ^s)
visor down	12,29(50,14 ^s)
person	83,89
mAP (mean)	60,08

s - with stickers

The existing Nath et al. [16] YOLOv3 based approach is a good example with high performance for fast work, but our approach gives more accurate prediction, but sacrificing at speed. This was more suitable for our task.

IV. POSSIBLE SOLUTION MODIFICATIONS

To assess the presence of PPE on a person in the frame, a heuristic approach (kind of decision tree) was used, which can be described as follows, for example, for a helmet:

As a result of the work of the neural network, we have an understanding of the presence of a person in the image and its relative coordinates, because the model is trained to localize

the image of a person too. At the same step, we know the coordinates of the head with the helmet or its absence (in the training sample, there are classes - “with helmet”, “without helmet”). Further, knowing the coordinates of the “person” object in the image, there is an understanding that the “helmet” object should not go beyond the boundaries of the “person” object.

In cases where it is necessary to expand the functions of the video analytics system, optionally, a variant of the composition of the detector algorithm and the algorithm for determining a person’s posture is possible, which allows you to analyze a person’s posture to assess and prevent accidents in hazardous situations: employee fall, immobility, unusual behavior, etc.

To determine the coordinates of body parts and the human posture, the OpenPose algorithm [17] is used. The implemented algorithm has the possibility of several people being in the image. At the output of the convolutional neural network, we get a discrete set of reference points that correspond to parts of the body, and then we analyze the associations of pairs of points.

V. CONCLUSION

Modern methods of data analysis and computer vision can be applied to effectively monitor compliance with safety standards by employees, which will lead to a reduction in emergency situations in hazardous industries. As part of this work, an approach using deep learning tools to the task of determining the availability of personal protective equipment for employees was proposed: a training data set was prepared, the neural network architecture was selected and the optimal combination of hyper parameters was established. The value of the average precision of the trained model (Average precision) $AP_{50} = 60.08$. To further improve the quality of the algorithm, it is planned to quantitatively and qualitatively increase the set of training data, and modify the architecture of the neural network.

REFERENCES

- [1] M.-W. Park, N. Elsafty, Z. Zhu, Hardhat-wearing detection for enhancing on-site safety of construction workers, *J. Constr. Eng. Manag.* 141 (9) (2015).
- [2] W. Liu, D. Anguelov, D. Erhan, C. Szegedy, S. Reed, C.-Y. Fu, A. C. Berg, SSD: Single Shot MultiBox Detector. In: Leibe B., Matas J., Sebe N., Welling M. (eds) *Computer Vision – ECCV 2016*. ECCV 2016. Lecture Notes in Computer Science, vol 9905. Springer, Cham. (2016).
- [3] J. Redmon, A. Farhadi, YOLOv3: An Incremental Improvement, (cite arxiv:1804.02767 Comment: Tech Report), (2018).

- [4] S. Ren, K. He, R. Girshick, J. Sun, Faster R-CNN: Towards Real-Time Object Detection with Region Proposal Networks, in *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 39, no. 6, pp. 1137-1149, (2017).
- [5] K. He, G. Gkioxari, P. Dollár, R. Girshick, Mask R-CNN, 2017 IEEE International Conference on Computer Vision (ICCV), Venice, pp. 2980-2988, (2017).
- [6] T. Lin, P. Goyal, R. Girshick, K. He, P. Dollár, Focal Loss for Dense Object Detection, 2017 IEEE International Conference on Computer Vision (ICCV), Venice, pp. 2999-3007, (2017).
- [7] A. Howard, M. Sandler, G. Chu, L.-C. Chen, B. Chen, M. Tan, W. Wang, Y. Zhu, R. Pang, V. Vasudevan, Q. V. Le, H. Adam. Searching for MobileNetV3 (cite arxiv: 1905.02244), (2019).
- [8] M. Sandler, A. Howard, M. Zhu, A. Zhmoginov, L. Chen, MobileNetV2: Inverted Residuals and Linear Bottlenecks, 2018 IEEE/CVF Conference on Computer Vision and Pattern Recognition, Salt Lake City, UT, 2018, pp. 4510-4520, (2018).
- [9] T.-Y. Lin et al. (2014) Microsoft COCO: Common Objects in Context. In: Fleet D., Pajdla T., Schiele B., Tuytelaars T. (eds) *Computer Vision – ECCV 2014*. ECCV 2014. Lecture Notes in Computer Science, vol 8693. Springer, Cham. (2014).
- [10] T. Lin, P. Dollár, R. Girshick, K. He, B. Hariharan, S. Belongie, Feature Pyramid Networks for Object Detection, 2017 IEEE Conference on Computer Vision and Pattern Recognition (CVPR), Honolulu, HI, 2017, pp. 936-944, (2017).
- [11] K. He, X. Zhang, S. Ren, J. Sun, Deep Residual Learning for Image Recognition, 2016 IEEE Conference on Computer Vision and Pattern Recognition (CVPR), Las Vegas, NV, 2016, pp. 770-778, (2016).
- [12] D. Kingma, J. Ba, Adam: A Method for Stochastic Optimization, International Conference on Learning Representations (2014).
- [13] Q. Fang, H. Li, X. Luo, L. Ding, H. Luo, T.M. Rose, W. An, Detecting non-hardhat-use by a deep learning method from far-field surveillance videos, *Autom. Constr.* 85 (2018).
- [14] J. Wu, N. Cai, W. Chen, H. Wang, G. Wang, Automatic detection of hardhats worn by construction personnel: a deep learning approach and benchmark dataset, *Autom. Constr.* 106 (2019).
- [15] Z. Xie, H. Liu, Z. Li, Y. He, A convolutional neural network based approach towards real-time hard hat detection, *Proc. IEEE International Conference on Progress in Informatics and Computing (PIC)*, IEEE, pp. 430, (2018).
- [16] N. D. Natha, A. H. Behzadanb, S. G. Paala, Deep learning for site safety: Real-time detection of personal protective equipment, *Automation in Construction*, Vol. 112, (2020).
- [17] Z. Cao, G. Hidalgo Martinez, T. Simon, S.-E. Wei, Y. A. Sheikh, OpenPose: Realtime Multi-Person 2D Pose Estimation using Part Affinity Fields, *IEEE Trans Pattern Transactions on Pattern Analysis and Machine Intelligence*, (2019).

Incorporating Continuity between Professional Subjects into the English Curriculum

Batbaatar Dashdemberel
Education department
Orkhon University
Ulaanbaatar, Mongolia
dbd12@yahoo.com

Abstract—The main goal of this work is to develop an English curriculum in line with the content of specialized design courses in order to improve the foreign language teaching process, and based on this, to create an English textbook with a wide range of content, practical applied exercises, and word chains. Based on some of the theories and methodologies of language teaching, students studying fashion design using a text-based grammar-translation method to develop a methodological framework for their application.

Keywords—*Fashion, design, textbook, teaching, phrase*

I. INTRODUCTION

In the Mongolian higher education system, English is taught as a general English course to students majoring in other majors. However, a small number of universities and colleges are beginning to change their teaching methods to include professional English. There is no consensus on the development and teaching of professional English curriculum yet some universities offer training based on their capabilities. Therefore, we need to explore opportunities to learn and teach text-based English, and we need to explore opportunities to improve the effectiveness of professional English training.

A. Rationale

There is a need to study the methodological issues of improving the teaching process using professional-oriented English textbooks for fashion design students that reflect modern needs. Therefore, the importance of this research work is that the issue of designing English textbooks and the curriculum for undergraduate students majoring in modeling is determined by the social significance and practical requirements. This study was used among students majoring in fashion design at the Fashion Design Institute (FDI) in order to ensure that students in the professional field are able to master the professional terminology and know the meaning and current news and trends.

B. Purpose

The main purpose of this work is to develop an English language curriculum in line with the content of specialized design courses in order to improve the foreign language teaching process. Based on this, to compile an English textbook with a wide range of design, appropriate exercises, and word chains, and to develop a methodological framework for students majoring in fashion design based on some theoretical and pedagogical methods of teaching foreign languages.

C. Objectives

- Conduct a survey on professional English language training in similar schools
- Develop a professional English design curriculum
- Develop professional English textbooks and manuals based on the program
- Conduct experimental lessons according to the curriculum
- Introduce innovative textbook versions into the training, conduct experimental training and evaluate the results

D. Research status of the topic

Demid.B. (1998) "Improving foreign language teaching methodology based on the text" [16], Richards, J.C. (2001). "Curriculum Development in Language Teaching" [29], Burma.Ts, (2011). "Methodological research to teach English language reading skills to students" [13], Narantsseg.M (2016) "Improving the learning process using professionally-oriented Russian language textbooks" [26], Mónica Rodríguez-Boncos, (2016) "A basis for the design of a curriculum incorporating music and drama in children's English language instruction" [25], Sirajul Munir, (2019) "Turning Classroom Project into Textbook Design in English for Specific Purposes Subject" [30].

E. Research methodology

Test method is used to determine the level of knowledge of students of the Fashion Design Institute with the content of the new textbook

Mathematical statistical methods are used to calculate the results of experimental training

Experimental training on the new textbook version was conducted using research analysis, summarization, comparison and observation methods

F. Scope of the study

Conduct a survey on eight different universities and colleges that provide fashion design training

The results of the experiment were presented to the first, second- and third-year undergraduate students of the Fashion Design Institute

G. Innovative aspects of research work

- 1) For the first time, studying and analyzing on the curriculum of professional design course and

developed the new curriculum of Fashion Design course.

- 2) Compiled an innovative textbook with a wide range of design texts, appropriate exercises, and word chains based on the content.
- 3) Introduced into teaching practice using professional English textbooks
- 4) 5 versions of new textbooks for English lessons with codes ENLA-100[8], ENLA-101[9], ENLA-102[10], ENLA-103[11], ENLA-104[12], were developed on a scientific basis, and the results were evaluated

H. Practical significance of the research

The School of Fine Arts, a branch of the University of Culture and Arts, and Fashion Design Institute have been involved in the development of English textbooks for students majoring in design.

I. Research hypotheses

If the innovative English language textbooks for vocational guidance are developed in a well-grounded and scientifically sound manner, effectiveness and quality of the training will be improved.

II. EXPERIMENTS AND RESULTS

A. The graphic representation of the surveyed students from all design universities is shown in the graph

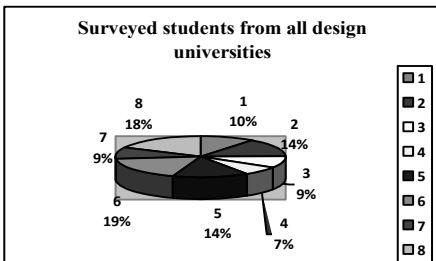


Fig. 1. Average number of respondents.

Within the framework of this needs assessment survey, a total of 154 students from 1st to 4th-year students majoring in fashion design and costume design at 8 universities and colleges in Ulaanbaatar were sampled using questionnaires[6]. The percentage of total school participants was similar. This is considered to be an opportunity for all students majoring in fashion design, as well as for the universities and colleges where they are trained, to facilitate further research. Surveyed students from all design universities:

1. Mongolia International University
2. Mongolian-Korean Polytechnic College

3. Uralakh Erdem Fashion Design Institute
4. Mongolian State University of Arts and Culture
5. City University
6. Ikh Zasag International University
7. Fine Arts Design and Technology School
8. Rajiv Gandhi Polytechnic College of Arts and Crafts

Provision of professional textbooks and manuals

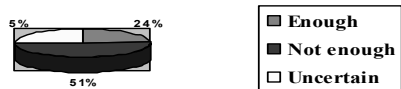


Fig. 2. Availability of professional textbooks.

The purpose of chart 2 is to show the availability of professional textbooks, newspapers and manuals resource in English[4]. The graph shows a figure of 24% enough, 25% not enough, and 51% uncertain, indicating that foreign language manuals, newspapers, and textbooks are inadequate throughout the school, as well as to enable students to conduct research and exploration. Providing the library fund with professional books and textbooks on fashion design in English and Mongolian will facilitate their research in this area, and it is necessary to create materials at hand.

B. Lessons in a modern curriculum that meets the needs of students

One of the most common methods used in foreign language teaching is text-based teaching, which is adapted to the learner's language level and selects sources that present minor linguistic difficulties. Topic-based training is unique in that it provides the advantage of using a variety of usage terms.

1) Model Lesson-1 Types of Necklines.

a) Fill in each blank with a suitable WORD.

Blurry, bosom, cleavage, deeper, elegant, halter, hangover, merits, plunging, striking

In women's fashion there are a lot of different types of neckline, each seeking to create a specific effect for the person wearing the dress, whether it's to increase the size of the _____, to display varying amounts of cleavage or simply to achieve a greater degree of comfort. In this guide we explore some of the more commonly used necklines and consider the _____ of each. The Plunging Neckline; This is a reasonably common neckline that is found on both tops and dresses, as the name suggests it consists of a low-

cut area at the front which allows for varying amount of _____ to be displayed. When describing a _____ we prefer to add a little more detail and would normally describe the shape as having a 'V', either a 'square' or a 'U' cut. The Scoop Neckline; Scoop necks are very similar to a 'U' cut 'Plunging Neckline'; however, they usually have a much _____ cut and are not uncommonly found on things like T-Shirts, with a recent trend making them very popular especially in men's fashion. A scoop neck tends to allow for more cleavage than a 'U' cut plunging neckline would, but as you will appreciate where we draw the distinction between the two can be a bit _____.

Scoop necklines are ideal for a slightly more flirtatious outfit and are often seen in dresses aimed at the club wear market. The Boat Neckline; A Boat Neck is a much wider neckline that is usually cut into a shallow 'U' shape which often passes the collar bones and hangs on the shoulders.



Fig. 3. This picture is a part of the textbook [11].

It creates an _____ look and is often seen in cocktail and evening dresses. A very modest neckline that is ideal for those situations where you want to show a bit of flesh but where it is probably less appropriate to display large amounts of cleavage. It is rarely seen in less formal attire. The Off-the-Shoulder Neckline; Often referred to a 'strapless neckline' these necklines are similar to the 'Boat Neckline' except they hang entirely off the shoulder. They normally _____ the arms below where the shoulder ends; however, when referred to as a 'strapless neckline' this would normally imply the neckline passes under the arms. This is an ideal neckline for to accentuate the shoulders and neck of the wearing and often lends to a very elegant look. [11].

b) Crosswords

In addition to thinking skills, two types of word network exercises were introduced to develop visual and spatial skills, allowing students to work in pairs, individually, and

in groups. Between 10-15 new words are included to avoid duplicating data and taking less time [11].

TABLE I. CROSSWORD-1 [11]

№	Crosswords' questions-down
2	more attractive than usual:
3	graceful and attractive in appearance or behavior:
5	the narrow space between a woman's breasts, that is seen when she wears a piece of clothing that does not cover the top of them:
7	a piece of women's clothing that is held in position by a strap that goes behind the neck so that the upper back and shoulders are not covered:
8	a woman's breasts:

TABLE II. CROSSWORD-2 [11]

№	Crosswords' questions-across
1	the advantages something has compared to something else:
4	something that you can not remember or understand clearly:
6	dropping suddenly or having a shapet that drops a long way down:
9	If a threat or doubt hangs over a place or a situation, it exists:
10	extending far down from the top or surface:

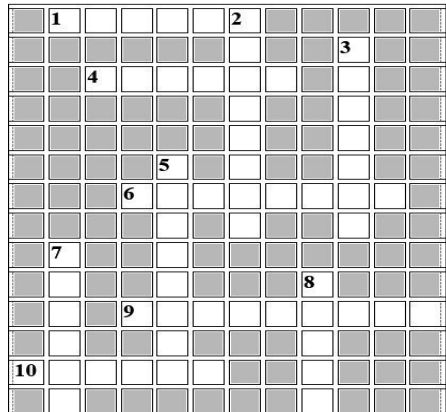


Fig. 4. Find the words [11].

c) Match the sentences, true or false Incorporating exercises to choose between true and false and matching sentences is intended to reinforce the basic meaning and information in the text, as well as to encourage specialized vocabulary within the text [11].

TABLE III. MATCH THE SENTENCES [11]

№	Sentence-A	№	Sentence-B
1	This is a reasonably common neckline that is found	1	shoulders and neck of the wearing

No	Sentence-A	No	Sentence-B
2	Scoop necklines are ideal for a slightly	2	where the shoulder ends
3	A very modest neckline that is ideal for	3	more flirtatious out fit
4	They normally hangover the arms below	4	those situations
5	This is an ideal neckline to accentuate the	5	on both tops and dresses





TABLE IV. TRUE/FALSE[11]

No	Put a tick () to show whether each sentence is TRUE or FALSE.	T	F
1	A keyhole neckline can have two different meanings		
2	Plunging neckline is rarely seen in less formal attire.		
3	A Boat Neck is a much wider neckline		
4	Neckline has become increasingly uncommon.		
5	Scoop necks are very similar to a 'U' cut		

d) Write the name of pictures from the text

Includes exercises for working with pictures that fit professional vocabulary to stimulate activities such as composing sentences based on pictures, creating dialogue, and comparing new words in text with pictures. When a teacher walks through a task and identifies a common mistake made by a student, the teacher can work closely with the student and encourage them if the student tries to find the mistake but is unable to do so. Students' inspiration from the teacher and the teacher's progress in the students' skills, as well as the interesting completion of the exercises, are the main motivations for the teacher to prepare well for the lesson [11].

TABLE V. WRITE THE NAME[11]

No	Write the name of pictures from the text		
1		2	
3		4	

e) Unscramble the words



Fig. 5. Drawing with names [7].



Fig. 6. Drawing with names [7].

According to the professional English curriculum, word ordering exercises are included to teach students to spell new professional terminology correctly.

Boosm, Mietsr, Cygaelae, Pgluning, Deeep, Blrury, Elgeant, Hvaengor, Hltear, Srtiikng

In addition to drawing according to the professional English program, the students also made small-scale works, which became a great experience in their sewing, design and embroidery techniques [7]. Satisfaction research clearly shows that students and teachers, became part of a training program that was very inspiring in terms of creativity and practice.



Fig. 7. Making small-scale of works [7].

There are a test sample of a mini-shape of a skirt design, which is widely used by women, to create a unique image of the garment. As a result of the course, innovative works are emerging.

2) *Memorize the words while drawing and making small-scale of work*

In an experiment to draw a picture of what is expressed in the vocabulary within a given topic to memorize professional vocabulary, 20% of the students answered that it was high residual, 13% easy to memorize, 3% difficult, 57% interesting, and 7% moderate. 90% of the respondents said that giving them a task to memorize professional vocabulary in accordance with their skills allows them to learn and motivate.

Memorize the words while drawing

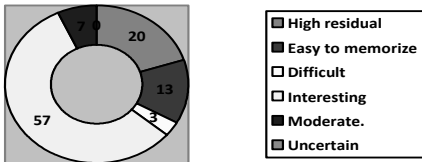


Fig. 8. Memorize the words [7].

3) *Integrate English lessons with other professional curriculum*

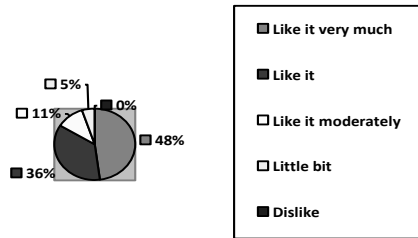


Fig. 9. Integrate English into professional curriculum.

This graph shows that 48% like it very much, 36% like it, 11% like it moderately, and 5% a little bit. This leads to the conclusion that in the future, it is necessary to integrate English into professional courses at universities.

4) *Average grade point for the 2011-2013 academic year [6].*

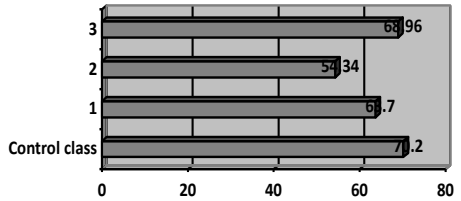


Fig. 10. The average grade of three years of study evaluation-2.

In the 2011-2013 academic year, English language training was provided based on the translation of short texts also without any professional manuals, only information was collected from the online environment and the words the professional terminology were explained to the students using a projector[6]. The graphic shows that the results are very low, only 1.24% higher than average. The average grade of C indicates the need to develop and introduce professional textbooks.

5) *Average grade point for the 2012-2014 academic year [6].*

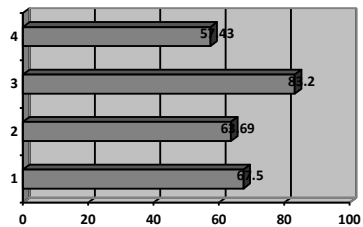


Fig. 11. The average grade of three years of study evaluation-1.

Experiments conducted in the 2012-2014 school year showed that the average grade of the control class was 14.54% higher than the highest grade of the normal class[6]. This suggests that it is more effective to use professional terminology in English lessons, and to use new words in sentences and dialogues in the form of role-plays. It was also 11.39% more effective than the average for the 2011-2013 school year.

1) *Average English language assessment for the first term of the 2019-2020 academic year*

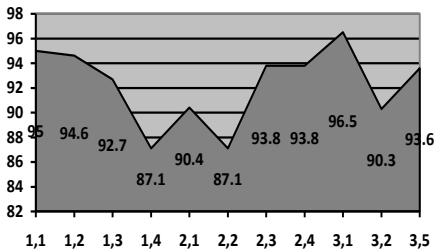


Fig. 12. The average grade of the last semester of study evaluation

In the first half of the year, the average score was 92.2% when the English language curriculum was developed in conjunction with the professional curricula of the university, and textbooks and manuals were developed and tested. This graph shows a dramatic change in the quality of education.

III. CONCLUSION

Based on our research on "Incorporating Continuity between Professional Subjects into the English Curriculum", we developed a detailed curriculum in conjunction with other professional curricula in collaboration with professional teachers of design theory and methodology. Experiments and research on professional English teaching methods have been successful. This is one of the most important issues for professional English teachers.

We have developed an English textbook for undergraduate students majoring in fashion design. The possibility of teaching English based on textbooks was studied, as a result, professional English language training provided them with the professional vocabulary of design and laid the foundation for research.

It is necessary to further improve the English language teaching methodology for professional fashion design and introduce it in university curricula. Educational institutions and communities that provide training not only in the field of design, but also in other innovative fields, should regularly develop textbooks and manuals that contain the content and concepts of the innovative field.

Creative assignments by students in accordance with the professional English curriculum had a positive effect on the learning outcomes and created the conditions for innovative work. Professional English training is more focused on the pragmatism than theory, and we believe that this professional English training is effective and extremely useful.

ACKNOWLEDGMENT

I express my gratitude to B. Mungunkhulug, Ph.D., Associate Professor, who encouraged me to do research work, G. Tungalag Ph. D, Director of the Mongolian Fashion Design Institute, who provided financial and

emotional support for the publication of Fashion design English textbooks. Above all I would like to express my deep gratitude to Professor D.Nyamjav, Ph.D., Sc.D who mentored and supported me in challenging times.

REFERENCES

- [1] Ayar, Z. & Yangin-Ekşi, Y. (2019), "Continuing professional development options of foreign language school directors", *International Online Journal of Education and Teaching (IOJET)*, 6(3), 707-721.
- [2] Azhar, S. M. & Shahid, A. (2014), "Sketching effective faculty professional development framework", *Asian Journal of Business Management*, 6(2), 118-123.
- [3] Baird, Alexander, (1976), "The study and teaching of literature", *ELTJ*, 30,4, 221-6. Google Scholar
- [4] Batbaatar.D (2012) "Opportunity to motivate students to learn English using professional learning materials" unpublished report
- [5] Batbaatar.D (2012) "Orientation to Teaching English to Professional Students" unpublished report
- [6] Batbaatar.D (2014) "Opportunities to introduce fashion design English to English training", Research paper №14, Orkhon University, 2014
- [7] Batbaatar.D (2016) "Methodological issues of closely linking the content of professional English courses with other curricula" (on the example of professional design), Research paper №16, Orkhon University 2016
- [8] Batbaatar.D, Fashion design English-1, UB 2016
- [9] Batbaatar.D, Fashion design English-2, UB 2016
- [10] Batbaatar.D, Fashion design English-3, UB 2016
- [11] Batbaatar.D, Fashion design English-4, UB 2016
- [12] Batbaatar.D, Fashion design English-5, UB 2016
- [13] Batmunkh.Ts and Erdenemaam.S, "Theory and methodology of foreign language teaching", UB, 2014
- [14] Batmunkh.Ts, "Theory and methodology of teaching foreign languages", UB, 2008
- [15] Bazarraghaa.B, "Comprehension of language", UB, 2004
- [16] Burmaa.Ts and Bayanjargal P, "Methodology of Teaching English", Ulaanbaatar, 2012
- [17] Burmaa.Ts, "Methodological research to teach English language reading skills to students", Doctoral dissertation, UB, 2011
- [18] Chuluundorj.B, "Introduction to the study of Mongolian language in parallel with non-native language", UB, 1999
- [19] "Collaborative Learning ISS Proceedings", 2013, Page 9
- [20] Demid.B, "Improving foreign language teaching methodology based on the text", Doctoral dissertation, UB, 1998.
- [21] Galsan.S, "Linguistics and other aspects", UB, 2008
- [22] Gurbazar.R, "Fundamentals of translation theory and practice", UB, 1996
- [23] Hajiduren.N, "Principles of foreign language teaching", UB, 1998
- [24] Ichinhorloo.Sh, "Training methodology reform", UB, 2009
- [25] Khishigdelger.B, "Foreign language teaching methods, theory and application", UB, 2015
- [26] Luvсандорj.Ts, "Curriculum development and educational standards", UB, 2004
- [27] Mira.N and Bumaa.Ts, "Problems of English language education and solutions", UB, 2009
- [28] Mira.N, "Theoretical and methodological issues of teaching English to secondary school students", Doctoral dissertation in Education, UB, 2003
- [29] Mónica Rodríguez-Bonces, "A basis for the design of a curriculum incorporating music and drama in children's English language instruction", *Issues in Teachers' Professional Development*, 19(2), 203-223.
- [30] Narantsetseg.M (2016) "Improving the learning process using professionally-oriented Russian language textbooks", Ph.D. thesis
- [31] Nyamjav.D, "Theory and methodology of foreign language teaching", UB, 2009

- [32] Oyun.B, "Exploring the possibility of using game methods in Russian language teaching in secondary schools", Doctoral dissertation in Education, UB, 2006
- [33] Richards, J.C. (2001). "Curriculum Development in Language Teaching", Cambridge: Cambridge University Press.
- [34] Sirajul Munir, "Turning Classroom Project into Textbook Design in English for Specific Purposes Subject", *Dinamika ilmu*, Volume 19(1), 2019
- [35] Sukhomlinsky VA, "One hundred tips for teachers", UB, 1985
- [36] Tsedev.Kh, "Ways to increase professional terminology in foreign language lessons", Page 180
- [37] Tuya.Sh, "Modern methods and technologies of foreign language teaching", UB, 2010

Education in Pandemic Crisis Implementation via ICT Online Technologies

Cyryl Koshyk

*Director of Technology, AI & Global Expansion (ICT & Innovation Department)
The Kyoto College of Graduate Studies for Informatics*

Kyoto, Japan
cyryl@kcg.edu

Abstract—Due to recent unpredicted COVID-19 pandemic, the worldwide global outbreak halted the world still. Education sectors were deeply disrupted and tremendously affected. The situation, forced nearly all schools and universities to rapidly adopt new ICT technologies, shifting into online technologies, adopting them partially or fully. This new modality, provided distance learning and teaching, called Education 2.0. Education 2.0 is online distributed learning for students, regardless of their physical location which may be affected by isolation restrictions and country lockdowns. Time critical assimilation of ICT into education sector became indispensable, in order to adhere side effects of pandemic outbreak of COVID-19.

In Japan, at The Kyoto College of Graduate Studies for Informatics, actions had to be taken rapidly regarding COVID-19, creating never tested before large scaled successful online ecosystem, that provided uninterrupted online based education platform consisting of an all in one learning education system. This included complete distance learning and teaching technologies as: scoring, attendance reporting, multi language support, direct interaction as group or one-on-one, advanced students monitoring.

Keywords—*ICT, Pandemic, Education, Artificial Intelligence, Distant Learning, eLearning*

I. INTRODUCTION

Distribution method for education has changed forever, the aftermath of COVID-19 (Coronavirus) will never be forgotten, preparing us today for similar, pandemic outbreaks in the near future, where ICT will be crucial and break major ground for all education sectors.

ICT (Integration of Information, Communication, and Technology) has long assisted school and universities - staff, teachers and professors, to replace traditional teaching methods with technology-based teaching and learning tools and facilities. While this process has been slow, at the beginning of 2020, the escalating and exponential infections of COVID-19 (Coronavirus) worldwide, forced all schools and universities to resume partial or full operations via ICT and specifically usage of online platforms, teachers professors and school staff had to quickly learn such systems, no matter their backgrounds or knowledge. By utilizing and adoption of ICT, education has been resumed.

In Japan, ICT is considered as one of the main elements, transforming the country into future development, with a strong focus on online eLearning systems and platforms. Technology-based importance in learning and teaching it is becoming more present in schools.

In 20th century education has changed rapidly with the development of learning technologies.

Technologies can now deliver easy to access, proactive and comprehensive learning and teaching environments.

II. EDUCATION 2.0

As of 2020, students have higher expectations, on integrating ICT into classrooms.

Many researches has proven that usage of ICT in the process of learning and teaching, can greatly improve students achievements, as well as technology based education can be useful in – increasing creativity and thinking skills.

New generations are born and have grown up with these technologies. They are defined as “digital natives”. As a result, the younger the students, the tendency for them to have a much higher interest and demand for strong ICT integration.

Current online systems provide easy, intuitive learning factors, giving confidence to professors, and engaging students more into achieving greater accomplishments.

Professors express high confidence and competency in using ICT to create deeper integrated forms in their classrooms. When used well, content can become richer, and allow for better visual explanations. ICT has to power to offer state of the art interaction, and is now available even on portable mobile devices such as – phones or tablets.

III. ADOPTED TECHNOLOGIES

Portable mobile device hardware and processor advancements, allow for the possibility of highly interactive learning without the need of personal computers. At KCG (The Kyoto College of Graduate Studies for Informatics) we have fully adopted various online platforms, systems and services which are fully supported on mobile devices, if no computers are present.

Current following technologies and platforms were used in online distant teaching and virtual classrooms:

- Artificial Intelligence auto translation services provided by Google - ML AI
- DeepL (www.deepl.com) for human like AI translated text content for online courses.
- Zoom (www.zoom.us) for live interaction and attendance monitoring

- YouTube Live (www.youtube.com) backed by Google cloud servers, for live 4k streaming
- Slack (www.slack.com) and Discord (www.discord.com) for mass interactive multi chat with students
- UNASENSE (www.unasense.com) Cutting edge, worlds first Artificial Intelligence online platform specifically designed for education
- dotCampus LMS (www.dotcampus.com) for publishing, posting, archiving content
- Custom written PHP powered modules for interactive quiz, tests and monitoring, served by Linux operating systems in the cloud, provided and hosted by Google Cloud.
- CDN (Content Delivery Networks) provided by CloudFlare (www.cloudflare.com), for fastest possible delivery to countries outside of Japan, ensuring steady and fast hosted content.

By mixing all these technologies together, a new learning system was provided for complete uninterrupted teaching and learning solution.

IV. CONTENT PREPARATION

For content preparation, screen capturing software was used for easy technical adoption for all professors (irrespective of age groups or ability with screen capturing/streaming knowledge. Software such as Screen-O-Matic (www.screencast-o-matic.com), and FastStone Screen Recorder (www.faststone.org) were employed.

Professors having access to PC based stationary computers or laptops equipped with Windows 10, additionally offered already built-in XBOX Game Bar feature, allow for high quality offline video content preparation, without the need of additional software. Professors were trained in groups and one on one, via online tutorials both in Japanese and English (multi language).

All school members, staff and professors were allocated small space in their locations, used green screen material backdrop mounted on wall or tripods, in order to display background elements on screen. "Green screen" is a known technique, normally used in TV stations for broadcasting as well as in feature films productions of visual effects, allowing green screen material to be replaced and instantly turning any wall into fully "transparent backdrop". This allowed for static pictures or animated videos to be displayed directly behind the speaker.

Powerful multi language open source software OBS (Open Broadcaster Software www.obsproject.com) was used to create virtual set, basic or complex containing multi-layered visual elements such as - pictures, charts, videos, giving more control of content placement, compared to standalone direct feed web camera.

OBS software platform enabled teachers to include live websites with interaction and browsing capabilities, specific full screen or cropped software screen grabs, interactive widgets, live playback YouTube reference videos, PowerPoint Charts and more.

OBS rendered output in form of "Virtual Web Camera" could be feed directly into any streaming software or online platform, as a single video feed at any given resolution (4k, HD).

To improve and provide clear audio quality, teachers used mobile phones as microphones.

WO Mic (www.wolicheng.com) app and software was used as virtual microphones. From in depth testing, we concluded that, mobile phone microphones provided superior quality with very low audio noise compared to even higher end webcams built-in microphones.

VI. CONTENT QUALITY CONTROL

To deliver the highest quality content possible where sound, verbal and visual communication were key factors of distant teaching, equipment such as camera and microphone were taken into consideration. We tested multiple hardware and devices and concluded mobile devices, specifically phones delivered the best quality, overall portability, and were already distributed to all faculty staff.

Technically benchmarked [1], mobile phones are equipped with much higher CMOS imaging sensors, then normal computer or laptop cameras. Where 4k and even 8k resolutions can be achieved, rendering high quality image quality, making it a main choice in our eLearning course teachings.

Performing well in low light conditions, mobile microphone sensitivity delivers high quality sound. Some teachers also used Bluetooth devices for more portability.

All performed well, and are highly suggested for any type of video/audio content recordings and online live streaming.

VI. INTERNET REQUIREMENTS

Many students without access to computer labs relayed solely on their own mobile devices (phones, tablets). All the school's eLearning content was accessible even on lower bandwidth networks such as 2g and 3g.

4k high resolution video streaming feed was automatically downgraded to lower resolutions, depending on viewing device, 4k for regular broadband internet (Cable), HD 1920x1080 for 4g, LTE, and 1280x720 for 3g networks and lower.

All live video content while streaming was also recorded and storage locally on teachers drive. This was, later uploaded and archived for offline viewing into dotCampus online eLearning LMS platform.

VII. CLASSROOM INTERACTION

Virtual classrooms greatly differ from traditional ones (real presence in physical classrooms).

However, interesting patterns could be observed in virtual classrooms. Isolated "single-out" students seem to focus better, as they felt more responsible and more in control, while in their own private environments, students were less vulnerable, stressed and more open to discussion.

Better performing students were interacting and active more in online chat rooms, delivering higher quality homework and assignments.

All students class hours were tracked by the online platform dotCampus LMS; email and phone push notifications were sent to inform them of next upcoming lessons.

E-mail communication didn't satisfy our expectations. Students equipped with personal computers tend to have response that were usually delayed. We shifted into mobile devices, which were key in active and fast responsive communication.

Teachers and students used mobile apps for mass multi chat instant communications such as Slack and Discord at all times. Students were assigned to specific class groups, few contributing students were also assigned as administrators to filter chat content, and monitor all chat activities.

Additionally, the Discord app allowed for voice and webcam communication.

Online hours lesson were done via Zoom software app for live feed streaming.

Students using laptops or personal computers could share their screens directly with teachers, if help or support was needed. Teacher could access and control the student keyboard and mouse, helping in specific tasks.

Many students used both mobile devices for direct communication such as video, voice and chat and personal computer online or offline as work machines.

In mandatory courses and classrooms exceeding 250 students, to provide highest quality streaming, we used YouTube Live, with outputted low latency in video streaming delivery. At most a 5 second delay was noted.

From our testing, we conclude that YouTube Live is a solid platform for mass streaming. If one-way video streaming is sufficient for specific lessons, performance was superior and stable, and able to handle hundreds to thousands of students at once. Additionally YouTube Live offers up to 8 hours nonstop recording directly to YouTube, backed by Google servers, downloadable, with built in on the fly auto translation into over 30 languages.

VIII. ARTIFICIAL INTELLIGENCE FOR EDUCATION

The Kyoto College of Graduate Studies for Informatics is the world first university to fully utilize and adopt it's own, 100% online based artificial intelligence platform UNASENSE (www.unasense.com). The system which was originally designed and started by Prof. Cyril Koshyk. This powerful and flexible system is able to create standalone mobile AI systems and programs made by students. It was first tested for medical AI programs and content, detecting skin cancer on mobile devices, at Etugen University (www.etugen.edu.mn) in Mongolia.

UNASENSE AI has been deeply integrated into school operations and routines, including assessment of student knowledge and skill level. The platform will be available to universities and schools around world, after all features has been added and final testing phase has been conducted and complete.

IX. MULTILANGUAGE SUPPORT

Due international students' presence, live content was prepared in multi-language release and streamed by Google's

YouTube Live, which enabled live auto translations into different languages. In The Kyoto College of Graduate Studies for Informatics, international students were able to watch video streaming in their native language. Additionally, AI based DeepL services was used for preparing downloadable PowerPoint presentations in multi languages.

All live streaming content after online airing had embedded subtitles.

By using Google ML speech to text [2], audio spoken language could be embedded into the video stream as well.

Artificial intelligence has dominated speech to text and text to speech engines for years now, it is a great extension to any eLearning platforms.

X. ATTENDANCE MONITORING CHALLENGE

During the pandemic, where the online world was the only safe way of communication with students, eLearning class attendant monitoring has been a challenge, whereby students were not physically present in classrooms.

The Kyoto College of Graduate Studies for Informatics designed its own proprietary system for attendance monitoring. Students logged to the learning system, using their student unique ID number.

Additionally, in some classes, "Face ID" AI system were applied, by using custom built artificial intelligence based - face recognition system. Some students didn't have access to computer webcams, so mobile devices (phones, tablets) were used instead.

As mobile devices are multi-sensory devices, equipped with cameras and microphones, "Face ID" AI system directly scanned students faces from their phone, and recorded online attendance.

In conclusion, mobile devices are most versatile form for attendance monitoring no matter location or internet bandwidth speed.

XI. ASSIGNMENTS DELIVERY AND ONLINE GRADING

After completing their assignments, students directly uploaded their assignments in the form of digital files into dotCampus LMS online platform at specified deadlines. Teachers could then directly download the files as a single ZIP file containing all student assignments and review them.

Assignment uploading is supported by all devices in all forms personal computers and mobile devices (phones, tablets). In case of revisions, or additional comments, teachers were able to log directly to student' computers via ZOOM or TeamViewer, encrypted bi-directional platforms, and communicate directly with students in one on one sessions.

XII. CONLUSSION AND FEEDBACK

We performed an in depth student questionnaire online evaluation. Our outcome reports showed that 76% students found eLearning distant learning compared to traditional learning to be very good or good. Less then 5% of students found it technically difficult however they learned quickly how to use such systems.

Overall, we found that online courses and classes can provide a high engagement rate.

Students primary preferred choice of accessing eLearning content was by using mobile devices.

Strong focus should be given, to visual format of delivery, and content optimized for slower internet (mobile 3g,4g,LTE) for such devices. Most of our video content was delivered in vertical screen format, which allowed for simultaneous live chat communication while video streaming was performed.

Vertical and square format videos are well suited for eLearning delivery into mobile devices.

Teachers using mobile devices for their high-quality cameras and microphones render superior quality over most personal computer webcams; it also makes content more portable.

The learning curve is not complex both for teachers or students. We found that within a week, online eLearning systems can be learned, allowing students to navigate, post content, and enable overall interaction.

“Virtual office hours” were provided to all students. Professors, and staff specified hours and days where they can be contacted online, for direct one on one communication for students to seek advisory, support and ask questions.

Covid-19 (Coronavirus) has challenged education. Students may prefer online over physical schools, where artificial intelligence has been adopted and utilized. In 2021 we all will experience Education 2.0. More possibilities will exist by using technology, resulting in new rules, requirements, and new policies. The future edu has begun not as a choice, but as a path of transformation.

REFERENCES

- [1] Veli-Tapani Peltoketo, “Mobile phone camera benchmarking: Combination of camera speed and image quality”, DOI: 10.1117/12.2034348, January 2014.
- [2] Tim Ashwell, J.R. Elam, “How accurately can the Google Web Speech API recognize and transcribe Japanese L2 English learners’ oral production”, DOI: 10.29140/jaltcall.v13n1.212, 1892, April 2017.

Risks in the Educational Sector: Theory and Practice

Enkhtuvshin Jambaldorj

Sector for higher and professional education research

Mongolian Institute for Educational Research

Ulaanbaatar, Mongolia

enkhtuvshin@mier.mn

Abstract - This study explains the relationship between academic achievement and individual, family, and social life, identifies the causes of risks in the education sector, considers risks in relation to philosophical categories and systematic laws, develops risk identification and classification models, and formulates educational risks using this model. The issues related to the sector policy will be evaluated in relation to the research results and suggestions on what to do next will be considered.

Keywords: cause-effect, risk, system, risk classification, risks in education, risk management in education.

I. INTRODUCTION

The academic performance of Mongolian secondary school students is not in the level of satisfactory. For example:

- According to the international TIMSS and PIRSL scores, primary education is 37.8-41.5 percent and basic education is 22.9-28.5 percent, which is 7 percent lower than the international average; [10]
- In the general entrance exam held in 2019 only 28-37 percent performance in subjects with the largest number of examinees (Mongolian language, Mathematics and English); [11]
- According to the quality assessment of secondary education (Ministry of Education, Culture and Science. 2019), 63 out of 100 examiners have shown dissatisfied results; [11]

These outcomes, which are the first gateway to the education system, continue to have a negative impact not only on the quality of secondary education, but also on youth employment, quality of life, economic and social development, and competitiveness. It is still attracting attention that in “2019 the Mongolia's competitiveness ... ranks last in terms of indicators directly related to the education sector, such as skilled engineers, pollution issues, higher education, and knowledge exchange” [12] “There is currently no publicly accepted understanding of risk in education. Often, the risk is seen as a manifestation of uncertainty, damage to the operation of an educational institution, or an undesirable situation or outcome”. [1] All the data above, the researcher's conclusion and position

indicate that the Mongolian education sector is in a risky situation. Identifying the root causes of such consequences (risks) from the system is not only a challenge for the education sector but also for Mongolian society, but to reduce risks in the education sector, protect against potential risks and according to V.V. Razuvaev reduce “the likelihood of unintended consequences” [2] and improving the output and performance of the education sector has become a current need.

A. Goals

Contribute to the development of risk mitigation measures in Mongolia's education sector.

B. Objectives

- 1) Compare the theoretical formulas proposed by researchers on risk;
- 2) Formulate risks and highlight specifics in the education sector;
- 3) Identify the root causes of educational risk;
- 4) Compare theoretical formulas with practical examples;
- 5) Propose options for implementation at the national level;

C. Literature review

The concept of risk dates back hundreds of years and has the root back to antiquity. “In the sixteenth and sixteenth centuries, the basic concepts of opportunity and probability were developed, as well as gambling, in the seventeenth and eighteenth centuries, the theory of probability and statistics, in the nineteenth and twentieth centuries, progression and regression analysis. From the beginning of the twentieth century, when the theory of the game emerged, the concept of a new modern risk was formed, researchers say. [13] In the 1930s, A. Marshall and A. Pigou created a neoclassical flow of risk in the economic field, intensifying theoretical research.

In our country, banking and insurance companies have been implementing risk management and risk research since the mid-1990s, and government implementing agencies have been implementing risk management since 2006. The Education Inspection Agency (Education Inspection Agency is part of the government) uses checklists to identify risks associated with the material environment of secondary

schools and kindergartens. Apart from this, no risk studies have been conducted in the education sector.

Information on risk theory and methodology is often sourced from external sources, and government agencies include consulting services from the Institute for Risk Management in the United Kingdom (IRM), the Association of Insurance and Risk Managers (AIRMIC), and the National Forum for Public Risk Management (ALARM) Organizations. In addition, the ISO GUIDE 73: 2002 Risk Management - Vocabulary standard issued by the International Organization for Standardization has been used as a reference document. The standard (This standard is accepted in many countries, especially in all EU countries, including Russia, and in the Commonwealth of Independent States, such as Canada and Australia) states that risk is a combination of both the probability of an event (occurrence) and its consequences, both positive and negative (Risk Management Standard © AIRMIC, ALARM, IRM: 2002, translation copyright GDNT: 2007). The social sectors consider risks depending on the nature of their functions and activities under the law. For example:

- In many areas, such as security and the environment, “negative” “consequences” are defined as risks (International standards state that this is only the case in the security sector);
- In the legal field, “the likelihood of an increase in potential adverse effects”;
- In the field of civil law, “damage caused by natural and man-made disasters and dangers, regardless of human will [3];
- In the public service sector, “risk is the occurrence of a situation in which a service cannot be performed or is impossible to be fulfilled in accordance with a planned or obligation”, In the field of state control, “risk means that the failure to adequately fulfil the responsibilities of state control imposed by law will lead to social, economic damage and other adverse effects”. In the field of environment, it is stated that “there is a possibility of adverse effects on animals, plants, human health and the environment” (Introduction to the United States Agency for International Development (USAID) Economic Reform Project);

In the economic sphere, risk is defined as “risk that includes ... events that may or may not occur. When this happens, there are three economic consequences: negative (defeat, loss, failure), zero, positive (win, gain, profit)”. [4] Professor V. V. Razuvaev, a member of the Russian National Academy of Economics, discusses many aspects in his book. For instance the risk is:

- Percentage of potential losses and losses and damage;
- Probability and extent of unintended consequences;
- A combination of probabilities and consequences;
- A combination of three scenarios, the probability of a scenario and its consequences;
- A two-way combination of “event-consequence” and its associated “uncertainty”;

- Uncertain consequences of actions or events related to human values;
- A combination of opportunity and loss; [2]

Social risk is defined as “deviation from the norms of basic social indicators for individuals, groups, and society as a whole, and the basic indicators include unemployment, aging, death, disability, orphanhood, and divorce”. The survey results are:

- Risk is subject to (1) cause-and-effect patterns and systemic laws, (2) probabilistic in nature;
- Risk is a time-dependent continuous phenomenon that takes on a positive, negative or zero value at a given moment;
- Social sector risks are considered in relation to basic social indicators;
- Educational risks in Mongolia are largely unexplored.

D. Methodology

Research should follow as Colin Robson puts it, "to build a details and in-depth knowledge of one or a few interrelated examples." [5] and exemplified research strategies and system approaches. As the procedure;

- 1) Collect examples and analyse evidence related to output, outcome, and impact in education system;
- 2) To study the theoretical formulas proposed by researchers on risk;
- 3) Explain risks in terms of cause-and-effect, systematic patterns, and develop a classification model;
- 4) Identify educational risks based on the model;
- 5) Explain and evaluate the education system and the model of personal and social development in terms of risk theory;
- 6) Formulate ways and solutions to reduce risks in the education sector.

II. RESULTS

From the findings of the survey:

- Causes are the effects of systemic influences;
- The process of cause and effect is continuous;
- The state of the system at the moment is both a cause and a consequence;
- It is logical to assume that the process of causation is subject to the law of transition from quantity to quality.

The above-mentioned philosophical concepts will help to explain risk in education.

The Internationally Recognized Survey (TIMSS), at the national level, shows that students' academic achievement is very poor, indicating a risky situation in the education sector. The knowledge, skills, and attitudes of learners are the underlying causes of the quality of life, happiness, and development of a country, as “risk” itself is the cause of other consequences. According to researchers, “lack of knowledge and skills is the cause of poor human resources, poor human resources are the cause of poor wages, and poor wages are the cause of poor living conditions, on the other hand, general culture and moral weakness (risk), poor physical development. The risk of all aspects of human

development, these two risks create the risk of not being able to take their rightful place in society” [6].

Students' knowledge, skills and attitudes are the primary cause of civic development on the one hand, and a means of adapting and communicating with the external environment (family, school, community) on the other. In this regard, the theoretical conclusion is that “everything that exists contains a clear signal about its nature, origin and environment ...” [7] Every living thing adapts to endangered environments, whether they exist or not, develop or perish. Therefore, the evolution (development) of any individual (In Buddhism, all living beings are considered) is determined by its ability to adapt to a risky environment. Most of our students have not learned such skills. What is the reason for this?

Key factors influencing the outcome of the education system are teachers, programs, learning technologies, and budgetary and financial inputs. It is the responsibility of the state to compile, develop, allocate, and improve efficiency. The state makes decisions (policies, laws) and fulfills its responsibilities. Therefore, education policies and decisions are the starting point and key variable that affects academic achievement. Using these inputs in the education system, the learner undergoes a qualitative transformation, creating the following “consequences” for society.

- 1) Learner's knowledge, skills, and attitudes toward output.
- 2) The quality of life of the citizen (family) on the outcome.
- 3) The country's level of development and competitiveness on impact.

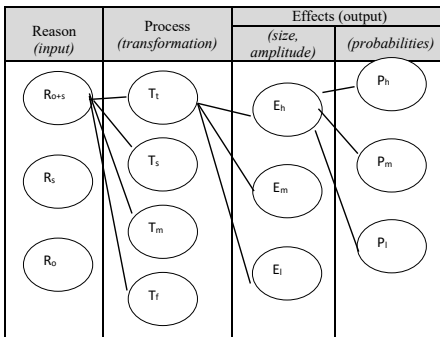
To summarize:

TABLE 1. EDUCATION SYSTEM MODEL

Input	Transformation process	Output	Outcome	Impact
Reason	Process	Effects		
The student	Education sector	Changes in individual	Changes in the family	Change in society

When the operation of the system brings positive results at every stage, a knowledgeable and capable citizen is developed, the well-being of the citizen is ensured, and thus the well-being of the society is ensured. Otherwise, the guarantee of the well-being of the "citizen" will be lost and the country will fall into decline. This correlation suggests that the primary cause of positive and negative consequences in any society is the state of education and the education system (risk situation). Therefore, researching and diagnosing sector risks and preventing potential threats is a policy issue. The education sector is a complex system that covers a wide range of social life under the influence of many external and internal factors. Therefore, a risk identification and classification model has been proposed and an attempt has been made to identify industry risks accordingly.

TABLE 2. RISK CLASSIFICATION MODEL



This includes:

- R_o - objective reason
- R_s - subjective reason
- R_{o+s} - combined (objective and subjective) reason
- T_t - time of the process
- T_s - space of the process
- T_m - ability to manage the process
- T_f - manifestation of the process
- E_h - large amplitude
- E_m - medium amplitude
- E_l - small amplitude
- P_h - high probability of occurrence
- P_m - medium probability of occurrence
- P_l - little probability of occurrence

In this model, educational risk is defined as $R_{o+s} \rightarrow [T_t + T_s + T_m + T_f] \rightarrow [E_h] \rightarrow [P_h]$, expressed in words:

- 1) for a combination of reasons;
- 2) medium and long-term exposure;
- 3) latent;
- 4) the magnitude of the consequences is large (insurmountable);
- 5) manageable;
- 6) Is a high probability social risk.

As mentioned above, “public policy decision”, which is the starting point of the system, is a subjective cause but a decisive one. Let's look at two related facts.

- 1) In the last 30 years:
 - Education law 12 times
 - 6 times the structure and type of school
 - Primary and secondary education standards 4 times
 - training program 5 times
 - the curriculum 11 times have been changed [8]
- 2) In the field of education:
 - Guidelines for government change in the education sector - 1
 - Master plan - 1
 - National program - 11
 - Sub-program - 3
 - Sector development step-by-step program - 2 was approved and implemented [14]

A sufficient number of policy documents have been adopted and a sufficient number of changes have been made. But, there is no independent body or human resources to analyze these conflicting decisions. "Risk awareness can be performed by external consultants, but a well-communicated, regular, and well-organized internal approach is likely to be more effective. It is essential that the risk management process be owned within the organization". (Risk Management Standard © AIRMIC, ALARM, IRM: 2002, translation copyright GDNT: 2007) Unfortunately, this international principle has not been implemented.

III. DISCUSSION

- Risks in the Mongolian education system have become one of the real causes of risks for Mongolian families and Mongolian society;
- Loss of continuity of government policy on education due to political instability; foreign education was simply imported; There is reason to believe that scientific research and undiagnosed risk-making policies and decisions have created a risk situation in the education sector. There is research evidence to support this. "One-third of the population is nomadic herders, and one-third is poor and extremely poor, but much of Mongolia's education reform is based on the experience of a high-income, sedentary country. Mongolian policymakers are actively involved in the policy lending process" [9];
- According to the agent's theory (the theory that, the body that oversees the implementation of parliamentary decisions is independent of the government) there is no independent entity to monitor the implementation of decisions on education issues in the interests of all citizens;
- Improving the capacity of Mongolia's policy research institutions on education and establishing and developing a risk management and control system is a pressing issue;
- Risks in the education sector need to be studied in depth at the institutional level.

IV. CONCLUSION

- 1) To establish a professional, independent "institution" of risk management independent of the executive, which exercises national oversight of education, reports to parliament;
- 2) Establish an independent policy research unit within the structure of educational research and methodological institutions and increase research capacity.

REFERENCES

- [1] R.A.Rasulya, "Problems of risk research in education", Scientific article. vol 3, Kazan RA Federal University, Russia, 2016, pp 2.
- [2] V. V. Razuvaev, "Theoretical definition of the concept of risk" // Modern scientific research and innovation, URL: <http://web.snauka.ru/issues/2016/09/72007>.
- [3] S. Narangerel, "Legal dictionary", Ulaanbaatar: 1 rd ed, 2007, pp 626.
- [4] B. Tserendorzh, "Risk management" Ulaanbaatar. T&U printing LLC, 2008, Page 11.
- [5] Colin Robson, "Real word research", (1993) Copyright © 2006 "Monsudar", Open Society Forum,Ulaanbaatar, pp 42.
- [6] P.E. Shcheglov, N.Sh.Nikitina, "The quality of higher education. Risks in the training of specialists", University Management. 2003, vol 24, pp 46-59.
- [7] D.Byambasuren," The wheel of the universe" Ulaanbaatar: Urlakh erdem LLC, 3rd ed, 2009, pp 30.
- [8] J.Enkhtuvshin, "On the reform of the education management system" 2017, Institute of Education. Research paper. vol 22. pp 43.
- [9] Gita Steiner-Khamsi, Ines Stolpe. "Educational Import: Local Encounters with Global Forces in Mongolia", Ulaanbaatar. Admon, 2003, pp 2.
- [10] Minister of Education, Culture and Science, "Concept of quality reform of primary and secondary education", 2013 <https://www.meds.gov.mn/>.
- [11] Educational Evaluation Center under the Ministry of Education and Science <http://stat.eec.mn/>.
- [12] Centre for Economic Policy and Competitiveness Research. <https://ecrc.mn/>.
- [13] Historical study of the development of risk management concepts. Electronic conference. <http://econfrac.ru/>.
- [14] Government of Mongolia, 2010, National Education Program of Mongolia, 2010, <https://www.legalinfo.mn/>.

Sample Model for Selecting State Examination Test Item

Examination test items in Social studies for the 12th grade students of Secondary School

Gan-Erdene Jigjid
Education Evaluation Center
of the Ministry of Education and Science
Ulaanbaatar, Mongolia
Ganaa1023@gmail.com

Ganbat Tsend
School of Information and Communication Technology,
Mongolian University of Science and Technology
Ulaanbaatar, Mongolia
ganbat@must.edu.mn

Abstract—The Education Evaluation Center develops assessment to assess the knowledge and skills of secondary school students and takes state exams every year, and currently it has a database of 23 subjects and 32000 tests. Select test item from the test database with expert's help and takes that year's state exam. To select test items that aren't similar or same as last year's is a very time-consuming process. In addition, a test item is not expected to be repeated in two consecutive examinations. This paper aims to present the experiment results we obtained in developing machine models to reduce human participation, to determine task similarity and to select different tasks from a database and to implement them in item database system of 12th grade social studies students of the Secondary Schools.

Keywords — *weight of a term, test item similarity, experimentation, vector, evaluation*

I. DICTIONARY DEVELOPMENT

5 types of tasks in Social studies include. Following tasks are reported in Mongolian due to usage of Mongolian vocabulary [2]. A task is means that a sample question of test unit except answers. .

D1 = иргэд суралцахаас өмнө хооллож, хувцаслаж, орон байртай байх ёстой

D2 = төрөөс иргэдэд орон сууц өмчлүүлсэн

D3 = иргэдийн ажилгүйдлыг төрөөс багасгах үүрэгтэй

D4 = нийлүүлэлт багасвал барааны үнэ өсдөг

D5 = илүүдэл нийлүүлэлт үнэ багасадаг

English translation:

D1 = citizens must fed, clothed and housed before they study

D2 = the Government has privatized the apartments to citizens

D3 = the Government has to bear the responsibility to reduce unemployment of citizens

D4 = when supply decreases, commodity prices will increase

D5 = excess supply will cause price to fall

A normalization can be used to extract a word stem from a test unit to create a corresponding word dictionary. Table I

A normalization in Mongolian language is not discussed here. Normalization is consisting of stemming and lemmatization [1]. You can find it in our previous article on word normalization published in Mongolian [4], [5].

Normalize source test item by using dictionary will be as follows. Following tasks are reported in Mongolian due to usage of mongolian vocabulary:

D1 = иргэн сурах өмнө хооллох хувцаслах оронбайр байх ёс

D2 = төр иргэн оронбайр өмчлөх

D3 = иргэн ажилгүйдэл төр багасгах үүрэг

D4 = нийлүүлэлт багасгах бараа үнэ өсөх

D5 = илүүдэл нийлүүлэлт үнэ багасгах

English translations:

D1 = citizen study before feed clothe apartment be

D2 = government citizen apartment owns

D3 = citizen unemployment government decrease responsibility

D4 = supply decrease commodity price increase

D5 = excess supply price decrease

Let's consider a task as document.

II. DESCRIBING TASKS AS VECTORS

The term frequency TF of term t in document d is defined as the number of times that t occurs in d , ($TF > 0$) [1]. Construct incidence matrix by term frequency in task (see the Table II). DF - is the document frequency, the number of documents that t occurs in. IDF - is \log weight of term. It is found by the following formula [1]:

$$IDF = \log_{10} \frac{N}{DF}$$

N is the number of documents in the collection (in our case, collection is a test database or test). After that the log frequency weight of term is found by the formula:

$$TFW = 1 + \log_2 TF \quad (TFW \geq 1)$$

See the Table III.

Table I
DICTIONARY

Term ID	Dictionary term /Mongolian/	Source terms /Mongolian/	Dictionary term /English/	Source terms /English/
T1	Ажилгүйдэл	Ажилгүйдлыг	unemployment	unemployment
T2	Багасах	Багасвал, багасдаг	decrease	reduce, decreases, fall
T3	Байх	байх	be	be
T4	Бараа	Барааны	Commodity	commodity
T5	Ёстой	Ёстой	be	must
T6	Илүүдэл	илүүдэл	Excess	excess
T7	Иргэн	Иргэд, иргэдэд, иргэдийн	Citizen	Citizens, to citizens, of citizens
T8	Нийлүүдэлт	Нийлүүдэлт	Supply	supply
T9	оронбайр	Оронбайр, оронбайртай, оронсууц	House	housed, apartments
T10	Өмнө	өмнө	Before	before
T11	Өмчлөх	Өмчлүүлсэн	own	Privatized
T12	Өсөх	Өсдөг	increase	Increase
T13	Сурах	Суралшахаас	study	study
T14	Төр	Төрөөс	Government	government
T15	Үнэ	Үнэ	Price	prices
T16	Үүрэгтэй	Үүрэгтэй	Responsibility	Bear the responsibility
T17	Хооллох	Хооллож	feed	Fed
T18	Хувцаслах	хувцаслаж	clothe	Clothed

Table II
INCIDENCE MATRIX

TF	d1	d2	d3	d4	d5	DF	IDF
t1			1			1	0.70
t2			1	1	1	3	0.22
t3	1					1	0.70
t4				1		1	0.70
t5	1					1	0.70
t6					1	1	0.70
t7	1	1	1			3	0.22
t8				1	1	2	0.40
t9	1	1				2	0.40
t10	1					1	0.70
t11		1				1	0.70
t12				1		1	0.70
t13	1					1	0.70
t14		1	1			2	0.40
t15				1	1	2	0.40
t16			1			1	0.70
t17	1					1	0.70
t18	1					1	0.70

^aIn our case, d is a task.

Table III
log FREQUENCY WEIGHT OF TERM

TFW	d1	d2	d3	d4	d5
t1			1		
t2			1	1	1
t3	1				
t4				1	
t5	1				
t6					1
t7	1	1	1		
t8				1	1
t9	1	1			
t10	1				
t11		1			
t12				1	
t13	1				
t14		1	1		
t15				1	1
t16			1		
t17	1				
t18	1				

By finding the weight of a term as IDF is multiplied by TFW (Table IV) each task is expressed as a real-valued vector [3]. Each task is now presented as vector. In a vector space

Table IV
WEIGHT OF A TASK'S TERM

TW	d1	d2	d3	d4	d5
t1	0.00	0.00	0.70	0.00	0.00
t2	0.00	0.00	0.22	0.22	0.22
t3	0.70	0.00	0.00	0.00	0.00
t4	0.00	0.00	0.00	0.70	0.00
t5	0.70	0.00	0.00	0.00	0.00
t6	0.00	0.00	0.00	0.00	0.70
t7	0.22	0.22	0.22	0.00	0.00
t8	0.00	0.00	0.00	0.40	0.40
t9	0.40	0.40	0.00	0.00	0.00
t10	0.70	0.00	0.00	0.00	0.00
t11	0.00	0.70	0.00	0.00	0.00
t12	0.00	0.00	0.00	0.70	0.00
t13	0.70	0.00	0.00	0.00	0.00
t14	0.00	0.40	0.40	0.00	0.00
t15	0.00	0.00	0.00	0.40	0.40
t16	0.00	0.00	0.70	0.00	0.00
t17	0.70	0.00	0.00	0.00	0.00
t18	0.70	0.00	0.00	0.00	0.00
length	1.772	0.924	1.111	1.159	0.924

with 18 axes of $t1 \dots t18$, documents $d1$ to $d5$ in Table IV, will be the coordinate vector

$$D1 = (0, 0, 0.7, 0, 0.7, 0, 0.22, 0, 0.4, 0.7, 0, 0, 0.7, 0, 0, 0, 0.7, 0, 0, 0)$$

$$D2 = (0, 0, 0, 0, 0, 0, 0.22, 0, 0.4, 0, 0.7, 0, 0, 0.4, 0, 0, 0, 0, 0, 0)$$

$$D3 = (0.7, 0.22, 0, 0, 0, 0, 0.22, 0, 0, 0, 0, 0, 0, 0.4, 0, 0.7, 0, 0, 0, 0)$$

$$D4 = (0, 0.22, 0, 0.7, 0, 0, 0, 0.4, 0, 0, 0, 0.7, 0, 0, 0.4, 0, 0, 0, 0, 0)$$

$$D5 = (0, 0.22, 0, 0, 0, 0.7, 0, 0.4, 0, 0, 0, 0, 0, 0, 0.4, 0, 0, 0, 0, 0)$$

In the last row of a Table, there are length of vectors. The task length is found by follow formula

$$|D_i| = \sqrt{\sum d_i^2} \quad i = \overline{1, 5}$$

III. COMPUTING COSINE SIMILARITY OF TASK

Since each task is represented by a vector in a vector space model, cosine similarity is measured by the cosine of the angle between two vectors. The smaller the angle between two vectors, the more similar are the vectors, and the less similar otherwise. The formula to find the angle between two vectors is shown below [3].

$$\text{cosine similarity} = \cos(\theta) = \frac{\sum_{i=1}^n A_i \cdot B_i}{\sqrt{\sum_{i=1}^n A_i^2} \cdot \sqrt{\sum_{i=1}^n B_i^2}}$$

Where, A_i, B_i - different tasks. A_i, B_i - its coordinates
 Since each document is similar to itself, its cosine similarity is 1. If the cosine value is closer to 0, the two tasks' similarity will be less. The similarity of documents has been found using the cosine formula given below. (See the Table V)
 The three tasks d_1, d_2 and d_3 with the words t_1 and t_2 in the case describe the state exam in vector space,

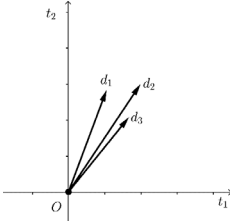


Figure 1. A state exam consisting of many similar tasks

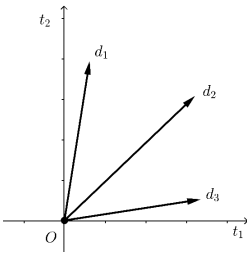


Figure 2. A state exam consisting of less similar tasks

The average value of cosine similarity between other tasks is given in the last column of the Table. The cosine similarity of given documents can be evaluated by the overall average of separately averaged values. Cosine similarity of the given 5 test item-based database is 0.0782, cosine similarity for d_4 and d_5 is 0.342 which means that they are the most similar against each other. It is clearly seen that d_4 and d_5 are

Table V
COSINE SIMILARITY OF DOCUMENTS

\sim	$d1$	$d2$	$d3$	$d4$	$d5$	Average
$d1$	1	0.127	0.025	0	0	0.0379
$d2$	0.127	1	0.202	0	0	0.0822
$d3$	0.025	0.202	1	0.038	0.048	0.0783
$d4$	0	0	0.038	1	0.342	0.095
$d5$	0	0	0.048	0.342	1	0.0974
Average of $d1$ to $d5$						0.0782

least similar compared to $d1$ and $d2$. The content of the tasks also shows the difference. The cosine averages of the given 5 tasks can be ranked in ascending order as follows. (Table VI)

Table VI
RANK OF DOCUMENTS

Rank	Average	Document similarity
1	0.0379	$d1$ The least similar
2	0.0822	$d2$
3	0.0783	$d3$
4	0.095	$d4$
5	0.0974	$d5$ The most similar

^a If the average is close to 1, it is similar to the others. Conversely, closer to zero is different from others.

IV. SOME RESULT OF EXPERIMENT AND CONCLUSION

When we used this model to develop cosine similarity of tasks program to calculate cosine similarity from social studies' 1881 tasks, cosine similarity of test database of tasks was calculated as 0.741 [6]. Also, state exam tasks should be less similar, and the cosine similarity should be to closer to zero. The cosine similarity of test database after removing 800 similar tasks was 0.13. This sample model will be the most suitable to evaluate the performances of similarity measures of selected N state examination task documents and new tasks added to the test database, to make a list of similar tasks, to add the least similar tasks to a test database and to make task clustering by chapter or etc.

REFERENCES

- [1] Christopher D Manning, Prabhakar Raghavan, Hinrich Schütze, "Determining the vocabulary of terms, Scoring, term weighting and the vector space model," in *Introduction to Information Retrieval*, UK: Cambridge University press, 2008, pp. 69, 146, 155, 158.
- [2] Education Evaluation Center, "Sample test of documents," [Online]. Available: <http://itembank.eec.mn/home>.
- [3] Ganbat TS, Sarangerel D, "Fundamental of Information Retrieval in Mongolian", MUST edition, Ulaanbaatar, 2019, pp. 116, 121.
- [4] Gan-Erdene J, Ganbat Ts, "Experiment results of Mongol stemming algorithms in Mongolian," Technical report of the project to improve the quality of tasks by Machine Learning Method, Education Evaluation Center, Ulaanbaatar, January 2020.
- [5] Gan-Erdene J, Ganbat Ts, "Term normalization in Mongolian," Technical report of the project to improve the quality of tasks by Machine Learning Method, Education Evaluation Center, Ulaanbaatar, January, 2020.
- [6] Gan-Erdene J, Ser-Od B, Ganbat Ts "Evaluating Heap's law constants based on a document database in Mongolian," in *Proceedings of MMT 2020*, Ulaanbaatar.

Perception of Lane Curvature Detection for Situational Awareness

Julkar Nine
Department of Computer Engineering
Technische Universität Chemnitz
Chemnitz, Germany
julkar.nine
@informatik.tu-chemnitz.de

Shanmugapriyan Manoharan
M.Sc.Embedded Systems
Technische Universität Chemnitz
Chemnitz, Germany
shanmugapriyan.manoharan
@s2017.tu-chemnitz.de

Mohammad Didar Hossain Sagar
M.Sc. Automotive Software Engineering
Technische Universität Chemnitz
Chemnitz, Germany
mohammad-didar-hossain.sagar
@mb.tu-chemnitz.de

Shadi Saleh
Department of Software Engineering
Technische Universität Chemnitz
Chemnitz, Germany
shadi.saleh
@informatik.tu-chemnitz.de

Wolfram Hardt
Department of Computer Engineering
Technische Universität Chemnitz
Chemnitz, Germany
wolfram.hardt
@informatik.tu-chemnitz.de

Abstract—Lane curvature detection from the highway is one of the fundamental requirements for both autonomous driving and advanced driver assistance (ADAS) based applications. Curvy lane is a crucial factor that plays a significant role in the increasing number of road fatalities worldwide. Detection of the curvature radius of the lane and providing a warning message for upcoming curvy road conditions have the potential to improve driving safety. This paper presents an efficient algorithm for lane curvature detection combining multiple image processing techniques. The proposed algorithm has been implemented in Python and evaluated on a Raspberry Pi 3 B+ environment. It can detect and calculate lane curvature as well as provide warning messages for curvy road conditions.

Index Terms—Raspberry Pi, Binary Thresholding, Gradient, Bird's-eye View.

I. INTRODUCTION

Car production and purchase have increased to a high extent in the last few years to satisfy the increasing transportation demand of the world demography. The automotive industry is expecting to sell 74 million cars in 2020 worldwide [1]. With this increasing number of automobiles on the roads and highways, a huge deterioration of traffic management and safety are being observed. Number car crashes and road other fatalities are rising to a high degree. In 2017 over 21000 fatal car crashes happened in the USA. Intelligent Transport System (ITS) [2] is the modern technology that works for safety and traffic perfection by providing automation in vehicular communication. Many countries are planning and developing various ITS applications to improve transportation. Advanced driver assistance system (ADAS) is an example of ITS which supports drivers in driving, parking, etc. ADAS also helps drivers by proving warning messages about rough road conditions, curvy lanes, traffic signs, and speed limits, etc. Other than that, the self-driving car is also being considered as a solution to traffic problems and safety issues. But some dependencies must be satisfied with the successful development of these applications.

Traffic light and traffic sign detection, pedestrian detection, lane tracking, lane curvature detection, etc. are some example applications in this area that can be combined to build a smart application like driving assistance and self-driving car. Lane departure is a prime factor for most of the highway fatalities that causes loss of lives and money every year. Lane departure is the reason for more than 50% of the total car crashes happens every year in the USA [3]. Not following the curve on the highway lanes properly is the basic cause for departing from the highway. Lane curvature detection has the potential to provide a solution in this aspect. This is what motivates the automotive researchers to research on this topic. An efficient lane curvature detection can bless us with the solution for road safety. In this paper, an implementation of an image processing algorithms to detect and recognize the Lane Curvature for situation awareness using a monocular camera was developed. It focuses on Binary Thresholding, Bird-Eye view Transformation and Sliding window to detect the circles of traffic light signs. The implementation was tested on a Raspberry Pi 3B+.

II. LITERATURE REVIEW

A. Situation Awareness

In Mica R. Endsley's study [4], the three levels of situation awareness were introduced: perception, comprehension, and projection. Where the information from the environment perceived by the perception level, comprehension level understands this information, and projection projects a future action based on the taken action. In this situation, Lane curvature recognition will be a useful case study in the perception level of Situation Awareness.

B. Lane Curvature Recognition

Different methods have been offered in both machine vision and computer vision. Systems that have been developed so far can perform various tasks such as lane mark detection, lane departure warning, lane curvature

detection, lane-keeping assistance, etc. Researchers from Toyota Central Lab proposed a lane detection method for highway lane departure warning using an extended Hough Transform [5]. Extended Hough transform helped to improve the robustness in lane detection. Hardware cost is reduced because they used a wide-angle camera and an embedded CPU available in the market. Lee J.W. [6], presents a machine vision lane departure detection system using a unique edge distribution system. Noise effect and localization error are minimized with this function. Edge related information and lane related information is collected and combined by edge detection function (EDF) to identify the traveling direction. Park J.W. et al. [7], proposed an algorithm for lane curve detection using a Lane Curve Function (LCF). The proposed algorithm was tested on a video of a Korean superhighway and showed excellent results even in noisy frames. It is worth mentioning that, a robust lane curvature detection method has been proposed comparing the lane line's slope with the desired slope in [8]. Their target is to support driver assistance and autonomous driving. The proposed method works well in adverse conditions such as noise, lane mark discontinuity, and disturbances. It performs shadow and illumination correction and differentiates between different curves. The algorithm can be used in autonomous vehicles for lane detection as well as on normal vehicles for a speed control system. Jeon Y.W. [9], offers an image processing method for preventing lane deviation. By processing and compressing the captured image from the road, slope, and curvature of the lane can be determined in this method. Driving direction and can also be detected. Our internship also focuses on lane curvature detection using image processing without any learning algorithm. From a conceptual point of view, their goal is partially related to ours. Both Goldbeck J. et al. [10] and McCall J.C. [11], focus on lane detection and tracking. The system in [10] uses a highly dynamic CMOS video camera for real-time lane detection with high accuracy. It can adapt to any weather condition and road type without external adjustment. In [11] on the other hand, works for lane mark detection using a steerable later. It shows robustness to lighting changes and shadow effects. This method performs with accuracy in detecting circular reflector road marks as well as painted lane marks. Zou Q. et al. [12] proposes a hybrid deep architecture by combining the convolutional neural network (CNN) and the recurrent neural network (RNN) by investigating frames from a continuous driving scene. Apart from these, there are other researches related to our work. Jung C.R. et al. [13], is a linear parabolic method for lane following. Jung C.R. et al. [14], is a similar but improved approach by the same researchers, which includes curve detection as well. A lane detection method to support the lane-keeping system is offered in [15] by estimating the lane configuration and vehicle attitude. Tsogas M. et al. [16], supports the lane-keeping systems using the digital map. In this study, we focus on a combination of Binary Thresholding, Bird-Eye view Transformation and Sliding window for recognizing Lane Curvature.

III. CONCEPT

This paper presents the concept and implementation process of Lane Curvature Detection using Image Processing. The monocular camera feeds the input to the image processing algorithm to detect the lane curvature. The proposed method of lane curvature detection consists of several steps that include image processing techniques, as shown in the flow diagram (Fig. 1). The proposed algorithm is a pipeline with several steps such as Binary Thresholding, Bird's-eye View Transformation, Sliding Window to Locate Lanes, and Lane Curvature Detection.

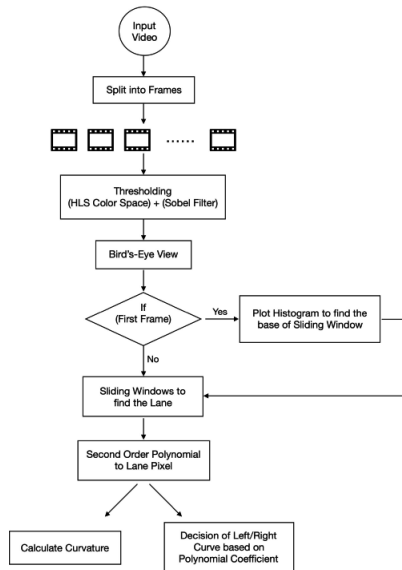


Fig. 1: Flow Chart of Lane Curvature Algorithm

The proposed algorithm is implemented on the Raspberry Pi 3B+. The operating system used in the Raspberry Pi is Raspbian Stretch. The libraries such as OpenCV, Numpy are installed on Raspberry Pi with Python dependencies for performing image processing tasks. OpenCV's `getPerspectiveTransform` function is used to transform the image into the bird's eye view. NumPy's `polyfit` function fits a second-order polynomial and returns the coefficients.

IV. IMPLEMENTATION

This work focused on the recognition of lane curvature from sequences of frames captured from a monocular camera mounted on the vehicle. Firstly, the thresholding techniques such as color thresholding and gradient thresholding are applied to the input frame, to get the binary image. The lane lines are visible in the binary image. In color thresholding, the S-Channel from the HLS color channel makes the lane line more visible. Using the gradient thresholding steep edges can be detected which is most probably indicates lanes. The Sobel filter and thresholding applied to the pixel value that falls inside the

range of minimum and maximum range. Then, the output of the color and gradient thresholding are combined to obtain the binary image.

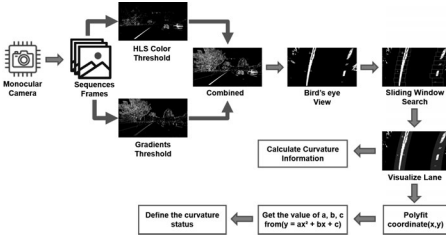


Fig. 2: Lane Curvature Recognition Algorithm

Secondly, using OpenCV's `getPerspectiveTransform`, the binary image is transformed into a bird's eye view. `getPerspectiveTransform` function accepts four sources and four destination points. In general, lane lines are parallel lines and they meet at a vanishing point that forms like a triangular shape. The tuning is applied to get the four source points for the Region of Interest (ROI) which avoids the region other than lane. Similarly, the destination points also selected to form a rectangle shape. The `getPerspectiveTransform` takes the source and destination points as input and provides the bird's eye view image of the region of interest polygon.

Thirdly, plotting a histogram will give two peaks on two different positions for left and right lane lines. These two peak points are the starting points for a sliding window search to locate both left and right lanes. Sliding windows are rectangles drawn over the pixel points of the left and right lanes. The size and number of the window are selected manually according to the shape of the image. The two windows are set at the bottom of the image on the two x-coordinate positions indicating to the left and right lanes. That means, two x-coordinates of the histogram peaks are two centers for two base windows. If the number of pixels inside a previous window (left or right) is greater than a fixed threshold the base position for the next window (x-axis) is updated on their mean position. If it does not exceed the threshold windows are not recentered. This way window on both the left and right sides follows the left and right lane lines respectively. Connecting the centers of these windows on both sides provides two curves that refer to the left and right lane.

Finally, the lane coordinates are stored in the list of python programming. The lane lines from the bird's eye view image are near vertical. It is more likely to have the same x-coordinate for multiple y-coordinate. In this case, it is a better idea to fit a 2nd order polynomial for $f(y)$:

$$x = f(y) = ay^2 + by + c \quad (1)$$

NumPy polyfit function fits a 2nd polynomial and returns the polynomial coefficients a, b, and c. The radius of curvature at any point x of the function $x = f(y)$ is calculated from the equation below:

$$R_{\text{curvature}} = \frac{[1 + \frac{dx}{dy}]^{3/2}}{\frac{d^2x}{dy^2}} \quad (2)$$

The equation can be simplified as below:

$$R_{\text{curvature}} = \frac{[1 + (2ay + b)^2]^{3/2}}{|2a|} \quad (3)$$

Furthermore, a warning message will be generated based on the lane curvature. If the curve is inclined to the direction left, the warning message should be 'Curve to the left'. If the curve is inclined to the right message should be 'Curve to the right'. The value of the polynomial coefficients analyzed such that a relational pattern is observed to decide whether the curvature is inclined towards left or right.

V. RESULTS

The proposed algorithm achieves the goals of this internship. The algorithm is implemented in Python3 and tested on a Raspberry Pi environment. It can detect the lane curvature from a highway video. It shows a warning message while there is a curvy lane moving to the right or left. Fig. 3 shows the result for both 'curve to the left' and 'curve to the right' respectively.

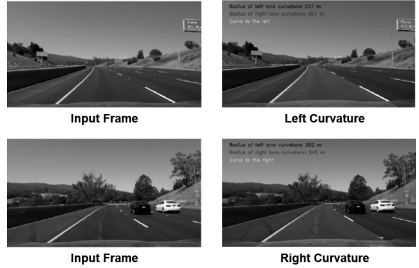


Fig. 3: Lane Curvature Recognition: Left Curvature → Radius to left and right lane curvature is 217m and 201m; **curve to the left** (top), Right Curvature → Radius to left and right lane curvature is 392m and 245m; **curve to the right** (bottom)

Blue text on the result frames shows the radius of curvature for the left lane and the red text shows the radius of curvature for the right lane. The green text refers to the warning message. Since the first original frame in the figure has a curvy lane moving to the left, our system is showing the warning message 'Curve to the left'. On the other, the second frame has a curve in the right direction, so the message says, 'Curve to the right'. This algorithm can detect lane curvature accurately even in shadow, noise, and less lighting conditions. Video frames were converted to the binary image before other processing techniques are applied. Applying HLS S-Channel helps with this situation by making the binary image less affected by the lightness and shadow. This algorithm works best on a 480p video. The proposed algorithm can process a 480p video with 25 FPS in an average on a windows platform. On the other hand, raspberry can process the video with a speed of 15-20FPS. The algorithm shows similarly accurate results for 720p video but the processing is lower. The algorithm calculates the radius of curvature accurately. In some rare cases, it shows a false positive decision for 'Curve to the left'. Thresholding on the value of polynomial coefficients

(a, b, and c) is tried to x the problem. It lowers the error rate but cannot solve it entirely.

Our algorithm fails to detect lane curvature in some special cases such as multi-lane conditions, dividing one lane into two or more, sudden narrow or wide lanes appearance, etc. In such cases, sometimes neighboring lanes are detected which is not the desired outcome. To handle this problem our system can take a pause when the road condition is critical to detect lane and resume it after a few frames.



Fig. 4: Lane Curvature Detection in Low Light Condition → Radius to left and right lane curvature is 3702m and 3796m; **curve to the right**



Fig. 5: Lane Curvature Detection in Critical Road Condition: Radius to left and right lane curvature is 330m and 493m; **curve to the right** (left), Radius to left and right lane curvature is 818m and 943m (right)

VI. CONCLUSIONS & FUTURE WORK

Curvy lane and lane departure are the reasons for many car fatalities on the highway. Accurately detecting lane curvature and providing warning messages for curvy road conditions can support many Intelligent Transport System (ITS) applications. The proposed algorithm in this report has been evaluated on a Raspberry Pi environment and it has shown success in lane curvature detection as well as a warning message. Analyzing the 2nd order polynomial coefficients from the curve fitting to decide the warning message is a novel idea to reduce a lot of computation complexity. This algorithm works fine in shadow and low light area. Combining this algorithm with other computer vision algorithms that concerns autonomous driving and driver assistance can develop a large-scale ITS application.

The future plan is to detect the current lane from a multi-lane highway. Other than that, detecting multiple lanes from the highway and showing warning messages for lane departure is also part of the future work.

REFERENCES

- [1] Statista-Research-Department: Global-car-sales-1990-2019 (June 2020), <https://www.statista.com/statistics/200002/international-car-sales-since-1990/>
- [2] I. Wagner: U.S. fatal passenger car crashes 2017 (April 2020), <https://www.statista.com/statistics/191530/fatal-passenger-car-crashes-in-the-us/>
- [3] G. Lu: A Lane Detection, Tracking and Recognition System for Smart Vehicles. Ph.D. thesis, University of Ottawa (2015).
- [4] M. R. Endsley "Toward a Theory of Situation Awareness in Dynamic Systems", *Human Factors Journal* 37(1), 32-64, 1995.
- [5] A. Takahashi, Y. Ninomiya, M. Ohta, M. Nishida, M. Takayama: Rear View Lane Detection by Wide Angle Camera. In: *Intelligent Vehicle Symposium*, 2002. IEEE. vol. 1, pp. 148-153. IEEE (2002).
- [6] J.W. Lee: A Machine Vision System for Lane-Departure Detection. *Computer vision and image understanding* 86(1), 52-78 (2002).
- [7] J.W. Park, J.W. Lee, K.Y. Jhang: A Lane-Curve Detection based on an LCF. *Pattern Recognition Letters* 24(14), 2301-2313 (2003).
- [8] A. Dubey, K. Bhurchandi: Robust and Real time Detection of Curvy Lanes (curves) with Desired Slopes for Driving Assistance and Autonomous Vehicles. arXiv preprint arXiv:1501.03124 (2015).
- [9] Y.W. Jeon: Image Processing Method for Preventing Lane Deviation (Feb 1 2005), uS Patent 6,850,629.
- [10] J. Goldbeck, B. Huertgen: Lane Detection and Tracking by Video Sensors. In: *Proceedings 199 IEEE/IEE/ISAI International Conference on Intelligent Transportation Systems (Cat. No. 99TH8383)*. pp. 74-79. IEEE (1999).
- [11] J.C. McCall, M.M. Trivedi: An Integrated, Robust Approach to Lane Marking Detection and Lane Tracking. In: *IEEE Intelligent Vehicles Symposium*, 2004. pp. 533-537. IEEE (2004).
- [12] Q. Zou, H.Jiang, Q. Dai, Y. Yue, L. Chen, Q. Wang: Robust Lane Detection from Continuous Driving Scenes using Deep Neural Networks. *IEEE Transactions on Vehicular Technology* (2019).
- [13] C.R. Jung, C.R. Kelber: A Robust Linear-Parabolic Model for Lane Following. In: *Proceedings. 17th Brazilian Symposium on Computer Graphics and Image Processing*. pp. 72-79. IEEE (2004).
- [14] C.R. Jung, C.R. Kelber: An Improved Linear-Parabolic Model for Lane Following and Curve Detection. In: *XVIII Brazilian Symposium on Computer Graphics and Image Processing (SIB-GRAP'05)*. pp. 131-138. IEEE (2005).
- [15] Tsuji, M., Shirato, R., Furusho, H., Akutagawa, K.: Estimation of Road Configuration and Vehicle Attitude by Lane Detection for a Lane-Keeping System. *SAE transactions* pp. 420-426 (2001).
- [16] M. Tsogas, A. Polychronopoulos, A. Amditis: Using Digital Maps to Enhance Lane Keeping Support Systems. In: *2007 IEEE Intelligent Vehicles Symposium*. pp. 148-153. IEEE (2007).

MRI Rendering with EEG Sensors Projection

Klementev Dmitrii
Computer Engineering Department
Novosibirsk State Technical University
Novosibirsk, Russia
KlementevDmitryRu@gmail.com

Abstract — The article describes MRI (Magnetic Resonance Imaging or Magnetic Resonance Investigation) visualization by Direct Volume Ray-Casting rendering method and the principle of the MRI process. The latter is important for understanding all circumstances of MRI visualization. For the high performance of the calculations, GPU (Graphics Processing Unit) was used. DirectX was used to link CPU and GPU. EEG (Electroencephalogram) is a method of brain electrical activity investigation. The method of projecting EEG data to the tissue was described. This method can be used to project any data.

Keywords— *Magnetic resonance imaging, direct volume rendering, real-time rendering (computer graphics), medical visualization.*

I. INTRODUCTION

MRI is one of the non-invasive methods that allow us to investigate the human body. Preventing unnecessary surgery, this aspect is very important for medical diagnostics and researches. In general, there are two similar approaches for the non-invasive investigations:

1. Using X-rays (Computed Tomography scan)
2. Using magnetic fields (Magnetic Resonance Investigation)

The CT (Computed Tomography scan) provides density information of tissues, MRI provides other information, based on the radio-wave response, getting with magnetic fields. The information can be about hydrogen density, neuron activity, or brown motion of particles. The MRI has a very strong advantage: it doesn't use X-rays, that could damage the body. This gives MRI a good reputation.

The problem of MRI rendering is the fact that radio-frequency response is not optical properties and different tissues can be indistinguishable in this field. For mapping MRI scalar data, representing radio-frequency response and saved as 3D texture, there are transfer functions. It makes transfer function generation an important part of MRI visualization.

The grey matter of a human brain is a major component of the central nervous system and it includes numeral neuronal cell bodies, while white matter includes few cell bodies, but a lot of long-range myelinated axons. The gray matter is found on the surface of the brain and is relatively thin. By this fact, sensors on the brain can measure neuron activity. This is performed by EEG. The neuron activity can be investigated for getting information about processes in the brain. Usually, EEG is represented by numbers or diagrams. The mapping of the EEG data relative to the brain could increase understanding of processes in the brain because visualization is one of the most important communications between a human and nature.

II. MRI PROCESS

MRI imaging process is based on hydrogen nuclei in a human body and its spin, a powerful magnetic field, and a weak oscillation magnetic field [1]. In the powerful magnetic field, which magnetic isolines are almost straight in the workspace, nuclei are aligning parallel to the field with very small relaxation time. In other words, nuclei spins are aligned parallel to the isolines of the powerful magnetic field. The weak magnetic field begins to oscillate perpendicular to the powerful stationary magnetic field with resonance frequency. With the oscillations, nuclei begin to precess around the powerful magnetic field. Such resonance frequency is called precess frequency and depends on a magnetic field magnitude. At 1 tesla this frequency is 42 MHz. After nuclei have been brought away from equilibrium, the weak magnetic field is turned off. Eventually, nuclei spin will align with the powerful magnetic field, but it takes some time. Meanwhile, radio waves at this frequency are emitted from the body. Those radio waves can be measured.

The question here is how to define from what places the radio waves have been detected on sensors. Paul Lauterbur has introduced a method, which allows determining nuclei positions [1]. His idea was to make the powerful magnetic field inhomogeneous and to use the effects of it. For that, he used three different linear magnetic fields, perpendicular to each other, along with X, Y, Z for example. There are three steps:

1. Precess frequency depends on the magnetic field magnitude. If you create a linear magnetic field, only nuclei on one isoline will have the same precess frequency. This step is choosing a slice and this magnetic field is called "slice encoding"
2. The next applied magnetic field is called "phase encoding". It is turned on for a short time. During that time nuclei rotate in the plane perpendicular to "phase encoding magnetic field". As the frequency of that rotation is dependent on magnetic field magnitude and the magnetic field is linear, each nucleus will have a personal alignment depending on the nuclear position along the magnetic field. As the magnetic field is turned on for a short time, nuclei will not change precess frequency along "slice encoding magnetic field" and radio waves frequency will be the same.
3. It gives the X slice. With the second step, we can determine nuclei along Z. The last step is to determine nuclei along Y and by that take row values. The last magnetic field is changing nuclei frequency along Y and we can determine row taking radio waves with only one frequency.

In the end, we have a row of nuclei with the same frequency and each nucleus has its phase.

An MRI image is a three-dimensional digital field, each of its cells represents an averaged nuclei response in the corresponding physical space as a scalar value [1]. Such cells are called “voxels” like “pixels” for a two-dimensional space. Values in those voxels will be called as “scalar data” in this paper.

III. MRI VISUALIZATION

Direct Volume Ray-Casting Rendering

Direct Volume Rendering is a ray-casting method for calculating the color of a screen pixel by casting a ray from the pixel through a three-dimensional texture, such as an MRI image [2]. In a simple implementation, each voxel has color and opacity parameters. By these parameters, the color of the screen pixel can be calculated (1,2) [2].

$$C = \sum_{i=1}^n C_i \prod_{j=1}^{i-1} (1 - A_j) \quad (1)$$

$$A = 1 - \prod_{j=1}^n (1 - A_j) \quad (2)$$

Where C is the color and A is the opacity. The opacity value is used for color blending between the volume and other objects. The opacity number is between 0 and 1 and the strength of the opacity is higher at 1.

But using these equations requires to be careful with choosing the color because color values with low opacity can make render white like in Fig. 1 because of the excess of color value.

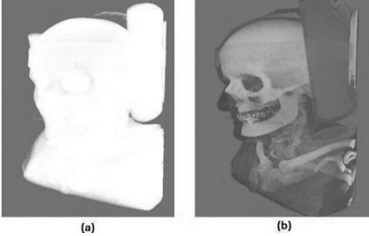


Fig. 1. MRI rendering with a 1D transfer function. In (a) skin has low opacity and not shifted color value. In (b) all colors have been divided by its opacity.

One of the practical questions here is how to calculate the start and the end positions of the ray. One of the simplest ways is to render a cube in additional textures with textures coordinates on it with FRONT and BACK call modes in the rasterization state, like in Fig. 2. Note that each polygon has a front and backside, depending on the vertex traversal order. Having that, ray positions might be sampled from the textures. The other way is to calculate ray directions and cast them from the camera. It can be completed in the local MRI texture space directly. But in this case, it's necessary to find a collision between ray and [0,1] XYZ coordinates, because calculations in exterior of this cube are excess. Both approaches are applicable and any can be chosen.

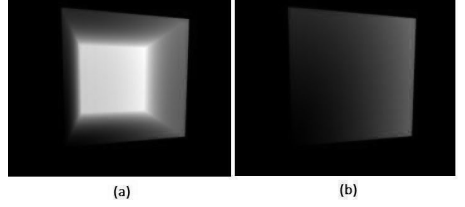


Fig. 2. (a) is cube rendering with back polygons only and (b) is cube rendering with front polygons only

High performance of rendering is in demand. The imaging can be calculated on CPU and GPU, but GPU is much more effective due to architecture for parallel calculating and a possibility to calculate pixels color in SIMD style. For that purpose, DirectX11 can be used. It includes pixel and computes shaders, each of these can be used for calculations.

To improve sensitivity, it is possible to shade opacity tissues. In general, normals can be represented as a normalized minus gradient of scalar data. So it can be calculated with the formula below (1):

$$grad_i = (value_{(x,y,z,\dots,i+1,\dots,k)} - value_{(x,y,z,\dots,i-1,\dots,k)}) / 2h \quad (3)$$

$$n = -grad \quad (4)$$

Where $grad$ is the gradient of scalar data, $grad_i$ is the i -component of the gradient, h is the distance between the voxels along the i axis, n is the normal.

This calculation is expensive due to six sample calls. The good practice is to save calculated normals into an additional texture before the main render loop. It will discard additional sample operators and leave only one. In shading calculations, it can be important to set threshold value, because of high noises, the difference between an image with and without threshold value is represented in Fig. 3.

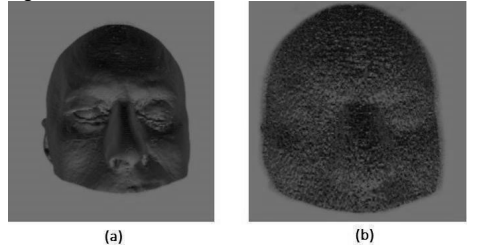


Fig. 3. simple MRI rendering with shading (a) with a threshold value and (b) without threshold value

Transfer function

The most important side of MRI visualization is how to make different tissues distinguishable. MRI scanners provide information about hydrogen response at the point and different tissues have various hydrogen concentrations,

the simplest way is to assign different colors and transparencies to different densities. A look-up table is used for that. In DirectX and other graphic API, the look-up table usually is a texture, which stores, in this particular case, optical parameters in pixels and scalar data along the axis. By this, we can assign optical properties to the field of MRI data directly and render it. Note that for sampling from an MRI texture it can be important to turn off interpolation between voxels because interpolation between max value and zero can return randomly optical properties.

The way described above is good. Nonetheless, this way isn't the best due to disturbances in MRI data. Another way is to use methods from computer vision and underline only boundaries between materials [3]. It increases the quality of rendering because tissues are described by a single scalar value, but boundaries are described by a set of two scalar values and it provides more combinations, allowing more detail to be emphasized. It also increases performance because modern shader models or modern GPUs can pass calculations in if-body operators for empty voxels in a few cases. Besides, it allows you to take the next step in transfer-function generation, by expanding a transfer function dimensional.

Boundaries can be detected by calculating the first derivative along the gradient of scalar data. The example of this is presented in figure 3. As can be seen, boundaries are distinguishable.

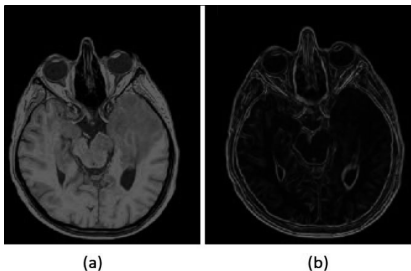


Fig. 4. (a) is a slice of MRI texture data. (b) represent the first derivative magnitude along the gradient.

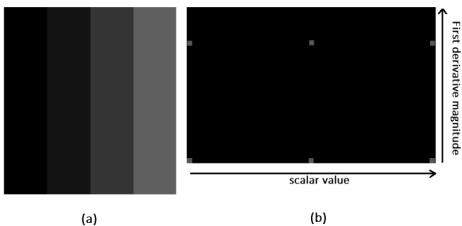


Fig. 5. (a) is an artificial texture and (b) is a 2D histogram of this texture. Red points represent all combinations of scalar data and first derivative magnitude.

We can use a 2D or 3D transfer function, based on scalar data, first and second derivatives along the gradient [3, 4]. 2D histogram includes two axes, the first is the scalar data, the second is the first derivative along with gradient magnitude and red intensity is a number of combinations. The 3D histogram, in addition, includes a second derivative along the gradient. Example of the 2D histogram, based on artificial data, is presented on Fig. 5 (b). As can be seen, the boundaries are represented by a few solo points. It happened due to the digital nature of using data (Fig. 5(a)).

For better results, there is a need to apply Gaussian blur to an MRI texture. The result is shown in the next figures: in Fig. 6(b) boundaries are represented by arcs, in Fig. 6(c) as waves. In Fig. 7 2D histogram based on a real MRI texture is represented.

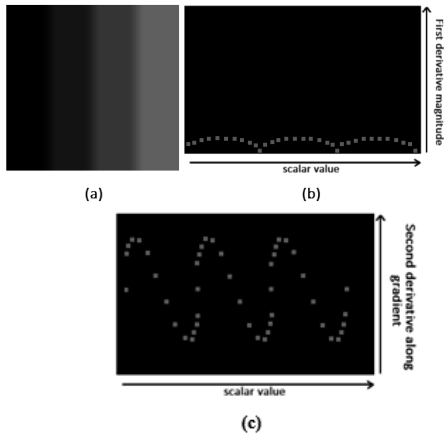


Fig. 6. (a) is blurred by Gaussian with sigma = 3 and core size = 7 artificial volume texture. (b) and (c) are the histograms of this texture

The first derivative along the gradient is the magnitude of the gradient and it can be obtained with (3). The second derivative along the gradient can be obtained with Hessian [5] (3).

$$D_{\nabla f}^2 f = \frac{1}{\|\nabla f\|^2} (\nabla f)^T H_f \nabla f \quad (5)$$

Using these, 2D or 3D histograms transfer function can be generated. He [5] used a genetic algorithm to breed transfer function. The system generated a few transfer functions randomly and he chose the best, "breeding" transfer function. Kniss described approach, where the user selected the transfer function manually [4]. Also, neural networks can be useful for finding a solution to increase the quality of MRI textures [7, 9]. But in this way, it's important to remember that neural networks are black boxes and they can hide important parts of the MRI texture or create artificial structures

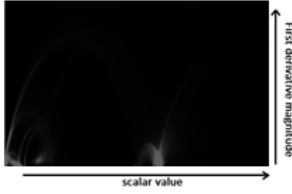


Fig. 7. 2D histogram based on a real MRI texture.

IV. EEG SENSORS PROJECTION

For projecting data from EEG sensors to the brain, the method like in deferred shading can be used [6]. The positions of the brain surface, represented by boundary, are stored into an additional texture (Fig. 8). With this, the distance between the surface to EEG sensors can be calculated. Having that, intensity can be represented as a function from the distance between the sensor and the tissue voxel.

There are a few methods of how to image intensity to the brain. The first is to render intensity in additional texture and blend it with the main image. Unfortunately, it will not make good sense. The second is to create an additional 3D texture, which will store intensity information in the whole 3D MRI field. But the last way will decrease performance.



Fig. 8. Positions of bone voxels in the local space of MRI texture. XYZ coordinates are displayed in RGB.

V. FUTURE WORK

One of the problems of generating transfer functions is the fact that scalar data depend on radio wave response. It doesn't distinguish all tissue and the result of visualization very relies on the parameters of the MRI process and disturbances.

The example of bad MRI data is represented by the 2D histogram in Fig. 9. There are few arcs, which represent the boundary between air and all tissues, which have the same scalar value.

The example of a problem with weakly distinguishable tissues is shown in Fig. 10. All tissues have similar scalar value and it became identify only after tonal compression (5)

$$C = 1 - e^{(-c_0 \cdot ex)} \quad (5)$$

Where C is an output color, C_0 is an initial color, ex is an exposition.

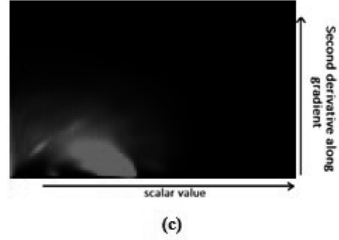


Fig. 9. The histogram, based on weak MRI texture.

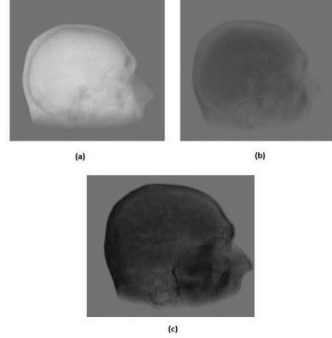


Fig. 10. (a) constant transfer function. (b) linear transfer function. (c) linear transfer function after compression

REFERENCES

- [1] Lars G. Hanson, Introduction to Magnetic Resonance Imaging Techniques. Danish Research Centre for Magnetic Resonance (DRCMR), Copenhagen University Hospital Hvidovre. 2009.
- [2] Milan Ikitis, Joe Kniss, Aaron Lefohn, Charles Hansen. GPU Gems. 2007.
- [3] Gordon Kindlman and James W. Durkin. Semi-Automatic Generation of Transfer Functions for Direct Volume Rendering. In IEEE Symposium On Volume Visualization, pages 79-86, 1998.
- [4] Joe Kniss and Gordon Kindlman. Multidimensional Transfer Function for Volume Rendering. In IEEE Transaction on Visualization and Computer Graphics, August 2002.
- [5] Taosong He, Lichan Hong, Arie Kaufman, and Hanspeter Pfister. Generation of Transfer Functions with Stochastic Search Techniques. In Proceedings Visualization '96, pages 227-234, 1996.
- [6] Jonathan Thaler. Deferred Rendering. TU Wein.
- [7] Salman UI Hassan Dar, Muzaffer Ozbey, Ahmet Burak Catli, Tolga Cukur. A Transfer-Learning Approach for Accelerated MRI using Deep Neural Networks.
- [8] Ljung P., Krueger J., Groeller E., Hadwiger M., Hansen C., Ynnerman A.. State of the Art in Transfer Function for Direct Volume Rendering. Computer graphic forum. 35(3), 669-691, June 2016.
- [9] Jia-Wan Zhang and Ji-Zhou Sun. Adaptive transfer function design for volume rendering by using a general regression neural network. Proceedings of the 2003 International Conference on Machine Learning and Cybernetics, 2003.
- [10] J. Hesser, R. Männer, D. F. Braus, G. Ende & F. A. Henn. Real-time direct volume rendering in functional magnetic resonance imaging. Magnetic Resonance Materials in Physics, Biology and Medicine volume 5, 1997

Analyses on Physics Textbooks for Secondary Schools

Munkhbold Mangalsuren
Department of Physics
School of Mathematics and Natural Science
Mongolian State University of Education
Ulaanbaatar, Mongolia
munkhbold@msuc.edu.mn

Purevdorj Dondovsambuu
Department of Physics
School of Mathematics and Natural Science
Mongolian State University of Education
Ulaanbaatar, Mongolia
pd@msuc.edu.mn

Sodov Tsendendamba
Physics Education Journal
Ulaanbaatar, Mongolia
sodov_ts@yahoo.com

Abstract - Textbook is committed to implement educational standards and training program, to provide information for students, to let them acquire independent learning methods, motivate and activate them.

Keywords—knowledge, measurement, regularity, conception

I. INTRODUCTION

Within a scope of definite topics, textbooks for secondary schools refer to principal materials of training composing of texts, pictures, tables, problems for confirmation, questions, tests and tasks on which basic knowledge for schoolchildren are clearly written. We would like to share my views with readers about how to make analysis on physics textbooks for secondary schools, training programs and standards were changed, developed, and how to enhance them in the future. For doing so, we have definitely concerned the correspondence of the content sustainability and succession with training standards and composition by mainly focusing on regularity, idea, dimension, level and practical scope from regularity, conception, measurement of physical science that were chosen as study materials.

Since victory of the People's Revolution in Mongolia (in 1921) translated versions of the Russian textbooks were used. The first ones that had been translated by D. Budari and published in 1929 and 1932 were books named after "Elementary textbook of physics" by A. V. Tsinger with 2 volumes, 10 chapters and 296 subchapters.

Textbook refers to clear meaning of training policy. It is specific teaching materials containing general goals, content, viewpoints, method and logics of the said science, appropriating to the age and mental characteristics of the student. Textbook is committed to implement educational standards and training program, to provide information for students, to let them acquire independent learning methods, motivate and activate them. Compared to scientific simplified literatures, textbook is different by teaching definite knowledge content based on facts and evidences and expressing content with precedent knowledge and continuity; it doesn't cite any views or ideas of authors like science books; pictures, decorations and independent exercises must be obligatorily included; its composition and stylistics must absolutely be clear. Textbooks should comply with the following requirements of scientific theories, concepts and regularity system:

- It must, scientifically, be honest
- Its terms should be rational
- Language and composition must be clear
- Classify major and minor matters

- It has to be attractive

In the textbook for secondary schools, sentences have to meet the following requirements: it does not have two possible meanings, it must be clear, interesting and exciting phrases and expressions, to provide as many tables, graphics, charts, drawings, pictures, schemes and examples as possible; it stipulates in which scopes the applicable laws and regularity can be used without providing subjects and matters that have not been proven scientifically and practically; to type learning formulae and measuring definitions with another colors or ciphers; to take examples from known and popular things for students; letter font must be readable and likeable; and it is available to compare the telling and explaining objects, things and subjects with another things^{14,16,18,20}.

Teaching and pedagogical materials for pupils and students must comply with the following requirements¹⁵:

- Its content must be transparent
- Ideal viewing size should be sufficient
- Color must be suitable
- Full use of the page area
- Not to fill readable area with supplementary materials
- The dashed lines are clear and distinctive
- Writing as little as possible.

Since 1951 Textbooks "Courses of Physics" by authors A.V.Pyerishkin, G.I.Faleev, V.V. Krauklis. I.I.Sokolov that had been used for the grades VI-X at secondary schools in the Soviet Union were translated by N. Elbeg, M. Chimiddorej, D. Tserendagav, B. Lkhamsuren, B. Baldoo, E. Radnaa and N. Sodnom, published and used. Then in the 60s and 70s of last century, National Institute of Pedagogy developed contents of textbooks with local authors, published under Order by Ministry of Enlightenment and applied them for teaching physics. So content, requirement and methodology of the Soviet Union were followed at that time.

Furthermore, it renewed educational program of physics in 1955, 1963, 1964, 1972, 1984, 1999 and 2014. Although the training content of physics is applied with textbook, workbook of problems, experience and lab works for show, supplementary materials of independent learning and studies for students (elective subjects, preparation for Olympiads or enrollment exams at colleges, universities), teaching and pedagogical manuals and supplementary materials for teachers; we have made analysis only on the textbooks that were approved officially.

II. MAJOR PART

This time we have analyzed the named textbooks of physics for secondary schools composed by national authors, having definitely considered the compliance with program and standards, compatibility to students' interests, needs and feature of training environment, design, pedagogical solution, optimal application of teaching methods, aids and tools, light and hard exercises and tasks for independent accomplishment by students. Then we have divided textbooks of physics into four main categories in the followings:

- A. Textbooks of physics in 1961-1979
- B. Textbooks of physics in 1984-1986
- C. Textbooks of physics in 1997-2001
- D. Textbook of physics in 2014 that was prepared under core program.

I. PHYSICS-VII. Each topic of this textbook has tests, pictures, explanation of terms, Mongolian names and nomenclatures and is in good order. For instance, it mentioned about solar energy and jet engine. But tables of physical constants were not numbered.

PHYSICS-X. Besides aiming at showing physical fundamentals of any phenomenon and developing independent skills of students, it sets goal to show scientific achievements and discoveries at that periods. Thus, for the first time the chapter "Fundamentals of Relativity Theory" was provided in this textbook and prepared in excellent order. But it observed that order of group topics was lost.

PHYSICS-VIII. It is consisted of two main parts: mechanics (1-11 chapters) and molecular physics (12-16 chapters). It clearly explained theoretical materials with experiences, practices, pictures and graphs, made derivation of formulae and mentioned in details about how to apply them in practices. For instances, it became advantageous by teaching relativity of movement, equations of smooth acceleration and deceleration, body weight, weight gain, weightlessness, centrifugal force, body movement on a sloping plane, conservation law in mechanics, work and energy with tests and formulae, and resolving relevant problems.

PHYSICS-IX. The crew composing of 5 members such as lecturers and researchers from Mongolian State University of Education, National University of Mongolia and Institute of Pedagogy wrote it. Its content was comprised of theory, methodology to solve problem, tasks and exercises, lab works; its terms were clear and smooth, mostly it paid more attention to explain theories by experiences and practices, describe by pictures and graphs, and to apply in practices. Additionally, it provided new chapters such as magnetic properties of matters, alternative current. But some pictures were not clear as follows: picture 84 – aluminum purification furnace, picture 115 – deviation of a set of electronics in magnetic field, picture 182 – scheme for long-distance transmission of electricity, picture 182 -

PHYSICS-VII. The most contents of this textbook (topics or articles 1, 3, 10, 16, 32, 33, 56, 65) coincided with briefed contents of corresponding topics in textbooks for the grades IX and X; its concepts were not completely identified; main values were bypassed and explained in poor orders. We don't agree such manner of educating knowledge of physics with periodical coincidence. Many topics were not clear for the 7th grade students and it didn't express physical value of the content; and much simplification might give false concepts for students.

After having analyzed two textbooks together at level of basic education, we found out that training of physics was conducted at two stages by imitating foreign country. We consider it would be better, much clear and accessible if fundamental regulations, laws and facts of physics are sufficiently studied in high schools; and integrated knowledge of natural sciences are taught in the grades VI and VII with physical and other natural phenomena.

PHYSICS-VII. Physical basis of mechanics was clearly provided according to the program of subject physics at that period. Besides that, it is appreciated that the most important things for each chapter were taught in manner of conclusions. But there were too many formulae with and without extraction in sections 12, 22, 42, 43, 50, 52, 53, 64, and 69. It seems that §5-7 and §41-43 can be integrated.

PHYSICS-IX. There was a preface for beginning parts of this textbook but there was no introduction for ending parts. It seems that its editors might not review some subjects of this textbook. Conceptual theory was wrongly explained in §18 and §24; the level of material science on electricity in vacuum and semi-conductor in chapter X "Electricity in various environments" is too weak. Moreover, volume of the textbook became thick since some topics (§31, 32, 33) were written too detailed. So it may integrate the too-detailed things and make conclusion, then make up other concepts, content and structure in manner of interpreting laws.

PHYSICS-X. The content of this textbook fully complied with the program and it might adhere an ideology of the Russian Federation too much. It didn't apply the opportunity to densify energy of mechanical and electromagnetic wave in huge amount; spectrum was classified and some of them were explained in details even there is no reference of spectrum (chapter 7). In our views, it may be optimal and clear if this chapter would have been written with method of deduction.

Questions conform to texts in textbooks for the 7th grade. 20% of questions could be answered after getting information from other books, teacher or taking additional information. Its level and content are conformed, it is difficult for children to understand hydraulic equipment, pressure measuring device and pumps, there is no reference on mechanism. Although mechanic movement is written there, thermal movement is not provided. So it bought the reason that the textbook of physics for the 7th grade is too thick. Some teachers couldn't teach the content in time. Since numbers of some pictures are not mentioned in texts, they are incomprehensible for students; principle of colorful textbook was broken even though theoretical and practical comparison was chosen well. However, there are many things to show and design are good, pictures are placed in right location, questions and exercises are optimal for students.

In the textbook for the 8th grade, many questions on thermal phenomena requires students to read other sources and books and to have logical thoughts. There are not few questions to answer by reading textbooks of high school. This textbook could respond to questions about electromagnetic, light, astronomic topics. Materials for the 7th grade were written on the first three chapters. Standards of electromagnetic and light content meet appropriate requirements. But the introduction about properties of the sun and stars in astronomy exceeded from appropriate standards. Design, composition, question, test and tasks were included appropriately. In picture 30, lessons such as

temperature at the bottom of lake in summer and winter, magnetization by influence, projection of celestial bodies in the sky are difficult for students, especially in picture 10.4, students are not able to work on it by looking at its annex. The design of the textbook is excellent, especially its background color of table and graphs are much suitable, many real pictures make it believable. Unfortunately, some mistakes were found in it as editors didn't review, detect and rectify mistakes.

In the textbook for the 9th grade, there are many tasks for students to make conclusion and answer after making discussion even too little information. Teachers don't believe that the 9th grade students would answer 128 questions (which occupy 30% of the textbook). In order to answer these questions, they need to read and know many things. How many such kind of materials do we have? In picture 198, it didn't mention with which kinds of materials glass and plastic sticks were rubbed; it put electroscope exclamation mark was put in picture 195; in pictures 272-276 exactly what materials of semi-conductor were described in text; it didn't mention what was marked by the circle with arrow in picture 291; it didn't concern about how to use picture 321. Authors didn't predict and imagine how students could answer such questions. Furthermore, editors didn't observe that pictures 233 and 243 were wrong. Unfortunately, it was published that way. Although the content of this physics textbook meets standards and levels, several things such as Cavendish experiment one of main experiment, experiment to determine coefficient of friction, electric statics coincided with the 7th and 8th grade textbooks. Choice of pictures is good and composition is affordable. But we would like to say it is extra vintage that there is each title of chapter 23 and phrase that "this chapter shall study those matters".

It is impossible to answer question after student reads information in the textbook for the 10th grade. It is similar to the 9th grade's. For example, pictures 39, 40, 41 describing rule for establishment of body shapes in mirror and lenses, interference, interpretation about electromagnetic waves by generation and distribution, picture 113 for polarization of the light. Its content and level complied with appropriate standards. Students don't have any chances to practice using picture of sky with stars on the pages 125-126 in chapter 13 and characteristics of some sharp stars. Even though design and composition are generally affordable, first six chapters have similar conceptual design. Design is good, but we deliberately note that pictures 116, 118, 153, 164, 184 and 205 should be colored for pedagogical requirements.

The students who have taken information from the textbook for the 7th grade written under new program can answer questions and carry out tasks after reading it well. But at the beginning of chapter 1 "general properties of body", it writes about how to measure length, weight and density of the body without explaining the term "body". Its content duly complied with the program. The chapter "Astronomy" is the most difficult part for students to read punctually and work hard. Some concepts don't conform to titles and preface. For instance, current and electric magnetic properties are not included in texts. Since it didn't clearly distinguish the difference between two concepts "magnet" and "magnetic", page 17 was explained by spring scale and three rings on the page 60 interpreted with word "five".

We would like deliberately note that the contents and program in four chapters "Forces and Interactions,

Mechanic movement and Mechanic energy, Electricity and Magnetics, Energy supply" in the textbook for the 8th grade have completely met the relevant requirements. Except that, tasks designed for students' knowledge and to resolve problems have been optimal. Instead of stating that current run on diode, engine and bulb on the pages 88 and 89, it would be more understandable to state that current would run through diode, engine and bulb. It needs to rectify percentage of heat loss more than 100% in the picture on the page 142.

Since the physics textbook for the 9th grade is the last textbook for students to acquire basic education of physics, it is appreciable that authors focused on giving orderly knowledge and concepts to students. To do that, it was written well for students to have universal concepts, skills and knowledge about thermal movement, energy, magnetic and electric fields, electric circuit and light based on accumulated experiences and knowledge in the 7th and 8th grades. In order to express these concepts, authors have optimally chosen pictures in texts.

The 10th grade textbook for secondary education is consisted of main chapters such as mechanics, heat, wave, sound, electromagnetism, problems for processing measurement results and letting students solving those problems. It was written good in manner that students could enrich and study matters such as description of body position, displacement, movement and forces by vectors; description of weight and center of gravity by torque / moments of force; use of thermal process phenomena in practices; wave and sound by expressions of wave refractions; electromagnetic field by modern electronic system, circuit, elements and logic functions respectively based on the acquired knowledge and competence about mechanics at level of basic education. It is very appreciable that another feature of this textbook is to make definite measurement on precedent theoretical knowledge, to make conclusion of its results based on digital processing, and to solve problems (on pages 126-148) relating to the said topics. The content and level of these problems have met concepts and conclusions of texts.

The 11th grade textbook stating that the movement quantity and impulse in the chapter "mechanics" by Bernoulli's equation; fundamentals of ideal gas equation and molecular genetic theory in the chapter "Molecular physics" were enriched by the second law of thermodynamics and its applications respectively; was written understandable for students. The topics "Electric and Magnetic fields" were mostly interpreted and explained by pictures without hard formulae. It was excitingly explained about electricity in semi-conductor and Ohm's law for complete circuit based on applicable examples. Also this textbook has excellent attractive experiences and experiments. For instance, much clear expression of mechanic and harmonic fluctuations, interactions of their parameters; shutdown and forced fluctuations, and specific explanation about transverse wave propagation mechanism based on Huygens-Fresnel principle. It is understandable that changes in frequency on the Doppler effect were described by picture. It is available for teachers to use it for teaching other waves.

Nowadays, in order to make contents understandable and accessible for students except than main content of the program, it created electronic textbook with CVDs / CDs by entering data, establishing diagram, scheme, graphic descriptions, with studying materials for micro lab works,

modern and future technology, information receivable and affordable film by answering questions of students, real trial and experiment, games, brief history, interviews, video recording and discussion, electronic tasks, assessment mission and tests. It requires to creatively and effectively apply them for training of physics.

The issue for the training of physics that is waiting for solution is how to completely and optimally insert problems in the textbooks for students of that class. Since such issue have not been fully resolved till today, it requires some authors to include problems at the end of each chapter / topic, every teacher to choose problems based on his / her own methods and experiences. Finally, it needs to create, compose and publish new core program, content, structure and directions of physics textbooks for "Compilation of Physics Problems" at the levels of basic and secondary education.

III. CONCLUSION AND POINT OF VIEW

As for 18 physics textbooks for general education schools that we have studied, the textbooks that were used by us till 1951 were directly translated from textbooks of the Soviet Union. As the program belonged to the Soviet Union, its content had the same meaning. Since 1951, physics textbooks for the 6-10th grades used in the Soviet Union were translated and applied under order by Minister of Enlightenment of Mongolia.

1. In the textbooks in 1961-1979 written by national authors, it paid more attention to provide polytechnic education for students based on definite goal of the country, to introduce scientific inventions in production and practices and to show their applications.

2. The textbooks written in 1984-1986 imitated foreign countries. During organizing and conducting trainings of physics at two stages (incomplete and complete secondary education), it has shortage in features of Mongolian national thoughts, accumulated teaching methods and experiences of teachers, introducing new technique and technological inventions, focused little on integrating content of physics training.

3. The physics textbooks in 1997 – 2001 were written according to educational standards of physics and astronomy for the first time. Their term and formulae were official, been taken into consideration of Mongolian household and living conditions fully suited for students, contained traditional and new content of astronomy.

4. Physics textbook of basic education according to newly approved core program are advantageous than previous old textbooks that their design and expressing methods are suitable for age and mental characteristics of students. After having studied these, we have made conclusion that ground to study physics at level of complete secondary education was set up. The physics textbooks for the 10th and 11th grades have carried out its obligations to provide systematic knowledge to students at high schools and to make them be interesting in physics.

5. Since we have had standards of basic and secondary education, it would be better to compose and publish textbooks at such two levels. That would bring us opportunities to get away from the economic pressure in manner that contents of textbooks would not be changed every year, not publishing each year, uncertainty of content for teachers, students and parents, to eliminate delayed delivery of textbook, to enhance sufficiency by completely testing results of contents in the published textbooks and by

letting teachers sharing and discussing their views. We considered that, as results of such trial, the content of physics textbook and all subjects would be stabilized and qualified, it would make strong contribution to development of general education system in our country by determining demands of the subjects (student, author, teacher, policy maker / developer, methodologist, researcher, employer, professional association, unions) that involve in educational relations.

6. If electronic textbook is invented and distributed teachers and disciples at all stages of schools, we may not reach the desired approaches but we could achieve certain results. The experiences of electronic training during the outbreak of pandemic disease Covid-19 has showed and warned us it is time for us to get to such work. So it needs to restore and renew the precedent experience (composition and regulation for such non-staff council have been ratified under order No.163 by chairman of State Committee of Science, Technique and Higher Education from Jun 10, 1989; order No.426 by Minister of Education dated from Nov 04, 1991; annex of order No. 03 dated from Jan 05, 1993) to establish *Training Methodology Classified Councils* with authority to make assessment and publish training program and textbooks of general education schools and to employ chairman, deputy chairman, and secretary under order by minister. Finally, we consider that the said measure would enhance quality of textbooks, level of training program, relationship between secondary, higher education and continuity of classes would be improved.

REFERENCES

- [1] Ya. Lyernyera, N. M. Shakhmayeva, "What a textbook should be: didactic principles of construction, in sequence," Part I-II, M, 1992.
- [2] V. P. Bepalko, "Theory of a textbook: Didactic aspects," M, 1988.
- [3] A. Sokhor, "About the didactic processing of science materials in textbooks (taking examples of physics), problems of school textbooks," M., 1978.
- [4] J. Gombojav, S. Batkhuyag, J. Battseren, D.Ragchaa, "PHYSICS-VI," Z. Badamsambuu and Ts. Nyamdorj, Eds. 1985.
- [5] L. Damba, Ts. Ragchaa, E. Radnaa E, "PHYSICS-VII," S. Batkhuyag and J. Battseren, Eds. 1984.
- [6] Ts. Nyandag, Ochirbat, S. Doyoddorj, "PHYSICS-VIII," G. Byambaa and L. Damba, Eds. 1985.
- [7] N. Altangerel, G. Byambaa, D. Khaltar, "PHYSICS-IX," D. Chultem and G. Gombojav, Eds. 1985.
- [8] D. Dambasuren, D. Gurdorj, N. Zundui, D. Tseren, "PHYSICS-X," D. Chultem and Z. Badamsambuu, Eds. 1986.
- [9] B. Burmaa, M. Ganbat, B. Jadambaa, "PHYSICS-VII," S. Batkhuyag and S. Danzan, Eds.1997.
- [10] M. Ganbat, B. Burmaa, D. Batbold, R. Maabazar, "PHYSICS-VIII," M. Ganbat, Ed. 1999.
- [11] G. Gombojav, O. Lkhagva, G. Batbyamba, "PHYSICS-IX," B. Jadambaa and G. Bold, Eds. 2001.
- [12] G. Gombojav, O. Lkhagva, G. Batbyamba, "PHYSICS-X," B. Jadambaa and R. Maabazar, Eds. 2001.
- [13] M.Gongor, Ts. Sodov, Kh. Khovd-Aba, N. Tugsuren, Ts. Erdenechuluun, "About textbooks and manuals which have been used for training of physics," Professional Education, vol. 10, pp 76-81, 1992.
- [14] N. Khajidsuren, Ts. Sodov, "Textbook – important pedagogical tools, scientific materials," vol. 01, pp. 87-93, 1998.
- [15] Ts. Sodov, J. Baigalmaa, "Technology to develop students' general and experimental learning skills in physical education," Education Research, vol. 3, pp 30-36, 2004.
- [16] A.V. Khutorskii, "Place of the textbook in the didactic system," Pedagogy, vol. 4, pp. 10-18, 2005.
- [17] "Mongolian Agency of Standard and Metrology (MASM): Physics and Astronomy in basic and secondary education standards," 1998.

- [18] I. Tuya, "Textbook analysis modeling," *Education research*, vol. 4(50), pp. 31-35, 2009.
- [19] UNESCO "Guidebook on textbook research and textbook revision", guideline for enhancing quality education, 2010.
- [20] J. Narantuya, "Issue for assessing quality of secondary education textbook," *Studies on education*, vol. 9, pp. 51-57, 2011.
- [21] J. Narantuya, "Textbook: What a dream should be?" *Education research*, vol. 4, pp. 31-36, 2012.
- [22] B. Bayarmaa, "Textbook development: at level of some foreign countries," *Education Research*, vol. 10(98), pp. 17-22, 2013.
- [23] R. Jigjiddorj, "Pedagogical issues of physics", 1996.
- [24] M. Nasanbuyan, G.S. Manyev, "Some issues in teaching of physics at secondary schools," *Gombojav*, Ed. 1962.
- [25] Ts. Sodov, M. Gongor, L. Udval, "Fundamentals of physics teaching," B. Jadambaa and Kh. Dondog, Eds. 2018.
- [26] B. Purev, B. Orgoi, "MECHANICS-VIII, Learning of physics as an elective subject," 1979.
- [27] S. Batkhuyag, Ts. Sodov, L. Jams, "Learning of physics as an elective subject: grades IX-X," N. Altangerel, Ed.
- [28] U. Bolormaa, Kh. Dondog, Yo. Jantsan, R. Maabazar, D. Oyun, D. Oyunchimeg, Ts. Sodov, "PHYSICS-ASTRONOMY (dedicated for basic education learners)," Ts. Sodov, Ed. 2004.
- [29] N. Amarjargal, J. Baigalmaa, I. Batmunkh, M. Gongor, R. Darkhijav, Ch. Dashnyam, L. Dolgormaa, D. Demchigsuren, D. Orgonbayar, B. Ulziikhutag, Ts. Sodov, N. Tugsuren, B. Tsendenbal, L. Tsendendamba, "PHYSICS-ASTRONOMY (dedicated for high school pupils or pupils are expected to admit colleges/universities)," Ts. Sodov, Ed. 2004.
- [30] E. Damdinsuren, S. Batkhuyag, Ts. Sodov, "PHYSICS," A.Samdan and P. Zuzaan, Eds. 1977.
- [31] E. Damdinsuren, S. Batkhuyag, Ts. Sodov, "PHYSICS," A.Samdan and P. Zuzaan, Eds. 1985.
- [32] E. Damdinsuren, S. Batkhuyag, Ts. Sodov, "PHYSICS," A.Samdan and P. Zuzaan, Eds. 1992.
- [33] E. Damdinsuren, S. Batkhuyag, Ts. Sodov, "PHYSICS," A.Samdan and P. Zuzaan, Eds. 2013.
- [34] R. Jigjidsuren, D. Khaltar, J. Gombojav, "PHYSICS-VII," D. Raghava, Ed. 1963.
- [35] G. Byambaa, G. Dodon, Ts. Nyandag, "PHYSICS-VIII," G. Dodon, Ed. 1975.
- [36] G. Byambaa, D. Gurdorj, D. Tseren, "PHYSICS-X," G. Dodon, Ed. 1975.
- [37] G. Byambaa, G. Dodon, D. Khaltar, Ts. Raghava, Ts. Nyandag "PHYSICS-IX," G. Dodon, Ed. 1975.
- [38] M. Ganbat, B. Burmaa, Ts. Amartaivan, J. Dulguun, Ya. Munkhsaikhan, S. Gendenjams, N. Sainbayar, A. Buyandelger, "PHYSICS-VII," N. Tugsuren, Ed. 2019.
- [39] M. Ganbat, B. Burmaa, B. Badam, J. Dulguun, Ya. Munkhsaikhan, S. Gendenjams, B. Purevjaln, "PHYSICS-VIII," N. Altangerel, Ed. 2019.
- [40] M. Ganbat, Ts. Amartaivan, Kh. Batbold, J. Dulguun, Ya. Munkhsaikha, B. Purevjal, "PHYSICS-IX," E. Damdinsuren, Ed. 2019.
- [41] M. Ganbat, B. Burmaa, Ts. Amartaivan, B. Bat-Otgon, G. Zorigt, Ya. Munkhsaikhan, D. Uurintuya, B. Tuvdendorj, "PHYSICS-X," Sh. Jargalsuren, Ed. 2019.
- [42] M. Ganbat, Sh. Chadraabal, O. Altangoo, Balt-Erdene, Bavuudorj, D. Uurintuya, Ch. Gonchigdorj, "PHYSICS-XI," Sh. Jargalsuren, Ed. 2019.
- [43] "PHYSICS – Core academic program of basic education (grades VI-IX) compiled by Ministry of Education, Science and Sports", 2015.
- [44] "PHYSICS – Core academic program of secondary education (grades X-XII) compiled by Ministry of Education, Science and Sports", 2016.

Autonomous Unmanned Aerial Vehicle Development: MAVLink Abstraction Layer

Marco Stephan
Professorship of Computer Engineering
Chemnitz University of Technology
Chemnitz, Germany
marco.stephan@s2015.tu-chemnitz.de

Batbayar Battseren
Professorship of Computer Engineering
Chemnitz University of Technology
Chemnitz, Germany
batbayar.battseren@informatik.tu-chemnitz.de

Uranchimeg Tudevdivgva
Professorship of Computer Engineering
Chemnitz University of Technology
Chemnitz, Germany
utu@hrz.tu-chemnitz.de

Abstract—In the domain of Unmanned Aerial Vehicle (UAV), the autonomy is getting more important. In order to reach a higher autonomy level, certain key software components have to be implemented. One of that is a middle layer, which lies between the decision-making higher-level and hardware-controlling lower-level components. This study aims to abstract the UAV control process by conceptualizing an abstraction layer for the UAV communication protocol.

In the context of the APOLI project, a MAVLink Abstraction Layer has been implemented to control and communicate with the UAV flight controller. Our proposed solution simplifies the usage of the MAVLink protocol significantly for the higher-level components. Also, the result indicates that an abstraction layer does have an advantage over existing APIs.

Keywords—unmanned aerial vehicle, UAV, autonomous mission, abstraction layer, MAVLink protocol

I. INTRODUCTION

Automated Power Line Inspection [1]-[3], also referred to as APOLI, is a research project carried out by the Professorship of Computer Engineering at the Chemnitz University of Technology. It aims to develop an Unmanned Aerial System (UAS) able to autonomously inspect power lines and detect damages of them. In the context of this project, we are developing an Adaptive Research Multicopter Platform (AREIOM) [2], which is a modular layered architecture, that can be used in any autonomous UAS.

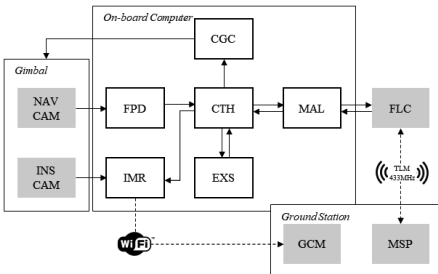


Fig. 1. APOLI Software Architecture [2].

In our autonomous system, the UAS is controlled by a single on-board computer, namely an ODROID-XU4 [4], being directly mounted on the Unmanned Aerial Vehicle (UAV). As illustrated in Figure 1, there are a number of

modular software components running on the on-board computer to execute the autonomous mission. Some of these components are the Camera Gimbal Controller (GCC), which controls the UAV’s gimbal, the Feature Point Detection (FPD) which detects objects that are to be inspected, as well as the Expert System (EXS) which chooses appropriate flight paths and makes real-time decisions. A separate component, the Control Handler (CTH), manages the communication and data conversion between the GCC, the FPD, and the EXS. In addition to the ODROID-XU4, a second board, the so-called Flight Controller (FLC), controls the individual actuators and sensors of the UAV on a lower level.

The protocol used for the communication between the FLC and the ODROID-XU4 is Micro Air Vehicle Link, or MAVLink [5]. As this protocol is too complex to be handled by the Control Handler itself, and the existing MAVLink APIs are not compatible and not supporting our system, the MAVLink Abstraction Layer (MAL) software component is proposed. The reason why these existing APIs are not the best solution is explained in detail in the Literature Review chapter.

The MAL abstracts the MAVLink protocol to be usable on a higher level and allows the companion computer to issue the flight commands on a high abstraction level. Furthermore, requested UAV data, e.g. GPS position or flight mode, can also be provided in a ready-to-use format.

II. RESEARCH QUESTION AND REQUIREMENTS

In this study, we will answer the question of how to abstract the MAVLink protocol for an autonomous UAS, considering the given requirements. Our main objective is to separate the decision-making layer of the autonomous system from the hardware or low-level software layers by implementing a MAVLink abstraction API.

The requirements are, firstly, and most importantly, it must be able to communicate with the FLC via a serial port so it can send data to and receive data from the Flight Controller. Additional communication interfaces that are to be supported for the communication between the MAL and the FLC are UDP as well as TCP sockets. These socket connections are necessary for integration into a software-in-the-loop simulation in which the FLC is running as a software component.

Furthermore, the MAL must provide a communication interface for the CTH-MAL communication. However, at the time of this article’s publication, the CTH has not been fully developed yet. Therefore, the MAL also mimics some basic logic of the CTH itself and provides a connection with the

Expert System. Communication with the Expert System is realized via file I/O. To issue a flight command, the software component, i.e. CTH or EXS, writes an encoding of the command into the corresponding connection. The MAL then needs to read this command, decodes it, and eventually executes it. If there is any response to this command provided by the UAV, e.g. the GPS position, it may then be written back into the connection by the MAL. After this, the CTH or EXS will read and evaluate this response.

In addition to these functional requirements, the MAL must also be efficient so UAV commands are executed as soon as they are issued. Furthermore, the MAL also has to fulfill high-reliability requirements. A failure of this component, while the UAV is flying, is disastrous and may result in crashes of the vehicle. Last but not least, the MAL must provide a cross-platform solution. While the APOLI's ODDROID-XU4 runs on a Linux distribution, the simulation loop runs on a Windows machine.

III. LITERATURE REVIEW

Currently, there are several MAVLink APIs available. The most popular MAVLink abstraction API is DroneKit [6]. It provides interfaces to control any UAV using high-level functions. Using this, flight commands like arming or a take-off are easily issued and handled by the DroneKit API itself. However, this API is not feasible for use in the MAL of the APOLI project. This is because DroneKit only provides an API for the Python programming language [7]. As Python is an interpreted language, the interpretation of the MAL itself requires additional resources that are to be avoided. Instead, a compiled programming language is preferred.

Another MAVLink API is MAVROS [8]. It is a package developed for the Robot Operation System (ROS) framework. MAVROS also provides, just like DroneKit, interfaces abstracting MAVLink commands. Unlike DroneKit, however, MAVROS can be used in the C++ programming language, and therefore, it can be integrated in a compiled language. That being said, MAVROS also entails some drawbacks. Firstly, it is relatively limited in its functionality. For example, MAVROS does not support issuing a reboot of the FLC. Another disadvantage of the API is that officially it is only supported on Linux.

A third MAVLink API can be obtained from the website of MAVLink itself [9]. There, they provide a C library for the MAVLink protocol. This library does not abstract the MAVLink commands themselves in any way but instead it provides functions to encode command parameters to byte streams equal to the MAVLink representation of that command. Furthermore, it provides functionality to decode the byte stream of received MAVLink messages so they can be evaluated as such. Additionally, the authors claim that this C library is "highly optimized for resource-contained systems with limited RAM". For these reasons, this library is more feasible for application in the MAL of the APOLI project. Furthermore, writing our own MAVLink Abstraction based on the MAVLink C library allows for more efficient use of the processor. For example, if the arming of the UAV is to be executed, our own MAL process can change into the blocked state and wait until an acknowledgment from the UAV has been received. It can then evaluate this acknowledgment to check whether the arming was successfully performed. Using DroneKit, we would either have to actively check whether the

UAV is armed using a loop or ignore a potential failure of this command altogether.

IV. IMPLEMENTATION

As declared before, the MAL should be implemented using a compiled programming language to be more efficient in comparison to an interpreted language. For this, the C language is feasible, because of the availability of the MAVLink C library. To further improve maintainability and code readability, the MAL is implemented in C++.

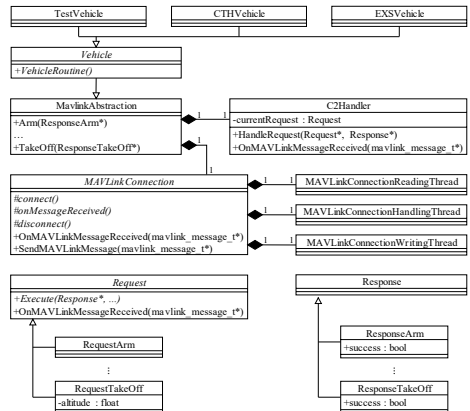


Fig. 2. Simplified MAL Class Diagram.

A. MAVLink Abstraction

As shown in Figure 2, an abstraction of the MAVLink protocol is implemented in the `MavlinkAbstraction` class. This class provides easy-to-use functions for the flight commands, e.g. `Arm()` or `TakeOff()`. Upon calling one of these abstraction functions, a command-specific so-called `Request` object is created. This object stores all parameters of the flight command, e.g. the take-off altitude. Additionally, it contains routines for the execution of the MAVLink command, i.e. encoding it to a MAVLink byte stream and sending the encoded MAVLink message. The `Request` object will then be passed to the `C2Handler`. This class manages the communication to the Flight Controller on a higher level. This means that it executes requests, forwards received MAVLink messages to them and also handles some basic MAVLink messages itself. For example, upon receiving a status message from the Flight Controller, the `C2Handler` outputs the text of the message to the console. By outsourcing the individual requests to separate classes, instead of implementing all of them in the `C2Handler` itself, this class and the requests themselves become much more manageable. In fact, in an earlier implementation of the MAL, this separation did not exist which led to an increasing number of lines of code that became harder to maintain over time. As elaborated before, the `C2Handler` forwards MAVLink messages to a `Request` object, if there is one currently executing. This is because a `Request` not only consists of sending a MAVLink command but most of the time also evaluates responses from the FLC. Such a response may be an acknowledgment or, if requested, flight data of the UAV.

The lower level implementation of the communication to the FLC is implemented in the `MAVLinkConnection` class. This abstract class provides functions to send and receive MAVLink messages provided as the low-level message structure of the MAVLink C library. The abstract component of this class is the connection to the FLC itself. Because this connection must be establishable via a serial port, a UDP socket, or a TCP socket, there are three child classes of `MAVLinkConnection`. Each of these classes overloads the abstract function to open and close the connection. In addition to this, `MAVLinkConnection` also consists of three threads.

- **Reading Thread:** Permanently reads bytes from the connection, builds a MAVLink message using these read bytes, and add it to a queue.
- **Handling Thread:** Unblocks, dequeues the received MAVLink message, and evaluates it by executing the appropriate function of the `C2Handler`.
- **Writing Thread:** Writes queued MAVLink messages to the connection.

The Reading Thread exists because the reading from the connection is implemented as a synchronous operation. This means that reading blocks until data could be read. This is to avoid busy-loops. Furthermore, writing to the connection may also block. This is especially true if a TCP socket is being used. To avoid blocking while sending a MAVLink message on a higher level, they are therefore queued for sending and sent to the Writing Thread. Lastly, the handling of received MAVLink messages is also outsourced to the Handling Thread. This is so the Reading Thread immediately returns to reading from the connection. Therefore, the chance of losing any data sent from the FLC is minimized.

B. Vehicles

Figure 3 illustrates the architecture of the implemented MAL. In the architecture, the specific use cases of the MAL are implemented in so-called `Vehicle` classes. Here, a vehicle denotes a specialization of the `MAVLinkAbstraction` class itself. Currently, there are three such classes.

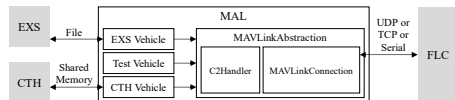


Fig. 3. Simplified Architecture of the MAL .

Firstly, the Test Vehicle is primarily created for testing and development purposes. It takes input from the console and executes the given command. If appropriate, additional parameters are also read. The execution of the command then, as described above, may block until the corresponding response has been received. For example, there exists a command that retrieves all relevant UAV flight data such as the GPS position. This command, which itself consists of multiple individual commands, blocks until all flight data is received. That data is then output to the console.

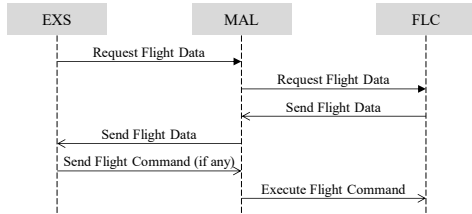


Fig. 4. Sequence Diagram showing the EXS-MAL-FLC Interaction.

The second vehicle is the EXS Vehicle. This class is used for communication with the Expert System. Figure 4 shows the communication sequence of this interaction. The Expert System first requests the UAV's flight data from the MAL which it provides by using its abstraction functions. After the MAL received the flight data, it sends it to the EXS. Then, the EXS evaluates this flight data and, if appropriate, sends a flight command to be executed to the MAL. This flight command is then executed by the MAL by using the corresponding abstraction function. Currently, however, the EXS does not exist in a state in which it is useable in such a manner and therefore the EXS Vehicle does not implement this sequence. Instead, the EXS Vehicle first requests the UAV's flight data itself. Upon receiving it, it is being written into the input file used for the communication with the Expert System. The EXS Vehicle then executes the Expert System itself once which modifies the output file. This output file then contains rules on how to handle the UAV data, i.e. the flight command to execute.

The last vehicle is the CTH Vehicle. This vehicle provides a basic loop intended to be used for the CTH communication. For the connection with the CTH, shared memory is chosen as it provides the lowest overhead and arbitrary data access is easily performed. More specifically, it permanently reads the shared memory block's command and, if there was one provided, executes it. In the future, the MAL shall also write all of the UAV flight data into the shared memory.

V. EVALUATION

The MAL has been tested in several environments. More specifically, the Test Vehicle has been used to evaluate the abstraction functions of the `MavlinkAbstraction`, e.g. arming. These commands have been tested in three phases. As a first phase, they were being evaluated in the simulation loop of the APOLI project. For this, the MAL has been built on a Windows machine. The MAL then has been started with command-line arguments specifying the address and the port of the simulated FLC (more precisely, these arguments are being passed to the `MavlinkAbstraction` class which then creates an object of the appropriate sub-class of `MAVLinkConnection`). All fifteen abstraction functions have been evaluated over a number of times. This includes the check whether the actual sent byte stream represents the correct command, which has been done by logging these streams into a file, as well as the evaluation of the received response data. These response data had to match their expected data in the corresponding flight environment. One issue that came up in this evaluation step was that several MAVLink commands were not supported by the FLC used. After the corresponding abstraction functions have been evaluated, the other two vehicles, i.e. the EXS and the CTH

Vehicle, have been evaluated as a whole. These tests succeeded, apart from some issues with the connection to the corresponding software component, right away. More specifically, the MAL executed the issued commands as well as provided the requested data in a fast manner.

TABLE I. IMPLEMENTED ABSTRACT COMMANDS

No	Commands	Description
1	Alt Hold	Change the flight mode to ALTHOLD
2	Guided	Change the flight mode to GUIDED
3	Land	Change the flight mode to LAND
4	Pos Hold	Change the flight mode to POSHOLD
5	RTL	Change the flight mode to RTL
6	Stabilize	Change the flight mode to STABILIZE
7	Arm	Start the motors
8	Disarm	Disarm the motors
9	Kill	Force disarm the motors
10	Take-off	Take the UAV from GROUND to AIR
11	Beep	Emit a sound
12	Move To	Move to a target location (latitude, longitude, altitude)
13	Move By	Move by an offset (forward, rightward, upward)
14	Get Device Data	Retrieve the flight data of the UAV
15	Pixhawk Reboot	Reboot the Pixhawk

After a MAVLink command has passed the simulation phase, it then has been tested in an indoor environment. More specifically, a UAV has been placed in a cage approximately the size of 4x4x3 meters. Most of the time if a MAVLink command passed the simulation phase, it also passed the indoor test without any problem. In cases where the indoor test has failed, the parameters of the indoor UAV differed from the simulated UAV. For example, the indoor UAV had its safety checks enabled while some of these were turned off for the simulated UAV. Therefore, arming sometimes failed the indoor test. This however does not represent an issue with the MAL and was therefore disregarded.

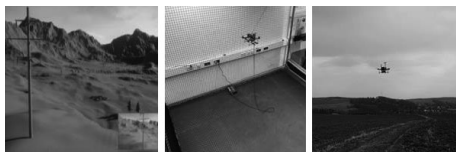


Fig. 5. Test environments.

As the last step, the MAL has also been tested in an outdoor environment once. Here, only the Test Vehicle has been used. Because the abstraction commands were already validated in the indoor environment, they worked as expected in the outdoor environment, too. It is worth mentioning though that the used thresholds to check whether a flight command, e.g. a take-off or a move command, has been successfully executed had to be adjusted. In the indoor environments, these commands were executed precisely, meaning that there was only little noise in the resulting UAV data. However, because of external influences in the outdoor environment, for example wind, the UAV's position temporarily had a larger distance to the expected position than expected.

VI. CONCLUSION AND FUTURE SCOPE

All in all, an abstraction of the MAVLink protocol simplifies the usage of this protocol drastically. Using the MAL, a user can easily write a MAVLink command sequence without the need to understand the underlying MAVLink commands executed or the need to evaluate responses from the FLC on their own. Lower level changes can also be applied more easily. While in the absence of a MAVLink abstraction, such changes have to potentially be applied several times, the MAL only needs to be changed once. For example, if the command to move the UAV had to be changed so a different underlying MAVLink message is to be used, only little changes need to be applied to the `MavlinkAbstraction` (or specifically to the move request). For the user, the abstraction interface does not change in any way. That being said, the biggest disadvantage of the MAL is the added complexity, both with respect to efficiency and maintenance. Using the MAVLink protocol directly to issue commands and request data is, if done correctly, more efficient than using a complex abstraction interface. This is because the user then has more control over the request made. Furthermore, the user then may only evaluate the responses necessary to be evaluated. Additionally, there is no overhead added by the abstraction classes and threads.

While the fifteen implemented abstraction functions were enough for the simple Expert System provided, in the future further abstraction functions are desired. For example, a function to circle around a specified point may be useful. Furthermore, the move commands implemented do not provide movement speed parameters so the exact speed cannot be controlled. However, this was mostly because the FLC currently does not support such arguments. In addition to these functionality aspects, another issue of the implemented MAVLink abstraction should be addressed in the future, especially if it is expanded upon. The `MavlinkAbstraction` class provides the user, if requested, with the flight data of the UAV. At the moment, this is done via a single abstraction function. However, this abstraction function internally requests several messages from the FLC in sequence. While this is done so the user receives all flight data at once, this also leads to the issue that all of these requests must be handled by the FLC regardless of if the user actually uses the corresponding data. A single flight data request may approximately take around 40ms to be completed. In the future, this flight data request should be separated so the user has more control of which data he requests and therefore is able to limit the amount of data the FLC has to process.

REFERENCES

- [1] U. Tudevadgva, B. Battseren, W. Hardt, S. Blokzyl, and M. Lippmann, "UAV-based Fully Automated Inspection System for High Voltage Transmission Lines."
- [2] H. Ariane, H. Reda, B. Battseren, and W. Hardt, "AREIOM: Adaptive Research Multicopter Platform," *IFOST*, pp. 219–223, 2019.
- [3] B. Battseren, U. Tudevadgva, and W. Hardt, "A Finite State Machine Based Adaptive Mission Control of Mini Aerial Vehicle," *Embed. Selforgan. Syst.*, vol. 5, no. 1, pp. 14–18, 2018, doi: 10.14464/ess5.1225.
- [4] Hardkernel co. Ltd., "ODROID-XU4: User Manual." 2015, Accessed: Aug. 05, 2020. [Online]. Available: <https://magazine.odroid.com/wp-content/uploads/odroid-xu4-user-manual.pdf>.
- [5] MAVLink, "MAVLink Developer Guide." <https://mavlink.io/en/> (accessed Aug. 05, 2020).

- [6] "DroneKit." <https://dronekit.io/> (accessed Aug. 06, 2020).
- [7] Python Software Foundation, "Python Language Reference." 2020, Accessed: Aug. 08, 2020. [Online]. Available: <https://docs.python.org/3/reference/>.
- [8] V. Ermakov, "mavros - ROS Wiki." <http://wiki.ros.org/mavros> (accessed Aug. 08, 2020).
- [9] MAVLink, "C (mavgen) - MAVLink Developer Guide." https://mavlink.io/en/mavgen_c/ (accessed Aug. 06, 2020).

Comprehensive Professional Competence Study of Legal University Professors

Narantuya Lkhundev
Department Law of the Orkhon University
Ulaanbaatar, Mongolia
narantuya@orkhon.edu.mn

Sodov Tsendambamba
Development center of Orkhon University.
Ulaanbaatar, Mongolia
Sodov_ts@yahoo.com

Abstract- We have clarified further objective and analysis requirements to lecturers who teach law in the university, and how to include and implement them in official legal acts. It's a challenge to foster in higher education of any professional area and level, the right proportion of competency of the subject matter, foundational competency and professional competency. We have administered questionnaires among law lecturers of National University of Mongolia, the Internal Affairs University, Ikh Zasag University and Orkhon University on their training, research and professional practice, and made a chronometrage of their daily work.

Keywords- *competence, law teacher in the university, performance indicators, Objective indicators of pedagogical work*

I. INTRODUCTION

One of the main challenges of our education sector, especially for the training and development of University professors who train various specialists, is the development of need based training policy for pedagogical activities. Many universities in our country are focusing on becoming research universities from training university at this time. Study and modeling of the operations of university professors who train specialists in various fields and reflecting them in their job requirements and qualification definitions has effect on improving the competitiveness and flexibility of graduates, as well as their professional skills.

Vocational professors of university master the content and develop methodology of teaching, as well as do scientific research. On top of which he/she has to have knowledge and complex competence (researching, training, personal) approach to education, psychology and professionalism of pedagogy, while consistently continue self development.

The university around the world has quality functions including to prepare specialists who work as their profession, to build a person, to organize training process, to prepare people who has liquidity in any fields, to organize training and research among the students and teachers, to prepare specialists in scientific organizations. Therefore teachers who work in university have features that to research and teach students, masters and doctors simultaneously.

Hundreds of years ago V.I.Vernadskii noted that the university has a form to organize scientific work and it has become one way to access to culture of whole humanity through higher education.

This presentation is about the findings of a research on the academic activities of law school students and teacher-professors, with focus on the foundational competency results.

Training programs should incorporate a set of competencies that take into account the complexity of knowledge, flexibility of methods, critical thinking, market awareness and current developments, demand based on the psychological characteristics of the individual, which will form the fundaments for proper decision making ability [1]. The comprehensive competencies of graduates of higher professional education consist of two parts: firstly, they are necessary for professional activities, and secondly, they are necessary for success in life and activities (development of social skills and personal development) [2]. The bachelor's degree graduate is prepared primarily on the basis of five groups of subjects: socio-personal, general academic, instructional, professional and professional.

II. THE PAINT PART

The status, activities and workload of lecturers in higher education institutions have been included by the examples of trainings, research of law teachers. It has become a priority for higher education to research into the characteristics of the profession, duties and status of professors at higher education institutions by developing the ergonomic basis for psychological diagnosis, prognosis, personal development, improving graduate-professionals capacity, and intensifying the process using market incentives.

One of the challenges of law education is to train lawyers with the basic competencies to meet the requirements of a broad and competent application of law norms in the law services market. A law teacher is unique in the sense that he/she is a transmitter of law culture – the regulatory aspect of social life, acquires the content of educational values based on professional and moral qualities, transmits professional knowledge to students in an understandable way, evaluates phenomena correctly, and actively influences them with law awareness. He/she should be able to diagnose the work of his or her students, plan the learning process to work individually, perform it independently, plan activities, formulate goals, use a variety of advanced learning technologies to implement them, and have the following professional competencies [3]:

- Cognitive - to reflect the knowledge, skills and activities of educational institutions in teaching the subject in accordance with the law norms, and to link the training with the profession.
- Psychological-pedagogical - basic knowledge of psychology and pedagogy of higher education, ability to work with students individually, ability to conduct educational activities based on their diagnosis
- Management - the ability to manage social processes and educational systems, processes, and to analyze and organize the learning process
- Problem solving - proposing and solving problems in planning professional activities and evaluating results
- Information - the ability to search, process and use various information in modern information technology tools in professional activities
- Communication - knowledge and skills of written communication, speaking and pedagogical communication.

At the same time, self-directed learning, humanization of education, democratization, competitiveness, intellectual and moral freedom to grow as a professional teacher, independence from others, intellectual strength to overcome life's challenges, law and educational changes. Nowadays, students are required to have a high level of intellectual and cultural awareness, to teach their research skills in the field of law, and to constantly improve their pedagogical, psychological and pedagogical skills.

We have included a total of 68 teachers from the Law Enforcement University, the Law School of the National University of Mongolia, the Law School of the University of Mongolia, the Law School of the University of Ulaanbaatar, the Law School of the Ikh Zasag, and the Law School of the Mongolian National University; in the research for information acquisition, processing, training, vocational training, and self-analysis. Table 1 shows the self-assessment of these skills by professors [4].

TABLE I. ASSESSMENT OF ONE'S ABILITIES BY LAW TEACHERS

Question \ Ability	A. Have you mastered these skills? B. Did you develop these skills during the law research? C. What skills do you need to prepare to teach? D. Note your underdeveloped or mandatory skills?			
	A	B	C	D
Communicate	40.4%	20.6%	4.4%	2.2%
Obtain, process and use information.	33.8%	22.8%	4.2%	6.6%
Training	33.4%	22.4%	8.8%	2.4%
Professional	35.5%	21.5%	7.5%	2.8%
Examine herself	41.0%	18.4%	4.4%	4.0%

Explanation: Number in the table shows average percentage of the answer.

This assessment shows that law teachers are well-versed in these skills, and that they have sufficient training, professional training, and skills to be more mature and useful when preparing for law research and teaching. However, the ability to obtain and process information in common foreign languages using modern information and communication tools is underdeveloped or needs to be further developed.

The study of how to build the basic competencies of law professionals has shown that the cooperation of universities,

professors and law enforcement experts is very important in developing new teaching methods and taking into account the needs of students.

The professional description of a law teacher includes the psychological norms and professional requirements for his/her professional activities, the essential nature of the profession shall include the content of the activities that define his/her professional goals. However, the model shows the comprehensive professional competence of law teacher by reflecting the type of professional activity and qualification of the teacher in the qualification as shown in Figure 1 [6].

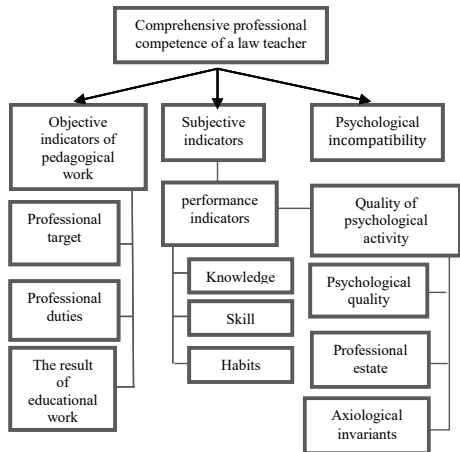


Fig 1. Comprehensive professional competence of a law teacher

According to our many years of research, there is a need to ensure the effectiveness of pedagogical activities in tertiary law education in front of the universities of our country, and there is no system for objectively evaluating the activities of professors and teachers; there is also a conflict between the need for their professional development and the ability to provide a level of expertise. The results of our research show that there is a need to improve the teaching methodology by identifying ways to improve it based on a detailed study and analysis.

Actual indicators of law professional teacher training (professional goals, responsibilities, teaching results); subjective indicators (performance indicators, knowledge, skills, habits, psychological characteristics, estate); There is a psychological assessment that is necessary to achieve these goals. Some researchers [3] teach law teachers methodological skills (giving students the ability to summarize and analyze law phenomena); ethical (related to accountability for professional and social actions); communication skills (stabilizes law relations based on verbal and non-verbal communication); We are pleased that the ability to work with sources of information (training in the use and efficient organization of information resources in the field of law relations) should be provided through additional training.

The Law professor of the University must have at least a master's degree in Law, mu have theoretical knowledge and

practice in teaching the subject, mastered research methodologies, possess knowledge of any common foreign language at a level of using professional books and literature and as well as skills and capabilities to develop methods to teach the materials, must have abilities to use communication technologies and tools, must be able to follow the ethics of a lawyer and a professor, and have professional and polite communication skills. In addition, the following knowledge, skills, competencies, and characteristics are required. Including:

Knowledge: Science-based foreign language, cyber information and communication technology curriculum design, development of new methods for technology, pedagogy, general information and culture.

Skills: Communication, public speaking, creativity, collaboration, research, methodological, correct and effective expression of ideas, independence, patient acceptance of what students say and write, discernment.

Competence: Responsibility, ability to withstand pressure from critics, independent research, basic professional competence of subject research, critical approach to the work of others and oneself, abstract thinking, identification of key issues in disputes, accurate assessment of phenomena, an appropriate use of cultural, ethical, and scientific research methods and results in teaching.

Characteristics: Emotional self control, observant, exploratory, humane, principled, interest in the profession, personal discipline, self-confidence, curiosity, sociable, legal awareness.

III. CONCLUSION

The law teachers of the surveyed universities have good communication, information skills, self-examination, professional training and teaching skills, and sufficient training skills, professional training and skills are better than when conducting law research and teaching; mature and useful. However, the ability to obtain and process information in common foreign languages using modern information and communication tools is underdeveloped or needs to be further developed.

During the research on how to build the basic competencies of law professionals, one of our observations

was that the cooperation of universities, professors and law enforcement specialists is very important in developing new teaching methods [5].

In order to eliminate the discrepancy between the need to ensure the effectiveness of pedagogical activities in Mongolian universities, the lack of a realistic system for evaluating the activities of professors and teachers, the need for their professional development and the possibility of ensuring the level of professional evaluation, professors of some Russian universities - Developed a standard for teaching professors and a standard of bachelor's degree in law approved by the Bachelor of Law Standards and Metrology in Resolution No. 36 of 2007, and developed a standard for university professors and teachers, and the average number of civil servants for senior lecturers. It is recommended that a salary commensurate with the salary be based on a credit hour system.

ACKNOWLEDGMENT

We would like to thank the members of the Symposium Organizing Committee and all those who provided in-depth assistance in conducting the research and writing the presentation.

REFERENCES

- [1] N.V.Kornichenko, "Competitiveness of the future specialist in the labor market conditions", Higher education today, 2008. vol.10, pp.72-74.
- [2] V.A.Devisilov "Competence-based Higher Professional Educational Education Standards: Structure and Content Issues", Higher education today, 2010. vol.9, pp.18-22.
- [3] V.D.Shadrikov "New specialist model: innovative training and competence-based approach", Higher education today, 2004. vol.8, pp.26-31.
- [4] L.Narantuya, Ts.Sodov, "Implementation, objectives, requirements of law teacher", 2019. vol.08/156, pp.28-37.
- [5] L.Narantuya, "Some issues of university professor-teacher evaluation", Research conference of OU, 2010. vol.11 pp.165-175.
- [6] L.Narantuya, Ts.Sodov "Basic Competence Study of Law Students and Teachers", "Challenges of Didactics in Preschool, Primary, Secondary and Higher Education" Proceedings of international scientific conferences, 2015. pp.144-150.

Assessing the Progress of Children's Competencies

Narantuya Jamyandorj
Department of Science and Engineering
University of Mandakh
Ulaanbaatar, Mongolia
narantuya@mandakh.edu.mn

Ganbat Tsend
School of Information and Communication
Technology, Mongolian University of Science and Technology
Ulaanbaatar, Mongolia
ganbat@must.edu.mn

Abstract—The purpose of this paper is that it can be used as a model for assessing the ability to understand and perform tasks of preschool children and compare them with other children, determining their progress in basic education, and estimating how they change with age and gender. The research was conducted among 60 girls and boys in a kindergarten. The method developed in this study suggests that training and play programs for children should be developed for each age and gender.

Keywords—Child and computer interaction; Child and cognition; Machine learning

I. INTRODUCTION

Pre-school education in Mongolia aims to develop young children through their own characteristics, skills, and creativity and to provide them with basic pre-school education. The content of the training includes the acquisition of language or speaking and thinking skills, the development of drawing and creativity. The basic teaching tools are visual materials and games. Procedures have been adopted to assess children's abilities, competencies, and developmental progress.

Pre-school education covers all children from the age of two to the time of enrollment. Kindergarten training is organized in primary, secondary, senior, and preparatory groups. Kindergarten is staffed by professional teachers. The head of the kindergarten has the right to test and introduce advanced methods and forms of teaching activities, and the teacher has the responsibility to discover and develop the talents, skills, and interests of the children.

The core curriculum of preschool education states that children must learn through all the senses gaining experiences. This includes listening to the teacher's instructions with the ears, seeing with the eyes, searching in the memory, reflecting and pointing to, holding, and moving the given material. For example, brushing teeth with a brush, combing hair with a comb, drawing on a paper with a pencil, painting shapes with colored pencils, picking up toys, etc. The teacher keeps a brief observation note on each child. It is also necessary to evaluate the progress of each child and compare the overall assessment of the children in the class [10, 11].

The teacher can give a task a child to draw the red dot on the paper and connect it with the green dot using a pencil. In this case, the teacher can record the time the child understood the teacher's task and the time it took to draw it. Also the children can be given a task to switch a shape from red to green using a smart phone. The authors conducted the survey data using smart devices (Fig.1.)



Fig. 1. A task to switch a shape on a smart phone.

II. RESEARCH DATA COLLECTION

Sixty male and female pre-school children aged 3 to 5 years (10 males and 10 females in each age group) were randomly selected and instructed by the teacher, the time for understanding and performing the task were recorded on the smart device [7, 8].

Task: Switch the "red" figure to the "green" one.

Before giving the task, the teacher records the child's age and sex on a smart device. As soon as the teacher has finished telling the child the task, the teacher records the time (su) when the child begins to think. After the child listens to the task, the device records the time (eu) that takes to finish thinking as soon as he places his finger on the screen.

If we consider the time to understand as u_time , it will be as follows:

$$u_time = eu - su \quad (1)$$

Once the child has switched the red shape to the green one, the device will record the time (em) that takes to complete the task.

If the time for performing the task is denoted as m_time , it will be as follows:

$$m_time = em - eu \quad (2)$$

The following table shows the identification numbers of the first 30 children, their age, gender, and the time taken to understand the task and the time taken to complete the task in (centisecond).

TABLE 1. Research data

ID	age	gender	u time	m time
1.	3.1	male	4089	245
2.	3.1	male	625	224
3.	3.3	male	8741	547
4.	3.1	male	5535	252
5.	3.1	male	4256	285
6.	3.1	female	2272	505
7.	3.3	female	4548	165
8.	3.6	female	327	239
9.	3.6	female	2197	446
10.	3.6	female	1127	247
11.	4.6	male	1418	293
12.	4.3	male	2853	125
13.	4.4	male	1301	770
14.	4.5	male	1229	298
15.	4.4	male	5048	190
16.	4.5	female	4699	497
17.	4.5	female	1379	463
18.	4.3	female	1485	311
19.	4.10	female	1375	626
20.	4.3	female	325	347
21.	5.6	male	1348	201
22.	5.3	male	1003	330
23.	5.6	male	3492	670
24.	5.7	male	5389	368
25.	5.7	male	1580	275
26.	5.3	female	4585	209
27.	5.8	female	856	277
28.	5.5	female	1759	139
29.	5.4	female	1766	778
30.	5.3	female	2155	284

III. METHODOLOGY

A vector space can be created on the two axes of time u time and m time to represent the time that each child will understand and perform the task in vector space. Each child can be considered as a vector with two coordinates. Rocchio's formula was used to find the average time to understand and complete the task for each age and gender. It was developed by Rocchio in 1971 and is a formula for finding the centroid coordinates of points in vector space [2].

$$\vec{\mu}(c) = \frac{1}{|D_c|} \sum_{d \in D_c} \vec{v}(d) \quad (3)$$

V(d) - Coordinate of d vectors

|Dc| - the length of the corresponding coordinates of the points

The cosine similarity formula for finding the similarity of two vectors was used to find out if the competencies of the two children were the same within the class.

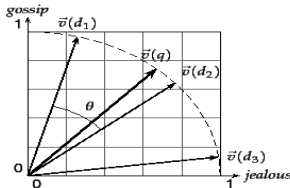


Fig. 2. The similarity of the two vectors will be found at angle. ($\text{sim}(d_1, d_2) = \cos \theta$)

The similarity of the two vectors in vector space will be found with the formula of cosine similarity.

$$\text{sim}(d_1, d_2) = \frac{\vec{V}(d_1) \cdot \vec{V}(d_2)}{|\vec{V}(d_1)| |\vec{V}(d_2)|} \quad (4)$$

Here V(d1) - d1 coordinate of a vector
 V(d2) - d2 coordinate of a vector
 |V(d1)| - d1 length of a vector

Using these two formulas shows how different the time of understanding and performing the task depending on children's age and gender.

IV. PROCESSING

The round blue shapes are 3-year-old boys and the triangular green shapes are 3-year-old girls; the rectangular shape is the centroid.

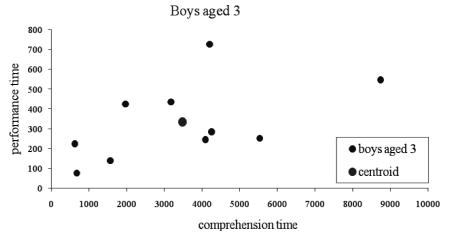


Fig. 3 Boys aged 3, their centroid.

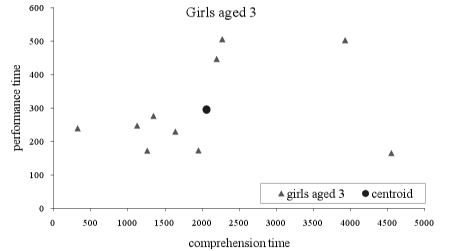


Fig. 4 Girls aged 3, their centroid.

In the same way the average centroid of boys and girls aged 4 and 5 was found.

With the centroid, children can be divided into the following four categories by their age and gender.

1. Children with good comprehension and performance
2. Children with good comprehension, but slow performance
3. Children with slow comprehension, but good performance
4. Children with both slow comprehension and performance

If we mark as c_x and c_y according to the coordinates of the centroid, the above 4 categories are defined as follows:

1. Class C1 of points with (x, y) coordinates that meet the condition of $0 < x < c_x$ and $0 < y < c_y$. Here will be involved the children who can understand and perform the task successfully.
2. Class C2 of points with (x, y) coordinates that meet the conditions $c_x < x$ and $0 < y < c_y$. Here will be involved the children who understand the task slower, but perform it successfully.
3. Class C3 of points with (x, y) coordinates that meet the conditions $0 < x < c_x$ and $c_y < y$. Here will be involved the children who understand the task successfully, but perform it slower.
4. Class C4 of points with coordinates (x, y) that meet the conditions $c_x < x$ and $c_y < y$. Here will be involved the children who understand and perform the task slower.

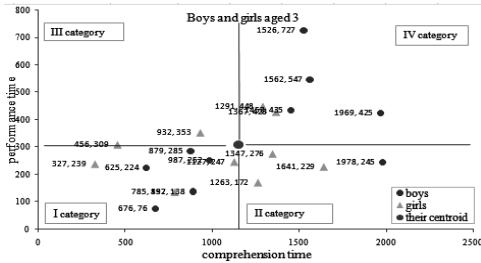


Fig. 5. Boys and girls aged 3, their centroid.

With the data of the 20 children aged 3, the probability of entering the four categories divided by h children was calculated.

$$P(h|C1)=8/20=0.4$$

$$P(h|C2)=4/20=0.2$$

$$P(h|C3)=2/20=0.1$$

$$P(h|C4)=6/20=0.3$$

In addition to this, the probability for the children of other remaining ages was calculated. As children got older, their chances of getting into C1 increased and their chances of getting into C4 dropped.

V. RESULTS

The graph shows the progress of boys' competencies.

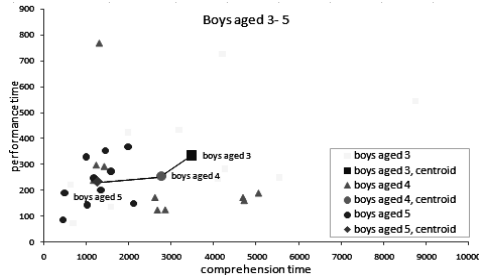


Fig. 6. Boys aged 3-5, their centroid.

In the same way, the progress of boys' competencies was determined with a graph. The following table shows the age and gender differences for children who successfully understood and completed the task.

TABLE 2. Age and gender difference and changes

	Age, gender	P(B A)
1.	All children aged 3	0.4
2.	All children aged 4	0.5
3.	All children aged 5	0.6
4.	Boys of all ages	0.59
5.	Girls of all ages	0.48
6.	Children of all ages	0.63

Judging from this, children's competencies are different with their age and gender.

VI. CONCLUSION

The authors have come to the following conclusion after this research work.

1. For 3-year-olds, girls have a higher ability to understand and perform tasks than boys, but with age, boys are able to understand and perform faster than girls.
2. Boys are slower to understand a task, but they perform better than girls.
3. This study is not an assessment of a child, but a measurement that is taken to determine a child's cognition level.

Except for using centroid, there can also be used achievement scores gained by all children to determine children's competencies.

REFERENCES

- [1] I.Scott MacKenzie, Fitts Law as a Research and "Design Tool in Human - Computer Interaction", 1992.
- [2] Rocchio, J.J.; Relevance Feedback in Information Retrieval. The SMART Retrieval System, pp.313-323, (1971).
- [3] Elomaa, T. & Rousu, J. (1999). General and Efficient Multisplitting of Numerical Attributes. Machine Learning 36, pp. 201-244.
- [4] Auer P. & Warmuth M. (1998). Tracking the Best Disjunction. Machine Learning 32, pp.127-150.
- [5] Breiman L., Friedman J.H., Olshen R.A., Stone C.J. (1984) Classification and Regression Trees, Wadsworth International Group.

- [6] S. B. Kotsiantis, Supervised Machine Learning: A Review of Classification Techniques, pp. 249-268, 2007.
- [7] Anry Vallon, "Formation of characters", 1934.
- [8] J. Batdelger, "A test to determine the general level of mental development of a child", Ulaanbaatar, 1996s
- [9] Ts. Ganbat, D. Sarangerel, "Human and Computer Interaction", Ulaanbaatar, Mongolia, 2018,
- [10] Law on preschool education, Laws of Mongolia. 2008.
- [11] Order # A/327, Policy on preschool education, 2013 .

Analysis of User Interface design methods

Nikolai Gervas
Computer Engineering department
Novosibirsk State Technical University
Novosibirsk, Russia
nik.gervas@mail.ru

Abstract — The article tells about the main approaches and methodologies for UI design, as well as the design process in general. Basic methodologies usually describe UI design in terms of an ergonomic aspect, rarely consider the features of functional design. Therefore, the article deals with the analysis of requirements and the role of the functional aspect in UI design. The decision to research this topic arose while developing its own web-application “Fireproof Corporation”. Therefore, the considered features of functional design will be accompanied by own examples from this application.

Keywords — *User Interface, analysis of requirements, design, aspect, scenario.*

I. INTRODUCTION

Actual problem for any web-application is the design of an effective interface, where efficiency is understood as simplicity of development, ease of maintenance and working with the program. There are enough standard methodologies and recommendations for UI design. However, most of the research is on the ergonomic aspect. The important point in UI design is the functional aspect. The user interface design process and its relationship to systems analysis (requirements analysis) should be investigated. The research began with the development of its own web-application “Fireproof Corporation”. During the development, several design oversights were made, which were corrected and analyzed. In the article, it will also be considered from the point of view of the functional aspect.

II. ANALYSIS OF UI DESIGN APPROACHES AND METHODOLOGIES

First of all, when analyzing UI design methodologies, design approaches should be considered. There are two approaches to UI design: Machine-Centered and Human-Centered [1]. These two approaches, in fact, represent an automated system at the highest level of detail (“human || computer”) and consider the interface development process either from the standpoint of a human operator or from the side of the functionality of a computer.

Machine-Centered approach to creating a UI is based on the assumption that a person works with a computer like the computer itself, i.e., according to a certain algorithm.

The algorithmic modeling technique GOMS (“Goals - Operators - Methods – Selection rules”), representing this approach, assumes that the result obtained when the user performs a certain task is a goal. To achieve it, the user can perform elementary actions - operators. A sequence of statements that allows you to achieve a goal is called a method. Selection rules based on the “if-then” principle allow changing the control flow. The structural scheme of this technique is shown in Fig. 1.

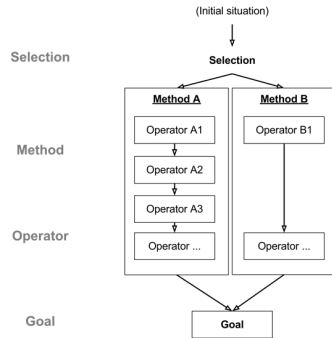


Fig. 1. Scheme of GOMS methodology.

Due to the fact that Machine-Centered approach to interface design is focused on the functional characteristics of the program, the user working with it is forced to “think like a developer”.

Human-Centered approach, which replaced algorithmic modeling, considers the user as the central figure in the process of interacting with the system. Orientation to the characteristics of the user, the study of perceptual and cognitive capabilities and limitations of a person made it possible to identify patterns of human interaction with an automated system. Considering the processes and patterns of perception, information processing and decision-making, cognitive psychology identified the factors that determine the success of the operator's task. And these turned out to be not the functional characteristics of the system, as it was assumed by engineers earlier, but the quality of the provision and management of information in terms of human capabilities and limitations.

However, as it turned out, the analysis of only the processes of perception and processing of information by a person is not enough to design an ergonomic interface, since it does not allow determining the composition and sequence of information displayed on the screen. This has led to the emergence of a number of cognitive-based UI design methodologies.

Activity-Centered Design. This methodology considers the “man-computer” system as a complex of related activity concepts and representations. The theory of activity underlying this approach presents the computer as a tool with which a person solves various problems and it is human activity that affects the interface [1, 2].

According to the principles of activity theory, the entire stream of user activity can be decomposed into a sequence of related tasks and subtasks, logical stages. This allows to analyze goals, external and internal tasks, the order and type of user operations performed to achieve the final result, and

based on the results of the analysis, develop an interface that is most suitable for this type of activity

Goal-oriented design. This user interface design methodology, which Alan Cooper is the ideologist of, is based on the premise that a careful study of the user's goals and understanding of what they are aiming for can solve the problem of "cognitive friction" [1, 3]. Cognitive friction is a concept introduced by A. Cooper and characterizes a person's attitude to a complex thing (for example, to a computer) as to another person. This attitude arises in situations where a person cannot understand how and why this thing works (or does not work).

User-Centered Design. The methodology has gained justified popularity and is applied not only in software development. Its essence boils down to studying the needs and capabilities of end users and adapting the product to their needs. In other words, it is the concept of creating products, including software, that people would like to use.

All the considered methodologies have a design process similar to each other. User interface design usually consists of several main consecutive steps [7-8] shown in Fig. 2:

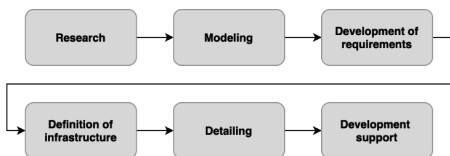


Fig. 2. UI design process structure.

- Research - collecting data about users of the product.
- Modeling - behavioral patterns identified through analysis are collected in the form of domain models.
- Development of requirements - analysis of data associated with characters, their functional needs and interaction with other characters in various contexts.
- Definition of infrastructure - the creation of a common product concept, a concept of behavior, graphic design and physical form.
- Detailing - similar to the infrastructure stage, but more focused on implementation details. Completion of design work.
- Development support - adjustment of design decisions.

For the purposes of this article, we are interested in the requirements analysis process and its relationship to UI design.

III. ANALYSIS OF REQUIREMENTS. FUNCTIONAL ASPECT

It has already been discussed in the article that in the methodologies for designing the UI, ergonomic standards are mainly described. In software design methodologies (e.g. Unified Process), UI development is a secondary activity. It is believed that if the functionality is sufficiently developed in the form of requirements and scenarios, then UI problems are limited by the features of graphic design, ergonomics, etc. [5, 6]. This is not entirely correct, because the functional aspect also plays an important role in UI design. The functionality of a software system should be considered the semantics of its UI. In this case, the role of syntax is played by expressive

forms of the interface and the sequence of manipulations with them. It is difficult to talk about the quality of the interface functionality regardless of the subject area, for example, to formulate the "guidelines for the functionality" of the user interface. Formally, it can be associated with the degree of "fit for purpose" [4]. This is described in the ISO 9241-10-1996 Ergonomic requirements for office work with visual display terminals (VDTs), p. 10, Dialogue principles. Referring to this same standard, p. 11, Guidance on usability specification and measures, we can assess the quality of the UI using three broad criteria:

- effectiveness - the effect of the interface on the completeness and accuracy of the user's achievement of the target results.
- efficiency or the effect of the interface on user productivity.
- the degree of subjective satisfaction of the user with this interface.

Efficiency is the criterion for the functionality of the interface, and the degree of satisfaction and, indirectly, productivity is the criterion for ergonomics.

When talking about the functional aspect of UI design, we need to consider such an important detail as requirements analysis. As described in the ISO 13407:1999 (Human-centered design processes for interactive systems) standard, user-centered design begins with a deep understanding of the needs and requirements of users. Methods for collecting requirements are not considered in this article, as it has been extensively researched. The main interest is processing requirements and functional interface design based on it.

Scenarios. All functional requirements are presented as scenarios. A scenario is a description of actions performed by a user in the framework of solving a specific task on the way to achieving his goal. Different types of scenarios are used at different stages of goal-oriented design, and at each subsequent stage more attention is paid to interface features than at the previous one. The first type of scenarios are contextual scenarios created during the initial design stage, written from the point of view of the character, and focusing on human actions, impressions, and desires. Next comes the development of key path scenarios that focus on the most important moments of the interaction, without losing sight of how the character uses the product to achieve his goals. Throughout the process, the design team uses test scenarios to test design solutions in various situations. Based on the identified scenarios, the structure of screens is developed, the number of screens, the functionality of each of them, navigation links between them is determined, the structure of the menu and other navigation elements is formed [6].

For clarity, it is necessary to consider an example scenario. The article will look here and further on examples from my own developed web-application "Fireproof Corporation". It should be said that the system is quite complex and contains many business entities related to each other. Therefore, scenarios usually involve the use of several core entities. Let's consider a simple scenario for adding basic information for the "object" business-entity. Fig. 3 shows the main panel of this business-entity, which contains basic information about the entity.

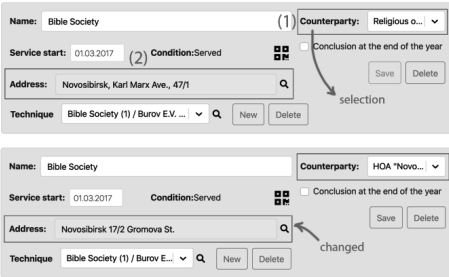


Fig. 3. Scenario for changing counterparty and address.

The administrator manually fills in all the fields with information: name, address, counterparty, etc., which is a painstaking process. It should be noted that both business-entities "object" and "counterparty" have a specific address. We know from the system requirements that the addresses are most often the same. Thus, we can get rid of an unnecessary action - the constant filling of the object address. It is enough to implement the interface in such a way that when the appropriate counterparty is selected, the address will be set automatically. With some exceptions, when the addresses of counterparties and objects do not match, the address can be manually changed. Fig. 3 shows that when the appropriate counterparty (1) is selected, the address (2) is automatically set for the object. With the help of such scenarios and requirements analysis, we can get rid of unnecessary steps in the early stages of UI design.

General structure design. Once we have defined the scenarios, we move on to designing the overall structure of the system. To do this, it is necessary to highlight individual functional blocks and determine how exactly these blocks are connected to each other. A separate functional block will mean a function or a group of functions related by purpose or scope.

Fig. 4 shows typical structures of common sites and complex technical systems. While sites are usually forked, in the sense that functions are usually placed on separate screens, then complex applications usually have only one changing screen, in which almost all functions are called.

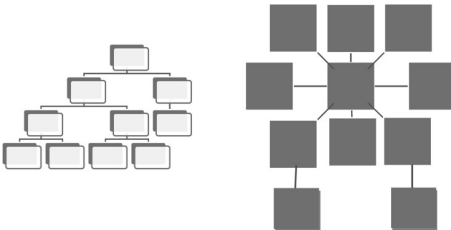


Fig. 4. Typical site structure (left) and complex application (right).

The implemented web-application "Fireproof Corporation" has the structure of a complex application shown in Fig. 4 on the right. This UI model was named "The cockpit", because a large number of functionalities is located as compactly as possible on one page. Also, the advantage of this interface is the use of context-sensitive elements and

positioning. The interface of the "contracts" page in the web-application is shown in Fig. 5.

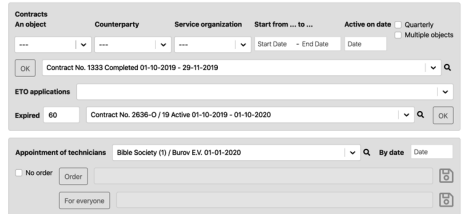


Fig. 5. Interface of the "Contracts" page.

The design of the general structure consists of two parallel processes: the allocation of independent blocks and the determination of the relationship between them. The allocation of independent blocks is performed based on the list of individual functions identified using user scenarios. In the application, a function is represented by a function block with a corresponding screen form. Typically, several functions are combined into one function block. On the ergonomic side, functional blocks on the page should be visually separated from each other. This is done using colored rectangular blocks.

Navigation. The navigation process should be designed to help users determine where they are, where they have been, and where they can go in the future. It is difficult to give any specific recommendations for this work, since a lot depends on the designed system.

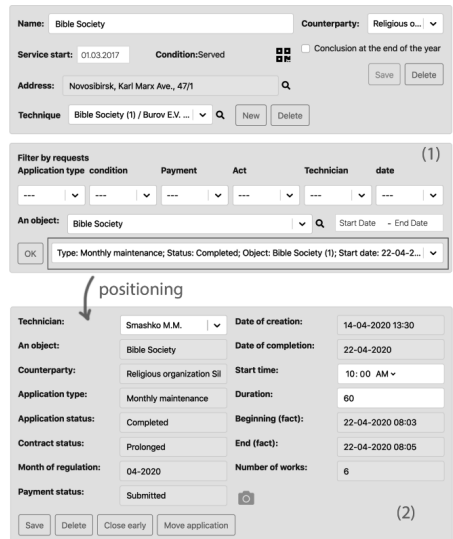


Fig. 6. Positioning from the "object" page to the selected application.

In the developed application, navigation is implemented in the simplest way in the site header. Each page (large functional block) has a corresponding tab. Based on the fact

that the system interacts with a large number of related business entities, a mechanism for positioning the business entity of interest to us is implemented (shown in Fig. 6). Suppose we are on the “object” business-entity page (1) and want to view one of its “application”. Choosing one application from the list, we automatically go to the page of the “application” business-entity (2) and can view the already selected information about this application.

Without the implementation of such a positioning mechanism, the user would have to independently go to the “application” page and look for the application of interest in the list.

Chains of scenarios to execute. In a complex technical system, positioning between pages can be performed within a complex scenario. Requirements analysis identifies which scenarios are typically executed sequentially. When you combine these scenarios, you can understand that some steps are unnecessary and will complicate the use of the program. Consider a typical scenario: we have an object in the maintenance where repair work is to be carried out. Therefore, we have the following sequence of actions:

- creating an object in the system.
- creating an application for this object.
- distributing an application using a calendar-scheduler.

It is necessary to simplify this process with automatic positioning. A visual representation of the chain of action is depicted in Fig. 7 as the corresponding business entity pages.

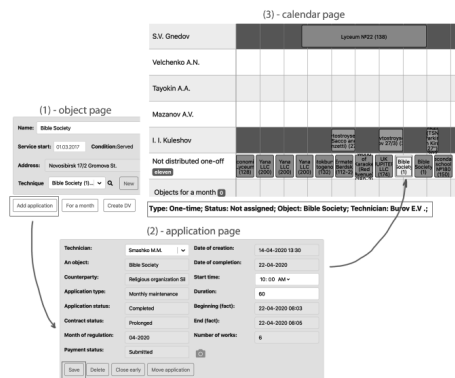


Fig. 7. Scenario for creating an application for an object.

First of all, we fill in the newly created object with information and click on the “Add application” button (1). After that, we automatically position ourselves on the page with applications, where we have an application that is already automatically created and filled with information (about the object, time of creation, etc.). Such functional design greatly facilitates the user’s work, since he would have to do all the automatic work manually. We also know from the

requirements analysis that the created applications are usually distributed immediately. Therefore, when saving the application (2), we automatically position ourselves on the page of the calendar planner. We also keep the context and among all the applications the one that we just created is selected (3). Everything is automatically ready for distribution.

CONCLUSION

As a result of the work, the main approaches and methodologies used in UI design were considered. The methodologies deal mainly with the ergonomic aspect, although the analysis of requirements and user needs is also taken into account in all the methodologies discussed. Despite this, not enough attention is paid to the functional aspect in UI design. In the software design methodology, UI development is a secondary task, it is considered that it is enough to work out the functionality. The article reviewed the process of requirements analysis, scenario development, the role of the functional aspect in UI design. Using examples from the own developed web-application “Fireproof Corporation”, the features of functional design identified during the analysis of requirements were considered. It is difficult to talk about some fundamental rules when designing the functional part of the UI, it is necessary to start from a specific subject area. Despite this, the developed set of rules and recommendations can help designers avoid obvious mistakes.

The next step towards developing own methodology is to consider the relationship of UI design with the main architectural patterns of the MVC / MVP / MVVM. Information can be found about the functional aspect in various methodologies, but the consideration of the relationship between architectural patterns and specific types of UI is not given in the methodologies, therefore this is a new research and approach. Certain types of UI should not be implemented using certain patterns, this will lead to system complexity and possible errors. This study contains an engineering approach and is aimed at helping software developers directly.

REFERENCES

- [1] A. Anatolyev, “Design of human-machine interfaces,” 2014. [online]. Available: <http://www.4stud.info/user-interfaces/>
- [2] D. Holmes, “Activity Centred Design,” 2018. [online]. Available: <https://medium.com/dermot-holmes/activity-centred-design-dd28ed1ec659>
- [3] Qubstudio, Design Agency, “How to Design Products with Goal-Centred Design,” 2018. [online]. Available: <https://qubstudio.com/blog/how-to-design-useful-products-with-goal-centered-design/>
- [4] E. Volchenkov, “User interface standardization,” 2002. [online]. Available: <https://www.osp.ru/os/2002/04/181312>
- [5] E.L. Romanov, G.V. Troshina, A.A. Yakimenko, “Teaching Software Engineering. A glance from the code,” vol. 8, no. 5, 2016. [online]. Available: <http://naukovedenie.ru/PDF/66TVNS16.pdf>
- [6] Brusentsova, T. P. Designing user interfaces: a guide for students of specialty 1-47 01 02 “Design of electronic and web publications”. Minsk: BSTU, pp. 172, 2019.
- [7] V.V. Golovach, User Interface Design. Russia, pp. 762, 2000.
- [8] S. Krug, Do not make me think. Web Usability and Common Sense. Moscow, Russia: Eksmo, pp. 229, 2014.

Developing an Information Culture for Teachers

Nyamsuren Amsarvaa
Science section
Orkhon Khasu secondary school
Ulaanbaatar, Mongolia
nyamsuren_a@orkhonschool.edu.mn

Tsedendamba Sodov
Teacher development center
Orkhon university
Ulaanbaatar, Mongolia
sodov_ts@yahoo.com

Abstract— Teachers' information culture is becoming more important in mastering modern information and communication technologies and introducing them into training and developing every student. Due to the fundamental changes in the teaching methods and attitudes of teachers, developing an information culture for professionals has become an important goal of education policy to build professional knowledge, skills and abilities, as well as the ability to create and use information resources.

Keywords— *information culture, teacher information culture, information and communication technology*

I. INTRODUCTION

In today's world where teachers' information culture is becoming more and more important for mastering and introducing modern information and communication technologies, the development of teachers' information methods and attitudes is fundamentally changing, so developing information culture for professionals has become an important goal for creating knowledge and skills.

An important condition for the transition from an industrial society to an information society is the development of an important component of open education for teachers - the information culture. There is a conflict between the need to use information and communication technologies (ICT) in education and the training of teachers to use them in the lessons they teach. First of all, this is primarily due to the lack of information culture for teachers; Second of all, many teachers are not sufficiently prepared to use new information technology in their teaching; Third of all, teachers and students are less motivated to use information technology in education. At a time when the pedagogical culture of teachers includes a comprehensive information-pedagogical capacity, the information culture is an orderly system of knowledge, skills and practices of ethical norms and cultural-spiritual values that ensure the activities of the person whose object is information [1].

Although information and information technology courses are taught in all levels of schools in our country, in addition to teaching materials, students and graduates need to be able to use ICT freely in solving many educational, household and professional tasks in today's society. This time, I wanted to study the teacher's information culture and the current situation in which it is used, and to share with you some of my experiences and opinions.

II. THE MAIN PART

The Teacher's Information Culture is an integral part of a teacher's general culture that incorporates knowledge, skills, and worldviews about information in a global networked information society in a professionally oriented, health-oriented manner. The teacher information culture includes elements of worldview, cognition, action, and ecology, and by mastering such a culture, one can communicate information in a way that is understandable to others by working with, structuring, systematizing, and summarizing it.

In general, a teacher's knowledge of computer involves computer knowledge (software usage, programming, educational process planner), ability to use new ICT tools to solve educational problems, ability to cooperate with students in developing themselves using telecommunications during the learning process, quick testing of others knowledge, reflecting necessary information into training. As teachers become more information literate, their teaching methods improve, as do their professional qualities, personality traits, aspirations, attitudes, and personal qualities.

For example, procedures for collecting, processing, storing, retrieving, using, and disseminating information are specific activities with information objects, so that ICTs not only enable a person to use information, but also work with information, acquire a moral and ethical culture, and develop cognitive skills.

First of all, the ability to use information and information technology; Secondly, the ability to communicate with ICTs by selecting what you need from the information resources, recognizing the importance of using information in print and electronic form and understanding the conditions that affect the source of the information; Thirdly, an information culture can only be achieved through a comprehensive set of knowledge, skills, and practices that support ICT and human action on moral norms, cultural, and spiritual values. Therefore, the level of teacher's information culture is the knowledge of information, information processes, models and technologies; the ability to develop and analyze information tools in a variety of activities and to use open information systems (the Internet, its services, and resources) in teaching is determined by practice. Create an information-intellectual environment by using the opportunity to create a teacher-site by posting the necessary information to your students on your Web-site; there is a need to constantly assess the comprehensive competencies of students in the field of

information culture using computers, local and global networks.

The content of a teacher's information culture is related to the holistic ability to master it. It is interesting and interesting to distinguish between ICT-based professional development, pedagogical activities, student education in the context of informatization of education, essential professional relations, and cooperation between stakeholders in education [6]. According to the results of the survey, we evaluated the information culture assessment of secondary school IT teachers. The ability of the surveyed teachers to work with information and textual information was 41% on average, and the ability to analyze the information found was 38%; Ability to translate information in common foreign languages independently and by computer, to search the Internet for search engines and specialized sites 34.7%, ability to work with WWW (Netscape Navigator, MS Internet Explorer, etc.) 37.5% %, ability to work with electronic textbooks, trainers and experts 23.8%, ability to search the library for necessary information from general and electronic catalogs and specialized journals 26.2%.

The methodology for using ICT in training is: first, ICT in certain circumstances, and the rules for selecting these components; Second, the planning, editing, selection, and adaptation of ICTs to specific subjects in a specific psychological-educational context; Third is the science of applying technology to achieve the learning objectives in a specific context of psychological-pedagogical content of a subject. Therefore, the training to use this ICT is:

- a. Explain the learning process using ICT
- b. Analyze existing ICTs
- c. Introduce ICT in certain pedagogical and psychological contexts
- d. By creating and modeling ICTs on their own, it is possible to enrich and develop the methodology for their use (to provide a pedagogical basis for studying the realities of pedagogy).

Taking this into account, teachers need to consider the relationship between content, purpose, principles, methods, activities of educational subjects, and diagnosing and monitoring the learning process when developing a methodology for using ICT in the classroom. According to I.M.Bogdanovskaya and others [2], the role of ICT in solving professional goals in the activities of educators-

psychologists has increased, taking into account the specifics and principles of information in pedagogy and psychology. For example, the use of the Internet, e-mail, computer tests, spreadsheets, databases to save time, increase the accuracy of calculations, detailed analysis, psychiatric diagnosis, editing information using the above technology and computer games, multimedia technology, graphic editors, Internet. It is possible to conduct social dispatching activities using e-mail, electronic presentations, multimedia technology, printing systems, graphic editors, consulting and enlightenment, and inviting highly qualified specialists to improve the quality of co-created materials without spending time.

We studied the pedagogical ability to develop a methodology for using ICT in the learning process using a model developed by I.N.Semenova and A.V.Slepukhin [3] (see Figure 1).

The teacher begins by planning a pedagogical approach to the student's activities based on a study of their students' interests and learning abilities. Practice has shown that it is necessary to take into account the potential impact of the teacher, as well as the possible pedagogical goals, possible pedagogical assessments and possible conditions for the learning process. Experiments have shown that our high school students are very willing to combine laboratory lessons with virtual and real-world experience [5].

We use the activities of teachers to implement ICT and diagnostic methods:

- a) Teacher knowledge of the pedagogical opportunities and features of ICT implementation;
- b) The teacher's ability to determine the course of action;
- c) The methodology for using ICT in professional practice is considered at the following three levels.

After learning to do such activities, a teacher can become an ICT trainer, caregiver, and consultant. In addition, the teacher becomes motivated and creative in all of these activities. In other words, a teacher with an information culture logically connects all the stages of modeling, planning, implementing, evaluating, diagnosing, forecasting, correcting, and motivating learning activities in a logical sequence to the specific characteristics of their students, the educational environment, and the current state of ICT. Students will be able to plan and implement lessons according to their abilities.

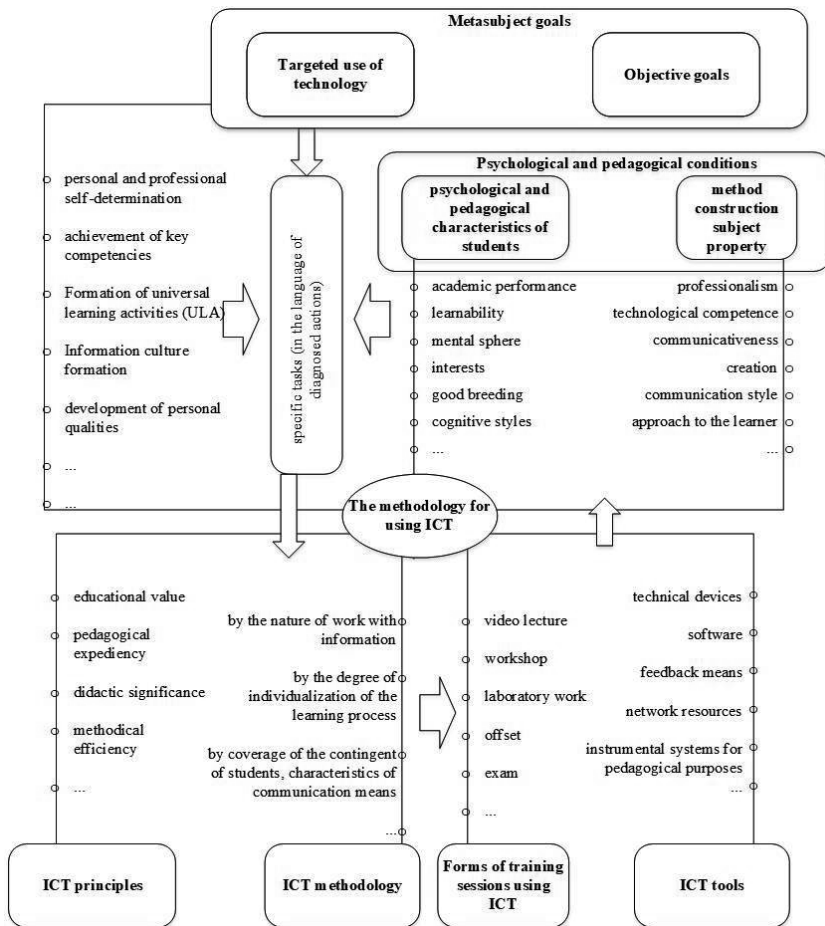


Fig. 1. A functional model of pedagogy to develop a methodology for using ICT in the learning process

One of the key factors in informing the learning process is the teacher's level of information culture, which determines the following unique and important indicators of the profession:

- Interest in improving the educational process using information technology and the need to constantly update their knowledge in the field
- Cautious and humane approach to news and information objects on the Internet, critical analysis of information use
- Ethical, realistic and patient approach to computer-network communication
- Democratic, ethical and ethical aspects of pedagogical communication and interaction with others in a virtual environment
- They will be able to adapt to the information society and have professional energy.

Due to the Covid-19 pandemic in 2020, all countries around the world are conducting online training and taking exams at all levels. In this regard, we are conducting some research and experiments to develop a methodology for preparing computer presentations and video lectures for teachers in the field of information culture.

III. CONCLUSION

1. A teacher working with students can only play the role of disseminator of information culture only if he or she constantly develops himself or herself [4]. By cultivating all the qualities of a teacher, we become a teacher (a source of professional knowledge, skills, practices, and experience), a counselor (a student who completes assignments online, a counselor in accessing Internet resources, and answers questions), and a facilitator in the learning process (to

conduct activities, to manage their joint activities, to organize administrative work), motivator (to encourage students to be creative and to acquire knowledge independently), planner (to plan and organize the learning process in the most effective way), can be a facilitator (facilitator of learning).

2. Create and use an open educational media system (educational site, Moodle system, ...) related to the psycho-physiological characteristics of the student-subject studying online, living environment, employer's order, and national development prospects. The challenge is to communicate results and share experiences.

3. Always keep in mind that students have the right to develop their curriculum. In addition to the exercises and assignments given online, the content of the lectures should be changed to suit their interests and needs, and the views of parents, the media, and other stakeholders should be explored. The challenge for the education sector is to develop ICT methodologies and technologies in the curricula of teacher training colleges and in-service teacher training programs, to organize a wide-ranging discussion of teachers' results and to implement them as a matter of urgency.

IV. REFERENCES

- [1] T. P. Zaichenko "Information culture as a psychological and pedagogical factor in the development of universal educational activities of students", 2015.
- [2] I. M. Bogdanovskaya, T. P. Zaichenko, Yu. L. Project "Information technologies in pedagogy and psychology", Saint Petersburg, 2015.
- [3] I. N. Semenova, A. V. Slepukhin "Methods of using information and communication technologies in the educational process" Part 2, Yekaterinburg, 2013.
- [4] M. Delgerjav, A. Adiyasuren, B. Bolormaa "Teacher training problem (survey review)", Ulaanbaatar, 2020.
- [5] Ts. Sodov, B. Purevaj "Research on the use of information technology tools in physics teaching", Educational research, №5, Ulaanbaatar, 2020.
- [6] L. N. Denisova, L. N. Chernova "Information culture of a teacher and renewal of professional education", Successes of modern natural science, No.5, 2011, p133-136.

“Mathshop” E-Learning Mathematics Program - Experiments And Opportunities For Future Development

Otgontugs Bayarrintsen
Foundation for Education Loan,
University of Finance and Economics
Ulaanbaatar, Mongolia
ts_oogiinoo@yahoo.com

Erdenebat Dashtseren
School of Mathematics and Natural Sciences, Mongolian Institute of Educational Research
Mongolian State University of Education
Ulaanbaatar, Mongolia
erdenebat.d@msue.edu.mn

Lhagvasuren Purev
Ulaanbaatar, Mongolia
lhagvasuren@mier.mn

Bilguunbaatar Tumurkhuyag
Baganuur joint stock company,
University of Finance and Economics
Ulaanbaatar, Mongolia
Bekedoiz@gmail.com

Abstract—The “Mathshop” e-learning math program is experimentally used by 263 randomly selected 12th grade students of high schools. The results of the experiments show that practice with Mathshop could help the participants to achieve better performance in the General admission test.

Keywords: Covid-19 learning, e-training, MathShop, self-learning,

I. INTRODUCTION

Among many sectors, deeply affected by the COVID-19 pandemic situation, the education sector emerged as one of the hardest hit and therefore required necessary adjustments. As per Mongolia, the education sector took steps into an unchartered, unprepared and unfamiliar territory of “e-learning” as replacement of “classroom learning” system, amid COVID-19 situation, starting 2nd week of 3rd semester of 2019-2020 school year.

It was major challenge for every secondary schools, universities and colleges. Yet, in order to overcome this challenge successfully within short period of time, collaborating with privately-owned training centers that offer e-learning program was wise and time-saving decision. Herewith, we will discuss how such collaboration between MATHSHOP e-learning initiative and Education department of Baganuur district benefited their target school children.

II. DEFINING THE NEEDS OF THE EXPERIMENT AND EVALUATION

A. Social perspectives

Following needs emerged due to emerging pandemic situation namely: try to preserve learning environment and process as much as could; not to lose behind global education system’s performance; further develop Mongolian children, intellectually; introduce innovative ways and technologies to educate children; maintain sustainability and inheritance of training curriculum; provide equal learning opportunities; improve access to education; improve outcomes and quality of education system; help children and adolescences spending their leisure time, effectively.

B. Consumers’ perspectives Maintaining the Integrity of the Specifications

- School and teacher: Conduct tailored training based on each child’s uniqueness, current level and learning speed; Promote confidence and creativity in children; Promote self-learning skills; teach them how to use extra training materials; increase parents’ involvement in children’s learning process.
- Parents: Support children’s learning processes (signing them up for extracurricular activities and helping on the homework); Educate children in a safe and healthy environment; Check on children’s grades and performances, regularly.
- Student: Learn successfully and stay on top of their program; constantly improve their grades; spend leisure time efficiently; always challenge yourselves by comparing with others; pick a subject to study in an advanced level; compete on a tournament and tryouts; learn foreign language(s); get admitted to an international institution; to fulfill Mongolian program requirement if living and studying in a foreign country with parents.

C. Program developers’ perspectives:

Improve quality of and access to mathematics education for all within the framework of social responsibility; develop respective programs further based on consumers’ desire and needs AND provide continuous support.

OBJECTIVES OF THE EXPERIMENT AND EVALUATION

- To introduce modern and innovative learning tool to Mongolian children and youth
- To bolster advantages and benefits of “MATHSHOP” e-learning mathematics program during global pandemic situation and quarantine
- To support school children who are not familiar with the e-learning transformation
- To study opportunities to further develop and improve the program

PROGRAM PROFILE

Meant for school children through Kindergarten to 12th grades. 0-7 grades have beginner, intermediate and advanced levels.

- a. To familiarize with the basic concepts
- b. To connect with previous knowledge and solve complex problem
- c. To solve critical thinking and complex problem by using basic concepts

9-12 grades have only 1 standard level for each. A student is considered to be meeting the criteria of each level when is able to solve all problems and tasks. Grade 12 program features various problems covering 75 different topics and most of them can be randomly assigned which makes it unrepeatable. It also has a section on General admission test. This interactive program features multiple functions such as fill-in-the-blank, choose, paint and draw, when solving problems.

III. METHODOLOGY OF THE EXPERIMENT AND EVALUATION

Total of 10 interviews were conducted among students during the experimental period. Such qualitative data collection processes were supported by essential steps such as taking notes, making analyses on weekly statistical results of solving problems and overall performances of the General admission test.

A. Collaborating partners

Education Department of Baganuur district of Ulaanbaatar city, "GUN GALUUTAI" complex school, "Education" complex school, "OYUNII ERIN" complex school, 24 randomly selected students from "Sod" secondary school (who have expressed their interest to participate and had prepared, accordingly), their parents/guardians, masters students from Non-profit organization's management program of Finance and Economics University, "MATHSHOP" Program developers and Senior executives of MOSS LLC.

B. Duration: 2020.4.1-2020.6.14

C. Phases of the experiment

- Introduction phase: Activities such as identifying key partners and target students, making them familiar with the program, get registered and briefing on users guidelines, took place in this phase.
- Monitoring use of the program and provision of additional support phase: Program uses of randomly selected students are regularly monitored in this phase. Number of solved problems, success rate, and actual spent time were also being recorded, weekly basis. Students were informed with their own performance scores and follow-up supports and praises were given, when necessary.
- The phase to introduce users' comments and suggestions to the program developers. Participating students were encouraged to document and share whichever flaws or relevant suggestions

that they may have with the program developers. Such two way communications were instrumental to improve the program.

IV. RESULTS

Ninety percent of the participants have responded that the "MATHSHOP" is the new tool and program that enabled individual learning techniques, skills and experiences, provided new knowledge while saving time. It was definitely interesting for students to solve math problem by using computer program, even more so, finding out whether they solved it correctly or not at the moment was a rewarding and motivating. Students were able to work on more problems within less days proved that it was a worthwhile. 14,023 is the total number of math problems solved by the participants during the experiment.

A. Total of 263 students' math skills were tested in Baganuur district and their average scaled score¹ was 524.99 (initial score² 32.14). This ranked them in the 1st place, nationwide.

Student B.Batsugar, one of the experiment participants from "Education" complex school, got the highest score while student B.Altan-Ochir, out of "Gun Galuutai" complex school took the 2nd place. The Fig. 1 shows the comparison of average scores. The average scaled score among all participants was 604.71 (79.72 score higher than the district average which was already ranked on top of the nation). The Fig. 2 shows comparison of initial score scores. The initial score of participant group was 45.33 (13.19 score higher than the district average). There were 3 students who have scored over 700, 8 students with over 600, 12 students with over 500, only 1 student with below 500 scores (484 scores), respectively. The Fig. 3 and Table 1 show the comparative results from the last two years.

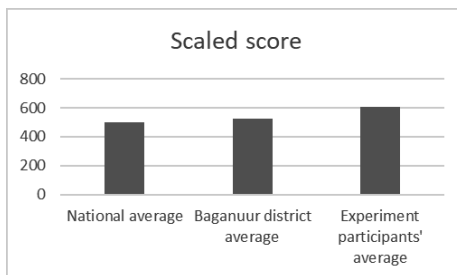


Fig. 1. Comparison of national average, Baganuur district average and experiment participants' average scaled scores

"It was a difficult time for us due to COVID-19 quarantine, not knowing how to prepare for the General admission test. Fortunately, MathShop program provided us detailed tools and methodology of solving various math problems step by step, in both online and offline settings. Offering bilingual (Mon and Eng) choices were super helpful for us who were also studying English.

¹ Scaled score is the score of an individual compared with all those tested.

² Initial score is the result of solving particular subject theme and task. It is expressed in percentage that is compared to maximum potential percentage.

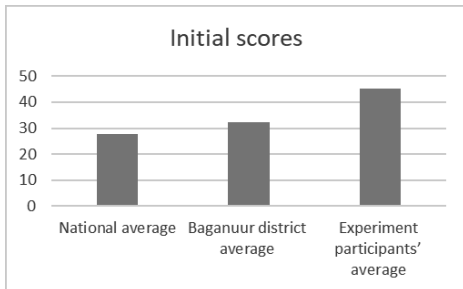


Fig. 2. Initial scores across the abovementioned 3 groups

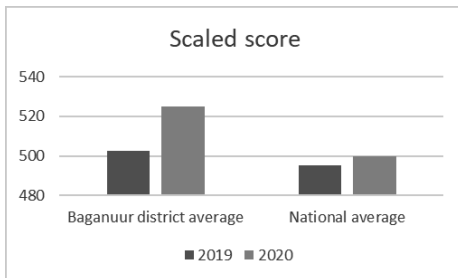


Fig. 3. Comparison of scaled scores between national and Baganuur district values from the last 2 years (2019, 2020)

TABLE I THE COMPARISON OF SCALED SCORES BETWEEN NATIONAL AND BAGANUUR DISTRICT VALUES FROM THE LAST 2 YEARS (2019, 2020)

Year	The national average	Average of Baganuur district
2019	495.05	502.6
2020	500.01	524.99
Improved percentage of scaled scores	1.0	4.5

By clicking on the help button we could always find necessary support without going through books. As a result of participating in this experiment, our self-learning skills and methodologies have gotten better. Most importantly, we got accepted to the schools we wanted, thanks to much improved General admission test score. Last but not least, we would like to thank the MathShop team for helping us out and inviting our feedback when developing this great program, further” says M.Tsenguun, E.Khosbayar and

O.Mungunbayar students from Baganuur districts’ participating schools.

B. Following set of recommendations were made for the program developers based on feedbacks of participants of the experiment.

- Make the registration part shorter
- Regularly update and fix identified flaws with program writing
- Look at similar programs, internationally
- Update website and interface of the program as well as make them more tailored to children

CONCLUSION

In 2018, “MATHSHOP” program was initially introduced in 2 kindergarten and 2 secondary schools (schools # 33 and “SHINE UE”) in order to demonstrate programs upbringings and positive results were disseminated at the number of events. This time, we supported high school students from 4 secondary schools out of Baganuur district of Ulaanbaatar city with their quest of preparing for the General admission test and the collaboration was successful. Once again, it is proven that “MATHSHOP” is the effective e-learning program as overall test scores of our participants improved, significantly.

The “MATHSHOP” program, which was built by’ leading scientists and professionals’ team, possesses crucial advantages of meeting the modern innovative teaching techniques and methodologies, stimulating students’ self-learning skills while being cost-effective and pandemic sensitive. Thus, we extend our invitation for collaboration to decision makers of the education sector, entrepreneurs, program developers and all other interested parties, in scaling up the “MATHSHOP” e-learning program’s use at the national level.

REFERENCES

- [1] P.Lkhagvasuren Ph.D, U.Oyunkhand, D. Erdenebat, B.Otgontugs, Interpreting student’s knowledge in Mathshop program implementation of Bayesian knowledge tracing, Management and Innovation scientific journal, №2(008), pp.103-107, 2018
- [2] P.Lkhagvasuren Ph.D, U.Oyunkhand, D. Erdenebat, B.Otgontugs, Interpreting student’s knowledge in Mathshop program implementation of Bayesian knowledge tracing, IBS International Symposium on Computer Science, Computer Engineering and Educational Technology 2019, Wolfram Hardt, pp.44-48, 2019
- [3] П.Лхавгасүрэн, Д.Эрдэнэбат, Б.Ганццэг, Математикийн хичээлийг цахимдуулах нь, МУ-ын ШУТИС Эрдэм шинжилгээний бүтээлийн эмхтгэл, pp20-24, 2018
- [4] <http://ecc.mn/?p=956>
- [5] <http://list.ecc.mn/>

Collision Warning Based on Multi-Object Detection and Distance Estimation

Shadi Saleh

Department of Software Engineering
Technische Universität Chemnitz
Chemnitz, Germany
shadi.saleh@informatik.tu-chemnitz.de

Chirag Rellan

Masters Embedded Systems
Technische Universität Chemnitz
Chemnitz, Germany
chirag.rellan@s2018.tu-chemnitz.de

Shubham Pareshkumar Surana

Masters Embedded Systems
Technische Universität Chemnitz
Chemnitz, Germany
shubham-pareshkumar.surana@s2018.tu-chemnitz.de

Julkar Nine

Department of Computer Engineering
Technische Universität Chemnitz
Chemnitz, Germany
julkar.nine@informatik.tu-chemnitz.de

Wolfram Hardt

Department of Computer Engineering
Technische Universität Chemnitz
Chemnitz, Germany
wolfram.hardt@informatik.tu-chemnitz.de

Abstract— Road accidents are a leading cause of non-natural deaths around the world. Traffic safety is of utmost priority in the modern age. This problem can be reduced by implementing a collision warning system that tells the driver when a vehicle is too close. However, assisting the driver in real-time is a challenging task. Traditionally, it requires high-end hardware and different and sophisticated algorithms for different environments. These algorithms require high expertise, to create and deploy inside a vehicle. In this paper, we discuss deep learning-based approaches to solve the problem at hand. Deep Neural Networks are notorious for their high computational costs and latency while performing object detection. Two approaches with low inference time and reduced complexity are discussed here to create a setup to perform real-time object detection with acceptable accuracy. A system is created such that a camera can be mounted onto a car that captures the scene in front of it. Then the Deep Neural Network detects and classifies the objects in the scene and estimates their distance from the host vehicle. A warning is then displayed when the distance is low to avoid a collision. The warning can be in the form of a visual cue, to alert the driver in advance.

Index Terms—, DNN- Deep Neural Network, SSD- Single Shot Detector, TensorRT, YOLO- You Only Look Once.

I. INTRODUCTION

Road traffic accidents, otherwise known as, “The Neglected Epidemic” are a leading cause of non-natural deaths around the world. According to WHO, 20-50 million people suffer non-fatal injuries every year in traffic accidents [1]. Vehicle-to-vehicle crashes are the most common amongst road traffic mishaps. Smart vehicle systems such as Vehicle detection and Collision warning can be used to improve traffic safety. Humans need only glance once and immediately know what is in front of them, how they behave [2]. Computers and automation systems, on the other hand, do not perceive the surrounding environment in the same way as humans do. “Object Detection” is spotting an object of interest in the scene, then, localizing it by drawing a bounding box around it and classifying it into one of many different classes [3] e.g. Human, Car, or Bus, etc. “Distance Estimation” is approximating the distance between the detected object, normally another vehicle or target object, and the host vehicle. “Collision Warning” is alerting the driver of an impending collision in advance if the detected object is too

close. Integrating Distance Estimation with Object Detection could play a significant role in efficient Collision Avoidance Systems[4] and can support a wide range of applications [5]. However, this task has been extensively investigated using traditional Computer Vision (CV) methods. Nowadays, integrating Object Detection and Distance Estimation based on visual sensors have gained much attraction and outstanding outcomes since the introduction of Deep Learning [6]. A Deep Learning approach has proven its outstanding performance in high-level perceptual and cognitive tasks such as detection, recognition, and understanding of scenery. Neural networks are much more suited to such tasks than traditional CV methods, as they [7]:

- Have higher accuracy when used for tasks such as image classification and object recognition.
- Require less problem-specific expertise.
- Provide more flexibility: the same neural network could be retrained for a different problem.

Deep Neural Networks such as RCNNs[8], YOLO[2], and SSD MultiBox[8] can be deployed for the vehicle detection task.

The remainder of this study is organized as follows: in the next section stating the goals of the study. In section III, former work concerning object detection and related fields is reviewed. Gaps in those works are examined briefly here. Next, the methodology of our proposed methods is shortly described in section IV. Afterward, in section V, a comparison between existing approaches and our approach alongside results is provided. Section VI concludes the paper and states the next steps of the proposed research.

II. RESEARCH OBJECTIVE

Our main objective is to predict to estimate a light paradigm/model of object detection and distance estimation with minimal space and power consumption requirements as well as real-time capability. Nowadays, a variety of neural network architectures are available for object detection. However, due to different performance parameters such as inference time, mAP (mean Average Precision), etc. not every neural architecture can be employed for our purpose. In this paper, we investigate models that are appropriate for inference on embedded GPUs.

A. Why is this important?

Deep Neural Networks are computationally expensive. This is primarily because millions of parameters need to be calculated and tuning for performing inference on even a single frame of a video. Thus, high-performance hardware, such as a desktop-grade computer complete with a discrete graphics card, is required to perform object detection (or inference) in real-time. However, the hardware available in a vehicle has only limited resources. A solution must, therefore, be developed to reduce the computational requirements of these DNNs.

In this paper, 2 different DNN architectures are examined, namely "Tiny YOLO" and "SSD MobileNet", which are tailor-made for low-performance hardware. These are implemented on a development board with embedded GPU to emulate the type of hardware inside a vehicle. The board used here is NVIDIA Jetson Nano. A monocular camera is utilized to capture the scene in real-time and provide input to the models.

Table 1 STATE OF THE ART TECHNIQUES FOR OBJECT DETECTION

Technique	Year	Benchmark used	Frame rate	mAP (%)	Verdict
Feature Extraction [9]	2004	Images from roads	-	~97%	Works with images
GMM based [10]	2016	Real life	30	96.85%	Static camera position
Faster R-CNN (VGG-16) [2]	2015	Pascal VOC 2007	7	73.2	Low fps
SSD-300 [11]	2016	Pascal VOC 2007	46	74.3	Good overall performance
SSD-500 [8]	2016	Pascal VOC 2007	19	76.8	Low fps at this resolution
YOLO [2]	2016	Pascal VOC 2007	45	63.4	Better performance than fast YOLO
Fast YOLO [2]	2016	Pascal VOC 2007	155	52.6	Very high frame rate but low precision

III. LITERATURE REVIEW

Nowadays three approaches are possible for object detection: Traditional CV techniques, approaches based on Machine Learning, and approaches based on Deep Learning. Table 1 above shows a comparison of the techniques from different approaches.

Traditional Computer vision approaches, which work on hand-crafted feature definition [7]. However, roads are dynamic, meaning that there can be different illuminations, backgrounds, etc. The location of vehicles, their size, and shape can be everchanging.

Machine learning models provide a better solution to this problem. They can extract features from input data and perform classification [12]. However, domain expertise is required to design feature extractors and the features are not scalable.

Deep learning models, these models are more suitable for automotive applications as there is a lot more compute power available nowadays than was previously available. Additionally, there is a lot more data e.g. ImageNet dataset that can be used to train a deep neural network. Neural networks inherently have the advantage of being retrainable. Deep learning approaches can perform complete object

detection without specific feature definition. They are based on the Convolutional Neural Network (CNN). There are mainly 2 types of deep learning networks, i.e. region proposal networks and 1-level networks [13]:

Region proposal networks: require 2 stages, one for generating region proposals, and the next to detect objects in the proposed region. They include networks like RCNNs and its successors.

On the other hand, *Single-stage networks* include networks like YOLO and SSD. They only require 1 stage/ a single forward pass of the network to detect multiple objects in an image/frame from a video.

Single-stage networks like YOLO and SSD are faster than their region proposal counterparts but have lower accuracy and mean Average Precision (mAP) [14]. Additionally, they have some problems detecting smaller objects. From the table above, single-stage networks have significantly higher inference speed (FPS) while not much trade-off in terms of accuracy (mAP).

IV. METHODOLOGY

In this section, the proposed method for carrying out the research is discussed.

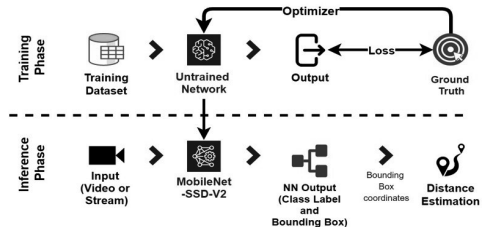


Fig. 1 General workflow of a DNN

I. Models

a. Tiny YOLOv3: Tiny YOLOv3 is a simplified version of YOLOv3, which is a state-of-the-art Object Detection System. The only difference is that there is a lesser number of convolutional layers in the Tiny version than YOLOv3. It requires less computational power than full-scale YOLOv3. Hence, it is ideal for deployment onto Jetson Nano with restricted computing capacity. The Fig.2 below shows the architecture of Tiny YOLOv3.

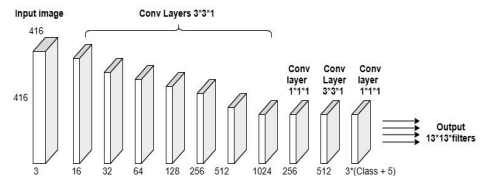


Fig. 2 General Architecture of Tiny YOLOv3 [15]

b. MobileNet-SSD-V2: MobileNet-SSD-V2 was deployed on Jetson Nano and inferencing was done using an optimized TensorRT engine as when combined they help reduce complexity and speed up the inference.

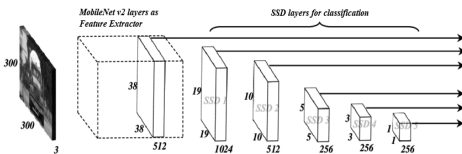


Fig. 3 General Architecture of MobileNet-SSD-V2 [16]

SSD- Single Shot Detector is a technique developed by Google research teams. It only requires a single forward pass of the network to perform classification as well as localization on an image/video frame. It is designed to be used independently of the base network. MobileNet architecture is used as the feature extractor for the SSD. The Fig. 3 above shows the architecture of MobileNet-SSD-V2.

II. Training and Dataset

In order to implement our proposed approach, it is very important to use an adequate dataset for the training with relevant traffic data. Different datasets are available for object detection. The two datasets which are used for training the above-mentioned models are listed below:

KITTI Dataset: KITTI dataset is used to train Tiny YOLOv3. It contains images labeled with eight different classes for a total of 7481 images for training [17]. Mostly, the images are focused on 2 classes namely cars and pedestrians. Classes vans and sitting persons are not counted as false positives for cars and pedestrians respectively due to similarity in appearance. The proposed model was trained on a PC with Intel Core i7 9th Gen processor, NVIDIA GTX 1660 TI GPU, 16 GB RAM. CUDA10 and CUDNN7.3 GPU accelerated libraries were used. The training was done on the Darknet framework using an 80-20 split of KITTI Dataset. The training was done until 250000 iterations with an average loss of 1.1. The weight file with the highest mAP and lowest loss was selected for deployment purposes.

COCO Dataset: MobileNet-SSD-V2 was pretrained on COCO Dataset- Common Objects in Context. COCO has 91 different object classes with more than 100,000 images for training [18]. It contains all the necessary classes required for automotive purposes. But the model was modified to detect only 6 classes relevant to the purpose of this research including Bus, Cars, Pedestrians.

III. Optimizations

The optimizations that were made in the two architectures that have been employed in this research are listed below.

Tiny YOLOv3: Tiny YOLOv3 uses the pooling layer instead of YOLOv3's convolutional layer with a step size of 2 to achieve dimensionality reduction.

MobileNet-SSD-V2: MobileNet Feature Extractor: MobileNet layers were used in SSD, to reduce processing requirements by attacking the convolutional layers. It converts traditional convolutions into depth-wise separable convolutions, thus speeding up calculations while having a very little accuracy trade-off [19]. The Fig.4 below shows the general MobileNet-V2 approach.

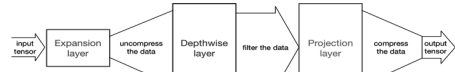


Fig. 4 MobileNet V2 Layers as used in MobileNet-SSD-V2

Optimized TensorRT engine Inference on Jetson Nano uses an optimized TensorRT Engine. It increases throughput and lowers latency while inferring. It offers several precision optimizations such as INT8 and FP16[20]. This decrease in inference precision translates in many cases to reduced latency without sacrificing accuracy much. Additionally, larger models can be made to fit in memory. Thus, with the help of these powerful optimizations, MobileNet-SSD-V2 can perform exceptionally on low-end hardware such as Jetson Nano.

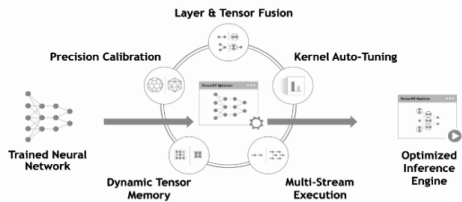


Fig. 5 Inference process TensorRT engine[20]

IV. Distance Estimation

Distance estimation is performed alongside vehicle detection on Jetson Nano. However, an approximation of real distance is unreliable due to the use of a monocular camera, inaccuracy in bounding box prediction, etc. Alternatively, a relative method is used to estimate distance using the bounding box dimensions and the total frame size (field of view). The relation is as described below:

$$Apx_distance = (1 - W)^4$$

Where W= ratio of the width of the predicted bounding box to frame width (between 0 and 1).

When the distance calculated is less than 0.5, then a warning is displayed meaning that the object is too close! As the objects get closer, the distance reduces quadratically. The relation is shown in Fig. 6.

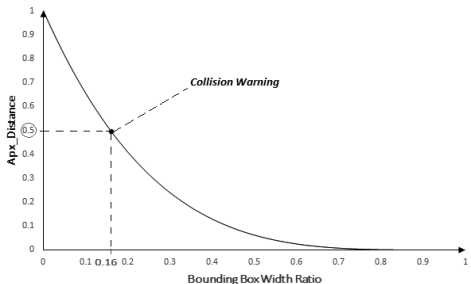


Fig. 6 Relation between Width of the bounding box and frame width



Fig. 7 Outputs from both networks running on Jetson Nano Hardware



Fig. 8 MobileNet-SSD-V2 Output on a still image

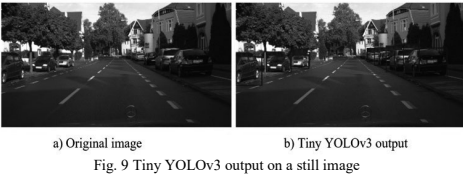


Fig. 9 Tiny YOLOv3 output on a still image

V. EVALUATION

In the Fig.7 are the screenshots of results from models MobileNet-SSD-V2 (a) and Tiny YOLOv3 (b) respectively running on the same video with the resolution 640 x 480 on Jetson Nano. Tiny YOLOv3 was able to achieve 18-19 during the run of the video. MobileNet-SSD-V2 was able to achieve 24-25 FPS on the same video. The differences were primarily due to TensorRT's memory optimizations. Both models had very similar performance otherwise. In Fig.8 and 9 are the outputs of MobileNet-SSD-V2 and Tiny YOLOv3 on an image. Both the original images are provided for reference on the left. In Table 2 below, are the results from different models run on Jetson Nano as well as on a laptop. The laptop used to run the test was equipped with Core i7-9750H CPU, 16GB DDR4-2666 RAM, and NVIDIA GeForce GTX 1660 Ti GPU with 6GB GDDR6 VRAM. For consistency, most of the tests were performed on live webcam at the resolution 640 x 480.

Table 2 COMPARISON OF DIFFERENT TECHNIQUE ON JETSON NANO AS WELL AS PC

Model	No. of classes	Deployment Hardware	FPS	Performance
SSD MobileNet v2	7 (COCO)	Jetson Nano + Webcam	23-25	Good detections but worse than SSD Inception v2
Tiny YOLOv3	9 (KITTI)	Jetson Nano + Webcam	19-20	Slightly better detections than SSD MobileNet v2
SSD Inception v2	91 (COCO)	Jetson Nano + Webcam	18-20	Very good and precise detections

SSD MobileNet v1	91 (COCO)	Jetson Nano + Webcam	28-30	Poor detection
Pednet	1	Jetson Nano + Webcam	9-10	Poor detection
YOLOv3	91 (COCO)	Jetson Nano	4-5	Poor Detections and very slow
Tiny YOLOv3 on PC	9 (KITTI)	Laptop	32-35	Good Detection

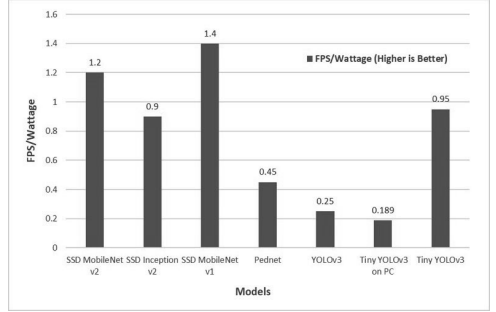


Fig. 10 FPS/Wattage metric compared with different models on Jetson Nano as well as PC

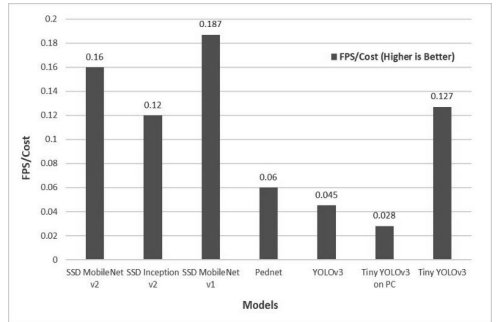


Fig. 11 FPS/Cost metric compared with different models on Jetson Nano as well as PC

Fig.10 and Fig. 11 illustrate the relationship between the FPS/Wattage and FPS/Cost metrics which can be used to compare the performance of the models used in this study and other candidate models for a similar purpose. The higher these metrics, the better the model is on an embedded device like Jetson Nano. Here, it can be seen SSD MobileNet v1 has the highest FPS/Cost as well as FPS/Wattage metrics. However, detections were poor. For a good balance, MobileNet-SSD-V2 and Tiny YOLOv3 were chosen. They had good detections without compromising much in terms of inference times or FPS (See Table 2). YOLOv3 on Jetson Nano had very poor detections and slow inference time around 250 milliseconds, thus making it unusable for real-time applications.

Thus, the models in this research outperformed the full-scale YOLOv3 on Jetson Nano by about 5 times in FPS/Wattage Metric and 3.5 times in FPS/Cost metric. Additionally, Tiny YOLOv3 on PC is also proven to be a lot less efficient than when deployed on Jetson Nano. It offers similar performance on limited hardware as well.

VI. CONCLUSION AND FUTURE SCOPES

Technology has come a long way. Compact devices and edge computing hardware are getting more powerful and powerful devices are getting more compact. Driver assistance with the help of vehicle detection in real-time is no longer a distant dream. Notably, the complete setup used in the study for implementation is a Jetson Nano and a CSI Camera, which in total costs about 150€! Besides, it only requires a 20W power supply to perform the complete calculations in real-time.

Overall, it can be concluded that nowadays, there is no need for more expensive and powerful hardware for such tasks. These improvements could and will certainly be successfully implemented to improve road safety and ADAS applications. A good example is a robust collision warning system based on the detection of multiple objects and the estimation of distance, which is presented in this study.

As part of the future aspect of this study, a precise approach for collision warning should include more features and additional optimizations, such as the integration of depth estimation with the object detection architecture. Furthermore, using the TensorRT engine with Tiny YOLOv3 will improve performance and allow better inference to be achieved. However, this should be considered and optimized in future work. Also, Hybrid Data processing: To improve detection in complex environments, combining and processing data from different sensors like LIDAR, IR, etc. can prove to be useful. [21].

REFERENCES

- [1] Global status report on road safety 2018. Geneva: World Health Organization; 2018. License: CC BYNC-SA 3.0 IGO.
- [2] J. Redmon, S. Divvala, R. Girshick and A. Farhadi, "You Only Look Once: Unified, Real-Time Object Detection," 2016 IEEE Conference on Computer Vision and Pattern Recognition (CVPR), Las Vegas, NV, 2016, pp. 779-788, doi: 10.1109/CVPR.2016.91.
- [3] Phillips, Derek J., et al. "Real-time Prediction of Automotive Collision Risk from Monocular Video." arXiv preprint arXiv:1902.01293 (2019).
- [4] Saleh, S., Khwandah, S., Heller, A., Mumtaz, A. and Hardt, W. (2019). Traffic Signs Recognition and Distance Estimation Using a Monocular Camera. In: 6th International Conference Actual Problems of System and Software Engineering. [online] Moscow: IEEE, pp.407-418. Available at: <http://ceur-ws.org/Vol-2514/>.
- [5] Saleh, S., Hadi, S., M., Amin Nazari, and Hardt, W. (2019). Outdoor Navigation for Visually Impaired Based on Deep Learning. In: 6th International Conference Actual Problems of System and Software Engineering. [online] Moscow: IEEE, pp.397-406. Available at: <http://ceur-ws.org/Vol-2514/>.
- [6] S. Saleh, S. Manoharan, and W. Hardt, "Real-time 3D Perception of Scenes with Monocular Camera", Embedded Self Organizing Systems (Vol 7. No 2. 2020), (accepted).
- [7] N. O'Mahony, S. Campbell, A. Carvalho, S. Harapanahalli, G. V. Hernandez, L. Krpalkova, et al., "Deep learning vs. traditional computer vision", Proc. Sci. Inf. Conf., pp. 128-144, 2019.
- [8] Liu, W., Anguelov, D., Erhan, D., Szegedy, C., Reed, S., Fu, C.Y. and Berg, A.C., 2016, October. SSD: Single shot multibox detector. In European conference on computer vision (pp. 21-37). Springer, Cham.
- [9] Huang, S.S., Chen, C.J., Hsiao, P.Y. and Fu, L.C., 2004, April. On-board vision system for lane recognition and front-vehicle detection to enhance driver's awareness. In IEEE International Conference on Robotics and Automation, 2004. Proceedings. ICRA'04. 2004 (Vol. 3, pp. 2456-2461). IEEE.
- [10] Seenoung, N., Watchareeruetai, U., Nuthong, C., Khongsomboon, K. and Ohnishi, N., 2016, February. A computer vision-based vehicle detection and counting system. In 2016 8th International Conference on Knowledge and Smart Technology (KST) (pp. 224-227). IEEE.
- [11] J. Redmon and A. Farhadi, YOLO9000: Better faster stronger, 2016.
- [12] Singh, K.B. and Arat, M.A. "Deep Learning in the Automotive Industry: Recent Advances and Application Examples," arXiv preprint arXiv:1906.08834, 2019.
- [13] Z. Zhao, P. Zheng, S. Xu and X. Wu, "Object Detection With Deep Learning: A Review," in IEEE Transactions on Neural Networks and Learning Systems, vol. 30, no. 11, pp. 3212-3232, Nov. 2019, doi: 10.1109/TNNLS.2018.2876865.
- [14] P. Adarsh, P. Rathi and M. Kumar, "YOLO v3-Tiny: Object Detection and Recognition using one stage improved model," 2020 6th International Conference on Advanced Computing and Communication Systems (ICACCS), Coimbatore, India, 2020, pp. 687-694, doi: 10.1109/ICACCS48705.2020.9074315.
- [15] D. Xiao, F. Shan, Z. Li, B. T. Le, X. Liu and X. Li, "A Target Detection Model Based on Improved Tiny-Yolov3 Under the Environment of Mining Truck," in IEEE Access, vol. 7, pp. 123757-123764, 2019, doi: 10.1109/ACCESS.2019.2928603.
- [16] Arabi, S., Highaghat, A. and Sharma, A. (2019). A deep learning based solution for construction equipment detection: from development to deployment. arXiv preprint arXiv:1904.09021.
- [17] Geiger, A., Lenz, P., Stiller, C. and Urtasun, R., "Vision meets Robotics: The KITTI Dataset," International Journal of Robotics Research (IJRR), 2013.
- [18] Lin, T.Y., Maire, M., Belongie, S., Hays, J., Perona, P., Ramanan, D., Dollár, P. and Zitnick, C.L., "Microsoft coco: Common objects in context," European conference on computer vision, pp. 740--755, 2014.
- [19] Howard, A.G., Zhu, M., Chen, B., Kalenichenko, D., Wang, W., Weyand, T., Andreetto, M. and Adam, H., "Mobilenets: Efficient convolutional neural networks for mobile vision applications," arXiv preprint arXiv:1704.04861, 2017.
- [20] "NVIDIA TensorRT: Programmable Inference Accelerator," NVIDIA, [Online]. Available: <https://developer.nvidia.com/tensorrt>. [Accessed 10 08 2020].
- [21] T. Gandhi and M. M. Trivedi, "Pedestrian collision avoidance systems: a survey of computer vision based recent studies," 2006 IEEE Intelligent Transportation Systems Conference, Toronto, Ont., 2006, pp. 976-981, doi: 10.1109/ITSC.2006.1706871.

The Study to Determine the Required Product Identification System

Sod-Od Batzorig

Department of Computer Science,
School of Information and Communication Technology,
Mongolian University of Science and Technology
Ulaanbaatar, Mongolia
sodstar@must.edu.mn

Gundsambuu Bold

Department of Computer Science,
School of Information and Communication Technology,
Mongolian University of Science and Technology
Ulaanbaatar, Mongolia
gundsambuu@must.edu.mn

Abstract— Demand and publication of commodities is a key factor in the trade sector. It is possible to predict random demand from consumers and find an optimal amount of resources. Therefore, we examine the methodology for estimating the optimal quantity of resources using data which recorded on the database in the inventory of the commodity (stock) demand. The cloud computing will be used to estimate the optimal quantity and calculation section uses mathematical techniques.

Keywords—resource depletion and surpluses; optimal quantity of resource; computing software; data processing; mathematical methodology;

I. INTRODUCTION

It is a good idea to implement the programming and technology solutions for development of the system is based on cloud-based technology solutions. With the rapidly updating of information technology around the world, the latest information technology has been developing in our country. An example of this is cloud computing technology and its products. Cloud computing is a technology development has brought big changes to the information technology industry.

As a programming solution, we use PHP which is the world's most widely used programming language [1] [2] and MySQL for databases. Developing a program based on cloud-based solutions provides the following advantages.

1. The user will be able to access their information and applications wherever they are and it is enough to connect to the Internet. The information is not available on the user's computer and is not restricted to the user's computer memory.
2. The cost of hardware of organization which is receiving services is reduced. Because the high-performance computers will be running the service provider side. Therefore, the user who receive the cloud service is enough that will have average performance computer to connect to the Cloud system.
3. Some organizations are temporarily borrowed data storage memory from other organizations because they lack memory. Therefore, they will not have to worry about data storage memory problems.

4. Organizations' information technology maintenance and assistance costs will decrease.
5. When large surveys and calculations are needed which required to estimate for a few years on the average computer will be able to run fast enough for multiple servers to compile.

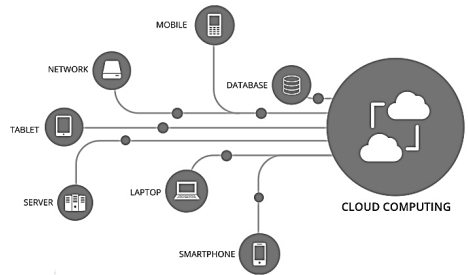


Fig. 1. Cloud computing [3]

For this development system, cloud computing is based web platforms [4] [5] and also allow to use their mobile phones to manage their full-featured system. From all this, there are many advantages.

II. RESEARCH

If the resource amount is random, its demand is a random quantity. The following values are used to find the optimal quantities of demand for randomly generated demand [6]. These includes:

- Real and practical quantities of demand (these values are regarded as registered in a database.);
- If the required resource exceeds the demand, the cost of unit surplus is c_1 ;
- If the required resources less than demand, the cost per unit depletion is c_2 ;

The demand for resources is a random quantity $X \in \{x_1, x_2, \dots, x_n, \dots\}$ and if the resource is x then total cost will be

$$z(x) = c_1 \sum_{x_i \leq x} (x - x_i) p(x_i) + c_2 \sum_{x_i > x} (x - x_i) p(x_i) \quad (1)$$

Here, $p(x_i)$ is probability that the demand for x_i . The minimum point of the function $z(x)$ is the optimal amount of resource.

$F(x)$ is distribution function of random variable X [7]. Then, the optimal amount of resources would be the following.

$$F(x_i) < \frac{c_2}{c_1 + c_2} < F(x_{i+1}) \quad (2)$$

And the value of x_i is to provide an inequality. The values of $F(x)$ are calculated as statistical data of demand. Therefore, we use the realistic and practical data of the resource demand which is calculated by setting the demand distribution function $F(x)$, to calculate the optimal amount of resource with the equation (2).

We propose a hypothesis of what distribution is needed in the statistics analysis of demand. This hypothesis will be verified by statistical analysis [8]. In practice, the demand is often a normal distribution. For example, if the demand has a mathematical average, σ standard deviation, and its distribution is normal, then the distribution function will be follows.

$$F(x) = \frac{1}{2} + \frac{1}{2} \cdot \Phi\left(\frac{x - a}{\sigma}\right) \quad (3)$$

In the above equation, $\Phi(x)$ is a function of Laplace and the function looks like this:

$$\Phi(x) = \frac{2}{\sqrt{2\pi}} \int_0^x e^{-t^2/2} dt \quad (4)$$

The optimal size of the product is the following equation and calculate this equation, use the Laplace function table.

$$\frac{1}{2} + \frac{1}{2} \cdot \Phi\left(\frac{x - a}{\sigma}\right) = \frac{c_2}{c_1 + c_2} \quad (5)$$

A. System pseudo code

1. Find the maximum and the lowest value of samples:

```

program getMinMax
set Xmin = X1, Xmax = Xn
Do i = 1 to n
  If Xi < Xmin
    set Xmin = Xi;
  If Xmax < Xi
    set Xmax = Xi;
end do
set k = n/2
set h = (Xmax - Xmin)/k

```

2. Find the starting values in the interval:

```

program getStartingValues

```

```

Do i = 0 to k + 1

```

```

  set Ti = Xmin - h/2 + i*h

```

```

end do

```

3. Find optimal quantities:

```

program getCalculateResult

```

```

Do i = 1 to k

```

```

  set Mi = 0

```

```

  Do j = 1 to n

```

```

    If Ti < Xi and Xj <= Ti + 1

```

```

  then

```

```

    set Mi = Mi + 1

```

```

  end do

```

```

set r = c2/(c1 + c2)

```

```

set P1 = M1/n

```

```

Do i = 1 to k

```

```

  set Pi + 1 = Pi + (Mi+1)/n

```

```

  if Pi < r and r <= Pi + 1

```

```

  then

```

```

    set print Ti

```

```

  end do

```

B. Implementation

Test data are shown below.

TABLE I. EXAMPLES OF TEST DATA

Item code	Date	Quantity
1	10/6/2017 0:00	9
1	10/6/2017 0:00	10
1	10/7/2017 0:00	19
1	10/4/2017 0:00	17
1	10/5/2017 0:00	15
1	10/9/2017 0:00	14
1	10/8/2017 0:00	11
1	10/1/2017 0:00	12
1	10/7/2017 0:00	15
1	10/7/2017 0:00	23
1	9/7/2017 0:00	22
1	9/6/2017 0:00	5
1	9/8/2017 0:00	1
1	9/7/2017 0:00	19

- c_1 or the cost of unit surplus is 250;

- c_2 or the cost per unit depletion is 50;

The following figure shows sales of goods and estimated outcome is 5.7142857142857 (optimal amount of clearance). This result is an optimal amount of random demand for goods clearance. In other words, it is to ensure that the surplus or depletion of the goods is minimal.

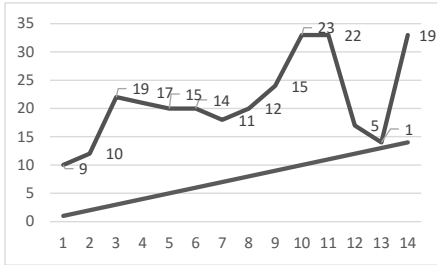


Fig. 2. Sales of goods

It is also possible to use the system to link the system with the resource management then the data will add the database, it can be automatically displayed at exactly one hour. This is especially suitable for organizations that hold permanent goods.

C. Inventory and resource system

In order to determine the optimal amount of product and production, the first thing we need is the notes of recorded on inventory paper and data stored on the electronic records system.

1. The need for inventory to reserve

There are several reasons why resources are reserved in the industry. Below are listed a few important reasons.

- Back up stock to keep the production constant;
- Backup to meet expected demand;
- Resources are stored to connect production, allocation systems and production phases.
- Protect against imbalance. Therefore, supply of industrial resources does not break down or when it comes to increased demand when resources are depleted.
- Use the order cycle advantages. Resources are reserved for purchasing and subscription costs which are limited to a certain amount.
- Sometimes resources are reserved for avoiding price increases and probability of resource depletion is likely to occur.
- Operations require a certain amount of time, and during this period certain resources exist in the production process.

The main objective of resource control is to provide consumers with the desired demand, at the desired time and with quality products that meet the needs and on the other hand to minimize the cost of the process.

The key issue of efficient resource management is

- Resource accounting for inventory is need to determine how much resources are available;
- Based on the resource accounting, we can determine the amount and timing of what resources to order or receive.

2. Inventory registration system

Inventory is the array of finished goods or goods used in production held by a company [9]. Inventory is classified as a current asset on a company's balance sheet, and it serves as a buffer between manufacturing and order fulfillment.

- Assets held for sale during normal business operations;
- Items in the production stages for sale;
- Materials or supplies to be allocated or used for the services;

Inventories constitute a major part of the working capital of business and trade directives, and are the main source of business income. There are two systems for inventory registering.

- Perpetual system - Each movement of the revenue and expenditure of inventory recorded inventory accounts and the inventory balance can be obtained from the information in the registry. If the amount determined in the inventory record is different from the amount of physical count, make the correction record of the inventory.
- Periodic system - It is impossible to determine the balance of inventory from the information in the record so the physical inventory will be made. There is no indication of a comparison with the physical count, so there is no surplus. Surplus and depletion are initially contained in the cost of the goods, so correction is not required.
- Furthermore, the system can be incorporated into the enterprise resource planning system and it can be upgraded to software development.

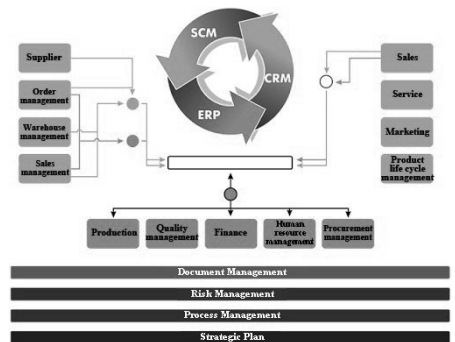


Fig. 3. An optimized system is in the ERP system [10]

Comparison of Photogrammetric Approaches for Estimating Motion Parameters from a Monocular Sequence

Tserennadmid Tumurbaatar
 Department of Information and Computer Science
 National University of Mongolia
 Ulaanbaatar, Mongolia
tserennadmid@seas.num.edu.mn

Abstract—The techniques of measuring position and orientation of the object using image correspondences are based on the principles of epipolar geometry in photogrammetric field. In this study, we aim to evaluate the main differences of approaches for estimating motion parameters, characterized by 3D rotation and 3D translation. The estimation methods developed in photogrammetric field were carried out. This paper describes the mathematical motion model for the proposed approaches and comparison of their results, indicated the differences between the estimations in terms of accuracy and test dataset. We showed that relative orientation based approach produced accurate results for image sequences of 3D objects but homography based relative orientation approach produced accurate results for image sequences of planar objects.

Keywords—motion estimation, correspondence point, moving object

I. INTRODUCTION

Recovering position and orientation of the object from images is becoming important task in the fields of the computer vision and photogrammetry. In photogrammetry, the position and orientation (exterior orientation parameters) between right image frame relative to left image frame in a sequence can be estimated by collinearity or coplanarity equations [1]-[5] with a sufficient set of corresponding points. In previous study, comparative study of motion estimations from image sequences in photogrammetry and computer vision has been published, introducing their accuracy to different datasets [6]-[8]. In computer vision, automatic relative orientation of image sequences has been widely investigated with assumption of a calibrated camera. Relative motion parameters of the perspective two views are computed by decomposing an essential matrix through eight point correspondences in the image pair [9][10]. Essential matrix is defined up to a scale factor for translations as set of linear homogeneous equations by establishing feature correspondences. The estimation methods of relative camera motion from image point correspondences [11] and from less than eight point correspondences [12]-[15] in various applications such as visual servoing and control were developed. Moreover, motion parameters of a camera relative to a planar object can be estimated by decomposing a homography matrix through point correspondences. The numerical and analytical methods for 3D motion from homography decomposition were introduced in detail [16]. The authors [17]-[22] also introduced efficient solutions to 3D motion estimation based on homography matrix through point correspondences for planar targets in augmented reality and robot control applications. Moreover, an additional investigation of the photogrammetric techniques that estimate the motion parameters.

In this paper, we investigate methods for estimating 3D motion of a moving object in image sequences taken by monocular camera in real-time. We have used a monocular web camera instead of other specialized magnetic devices to sense 3D motion since it is widely available. The aim of this paper is analyze and compare the photogrammetric approaches. We have used two estimation methods for determining 3D motion parameters based on tracked feature correspondences. They were developed in photogrammetric approach. Firstly, we will introduce mathematical formulations for the proposed approaches. Secondly, we will explain implementation steps of 3D motion estimations regarding image sequences from single camera. Thirdly, we will point out their practical differences in case of test datasets and analyze comparison results.

This paper is organized as follows. Mathematical formulations of the motion models in photogrammetry will be described in Section 2. Methodology to implement 3D motion estimations and test datasets are presented in Section 3. Comparison results will be discussed in Section 4.

II. MOTION MODELS

We review the basic geometry of the proposed motion models. The relative motion of a moving object in image sequences is determined once the correspondence points have been established. We have assumed that a camera is stationary. Consider $X_1 \in \mathbb{R}^3$ object space coordinates of a point P_1 on a rigid object moves to $X_2 \in \mathbb{R}^3$ object space coordinate of a point P_2 with respect to a camera coordinate system. Using a perspective projection model, the points $P_i, i = 1, 2$ are projected at $x_1 \in \mathbb{R}^3$ image space coordinates of a point p_1 at time t_1 and at $x_2 \in \mathbb{R}^3$ image space coordinates of a point p_2 at time t_2 on the image plane as shown in Fig. 1.

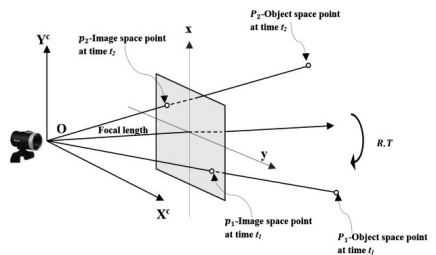


Fig. 1. Geometry of object in image sequences.

Due to the rigidity constraint of the object motion [23], P_1 and P_2 are related by rotation matrix R and translational vector T :

$$x_2^T \hat{T} R x_1 = 0 \quad (1)$$

This is called coplanarity or epipolar constraint written in triple product of vectors from Eq. (1).

A. Motion model from on relative orientation

Non-linear equations in coplanarity condition can be written as following:

$$\begin{bmatrix} D_1 \\ E_1 \\ F_1 \end{bmatrix} = \begin{bmatrix} r_1 x_1 \\ r_2 x_1 \\ r_3 x_1 \end{bmatrix}, \quad \begin{bmatrix} D_2 \\ E_2 \\ F_2 \end{bmatrix} = \begin{bmatrix} r_1 x_2 \\ r_2 x_2 \\ r_3 x_2 \end{bmatrix} \quad (2)$$

where

$$\begin{aligned} r_{1x} &= \cos\varphi * \cos\kappa; \\ r_{2x} &= -\cos\varphi * \sin\kappa; \\ r_{3x} &= \sin\varphi; \\ r_{1y} &= \sin\omega * \sin\varphi * \cos\kappa + \cos\omega * \sin\kappa; \\ r_{2y} &= -\sin\omega * \sin\varphi * \sin\kappa + \cos\omega * \cos\kappa; \\ r_{3y} &= -\sin\omega * \cos\varphi; \\ r_{1z} &= -\cos\omega * \sin\varphi * \cos\kappa + \sin\omega * \sin\kappa; \\ r_{2z} &= \cos\omega * \sin\varphi * \sin\kappa + \sin\omega * \cos\kappa; \\ r_{3z} &= \cos\omega * \cos\varphi; \end{aligned}$$

Then triple-scalar product of the three vectors as following:

$$T_x \cdot (E_1 F_2 - E_2 F_1) + T_y \cdot (F_1 D_2 - F_2 D_1) + T_z \cdot (D_1 E_2 - D_2 E_1) = 0. \quad (3)$$

Here, ω , φ , and κ are rotations about the x axis, y axis, and z axis, respectively. T_x , T_y , and T_z are translations about the x axis, y axis, and z axis, respectively. The three parameters of the rotation matrix R and the two components of the translation as unknowns can be determined by a non-linear least squares solution from Eq. (3).

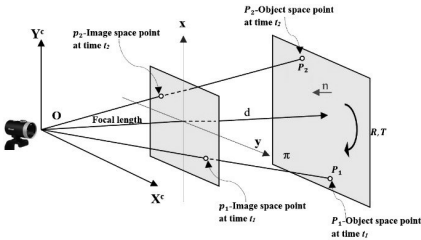


Fig. 2. Geometry of planar object in image sequences.

B. Motion model from homography based relative orientation

Since mapping between the right and the left image frame is given by the homography, motion and structure parameters can be obtained from a following non-linear equation.

$$x_2 \cong \left(R + \frac{1}{d} T n^T \right) x_1 \quad (4)$$

Here, $n = [n_1, n_2, n_3]$ is the unit normal vector to the 2D plane π , and d is the distance from the plane π to the optical center of the camera as shown in Fig. 2. The five parameters $(\omega, \varphi, \kappa, T_x, T_z)$ of the relative motion and three parameters (n_1, n_2, n_3) of the plane in object space can be estimated from this equation by a non-linear least squares solution.

III. THE IMPLEMENTATION OF THE PROPOSED METHODS

In this section, we explain implementation steps for performing the two estimations as shown in Fig. 4. Firstly, we capture an initial frame at time t_1 and extract a template region from it as shown in Fig. 3 (A). Then SIFT feature points as yellow dots in Fig. 3 (B) are computed for the template. Here, we assume N extracted feature points that are automatically tracked to the next each F frames. Secondly, when a new frame at time t_2 of a moving object is captured, feature points are extracted for the new frame. After matching feature points of the new frame with the feature points of the template region, the best matches (corresponding points) are found by a Brute Force matcher.

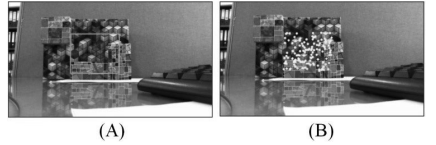


Fig. 3. (A) Template region as light green rectangle extracted in a frame, (B) Extracted features to be matched as yellow points in the template region.

Before estimation of the motion parameters, outliers among the best matches are eliminated by RANSAC [24] method. Thirdly, when all processing steps of two consecutive frames are accumulated as mentioned above, the proposed estimations defined in the Section 2 are used to estimate motion parameters.

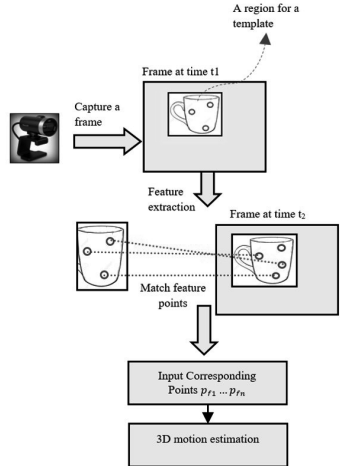


Fig. 4. Implementation steps for performing the two estimations.

IV. THE EXPERIMENTS OF THE PROPOSED METHOD

We implemented the proposed estimations in photogrammetry with the C++ programming language, Visual

Studio programming tool and OpenCV 2.4.9 library on a PC, Intel(R) Core(TM) i7-9700. We used a Microsoft LifeCam with known calibration parameters. We experimentally

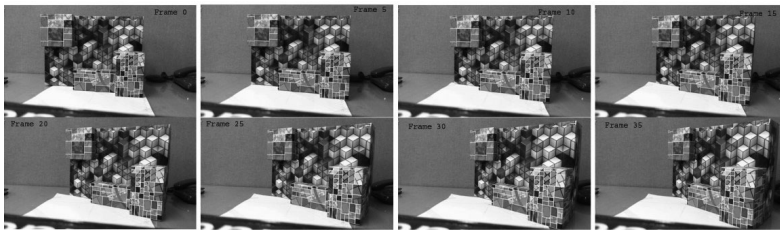


Fig. 5. Rotation of the object around y axis for dataset of real scene.

compared results from the two proposed estimations by preparing different test datasets such as real and simulated datasets. Video sequences for a moving object are captured with 640×360 pixel resolution. We used thousands of image sequences of the different textured 3D and planar objects to check estimation accuracy of the motion parameters.

For creation of the real dataset, we created video sequences while translating object position along each axis up to 200 mm and rotating around each axis up to 90 degrees in the front of static camera. The number of feature point for real dataset was around 150. One of the prepared datasets for real scene of the moving object rotated in 0° - 30° degrees around y axis is shown in Fig. 5 as an example. Estimation of motion parameters can be performed between an initial frame as shown in the first frame of the Fig. 5 and the next frames as shown in the second to last frame of the Fig. 5.

For creation of the simulated dataset, 3D object was translated by up to 15 units along x , y and z axes and rotated by up to 90 degrees around x , y and z axes in Euclidean space. The number of feature point for simulated dataset was around 25. The feature points from image sequences were measured with 2-4 pixel noisy for the both dataset cases.

We notated the estimation methods for experiment as PM_RO and PM_H for relative orientation and homography based relative orientation, respectively. For these estimations, we checked accuracy of the estimated rotation parameters with comparing true (known) rotation parameters. For reference true value, we manually measured corresponding points from the image sequences, and estimated their precise 3D motion. We analyzed mean, maximum (Max) and minimum (Min) errors for results from two estimations for all datasets as summarized in Table 1 and Table 2.

TABLE I. ERROR ANALYSIS FOR ROTATIONS AROUND x , y AND z AXES FOR REAL SCENE

	Error comparison of real datasets for 3D object /degrees/		Error comparison of real datasets for planar object /degrees/	
	PM_H	PM_RO	PM_H	PM_RO
Max	1.867	1.863	1.828	1.983
Min	0.0004	0.0004	0.0001	0.0009
Mean	0.538	0.527	0.312	0.408

As we see in Table 1 and Table 2 that the errors of the rotation results are small and accurate for each two approaches

for both of the datasets. Particularly, PM_H produced more accurate results for image sequences of the moving planar object since planar pattern is dominating in test dataset. On the other hand, the motion parameters estimated from PM_RO are the most accurate than PM_H for dataset of 3D object with noisy point correspondences. But PM_H and PM_RO still have produced comparable errors. Success rate of estimations stay in range of large motion of the moving object.

TABLE II. ERROR ANALYSIS FOR ROTATIONS AROUND x , y AND z AXES FOR SIMULATED DATASET

Error comparison of simulated datasets for 3D object /degrees/		
	PM_H	PM_RO
Max	1.647	1.589
Min	0.015	0.003
Mean	0.549	0.461

CONCLUSION

In this study, we compared the approaches for estimating 3D motion in photogrammetry with different datasets. We checked estimation errors for the approaches by using corresponding points between template region and subsequent frames. The results of estimations were accurate in change of translation and rotation under noisy correspondences. Specially, the homography based approach was more accurate for estimating motion of the planar object, and relative orientation based approach was more accurate for estimating motion of the 3D object. This means that the accuracy of the estimation approaches is depending on test dataset.

ACKNOWLEDGMENT

The work in this paper was supported by the grant of National University of Mongolia (No. P2019-3714).

REFERENCES

- [1] B. K. P. Horn, "Relative Orientation," Int J Comput Vision, vol. 4, pp. 59-78, 1990.
- [2] T. Schenk, "Digital Photogrammetry," Terra Science: Laurelville, USA, 1999.
- [3] P. Wolf, B. DeWitt, B.E. Wilkinson, "Elements of Photogrammetry with Applications in GIS," 4th ed. McGraw-Hill Science, USA, 2014.
- [4] J. Kim, H. Kim, T. Lee, T. Kim, "Photogrammetric Approach for Precise Correction of Camera Misalignment for 3D Image Generation.," Proceedings of the IEEE International Conference on Consumer Electronics, pp. 396-397, 2012.

- [5] J.C. McGlone, E.M. Mikhail, J. Bethel, "Manual of Photogrammetry," 5th ed. American Society of Photogrammetry and Remote Sensing, USA, 2004.
- [6] T. Tumurbaatar, T. Kim, "Comparison of computer vision and photogrammetric approaches for motion estimation of object in an image sequence," Proceedings of the IEEE International Conference on Image, Vision and Computing, Chongqing, China, 2018.
- [7] T. Tumurbaatar, T. Kim, "Comparative study of relative pose estimations from a monocular image sequence in computer vision and photogrammetry," *Sensors*, 19(8), 2019.
- [8] T. Tumurbaatar, D. Terbish, E. Adiya, "Computer vision approaches for motion estimation of object in image sequences," Proceedings of International Conference on Frontiers of Information Technology, Applications and Tools (FITAT), Hong Kong, 2018.
- [9] J. Weng, T.S. Huang, N. Ahuja, "Motion and Structure from Two Perspective Views: Algorithms, Error Analysis, and Error Estimation," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 11(5), May 1989.
- [10] R. Hartley and A. Zisserman, "Multiple view in computer vision," Cambridge University Press, 2000.
- [11] G. Chesi, "Estimation of the camera pose from image point correspondences through the essential matrix and convex optimization," *IEEE International Conference on Robotics and Automation*, 2009.
- [12] K. Fathian and N.R. Gans, "A new approach for solving the five-point relative pose problem for vision-based estimation and control," *IEEE American Control Conference*, 2014.
- [13] M. Sarkis, K. Diepold, K. Huper, "A Fast and robust solution to the five-point relative pose problem using Gauss-Newton optimization on a manifold," *IEEE International Conference on Acoustics, Speech and Signal Processing*, 2007.
- [14] D. Batra and B. Nabbe, M. Hebert, "An alternative formulation for five point relative pose problem," *IEEE, Workshop on Motion and Video Computing*, 2007.
- [15] G. Chesi and K. Hashimoto, "Camera pose estimation from less than eight points in visual servoing," *IEEE, International Conference on Robotics and Automation*, 2004.
- [16] E. Malis and M. Vargas, "Deeper understanding of the homography decomposition for vision-based control," *Research Report 6303, INRIA*, 2007.
- [17] K. Kim, V. Lepetit, W. Woo, "Scalable real-time planar targets tracking for digilog books," *Vis Comput*, vol. 26, pp. 1145–1154, 2010.
- [18] H. Bazargani, O. Bilaniuk, R. Laganière, "A fast and robust homography scheme for real-time planar target detection," *J Real-Time Image Proc*, pp. 1-20, 2015.
- [19] Y. Mae, J. Choi, H. Takahashi, K. Ohara, T. Takubo, T. Arai, "Interoperable vision component for object detection and 3D pose estimation for modularized robot control," *Mechatronics*, vol. 21 pp. 983-992, 2011.
- [20] E. Marchand, H. Uchiyama, F. Spindler, "Pose Estimation for Augmented Reality: A Hands-On Survey," *IEEE Transactions on Visualization and Computer Graphics*, vol. 22(12), pp. 2633-2651, 2016.
- [21] B. Zhu, "Self-Recalibration of the Camera Pose via Homography," *IEEE International Conference on Intelligent Computing and Intelligent Systems*, 2010.
- [22] C. Pirchheim and G. Reitmayr, "Homography-based planar mapping and tracking for mobile phones," *10th IEEE International Symposium on Mixed and Augmented Reality*, 2011.
- [23] S. Ullman, "The Interpretation of Visual Motion," Cambridge, MA: MIT Press, 1979.
- [24] A. Martin, M.A. Fischler, R.C. Bolles, "Random Sample Consensus: A Paradigm for Model Fitting with Applications to Image Analysis and Automated Cartography," *Commun. ACM*, pp. 381–395, 1981.

Studying the Students Information Technology Use

(On the example of the 2nd course of the Mongolian National Institute of Physical Education)

#1Tuvshinjargal Radnaa
Doctor, Researcher

Studies Programm Sector
Mongolian Institute for Educational Research
Ulaanbaatar, Mongolia
tuvshinjargal.r@mier.mn

#2Tserengavaa Tserenpurev
MA,Teacher

Theory and Methodology Department
Mongolian National Institute of Physical Education
Ulaanbaatar, Mongolia
Tetetu3h@gmail.com

Abstract-In today's era of rapid development of data and digital technology, it is vital for higher education students to have knowledge and skills about how to learn and use the information technology, learn to use the devices such as computers and other hardware. Thus they will be able to work freely in the internet environment to obtain useful information.

Keywords-The needs and use of students' information technology.

I. BACKGROUND

It is impossible to think of the current students separate from the information technology. Therefore, it is much of an importance to equip them to work and live in the information technology society. The situation with information technology infrastructure in major cities and rural areas including sums and smaller units vary a lot. [1]. Therefore, the information technology & science subject has an important role to give the knowledge and skills of the information technology consumption.

Media equipments such as computers, audio, video, CD, VCD, information, and communication networks, are used in the process of students' developmet 'self-knowledge, knowledge-based skills, and practical skills, taking into account the specifics of students' mental and information processing and perception. There is a real need to develop effective methodologies for the information technology-based professional training such as the proper use of the Internet, websites, computer applications and Internet applications.

As of the first half of 2013, there had been 609,000 Facebook users registered in Mongolia, that was 22 percent of the population, but now, after 6 years the number has grown by 13 percent or it means that 35 percent of the Mongolian population are Facebook users. According to a survey, 70 percent of all users are young people aged between 18-35. [2].

In the United States and Spain, students and learners use information technology on a computer to practice, strengthen knowledge and skills, problem solving and for continuously improving their information management and learning skills. In many countries around the world, the know how on how to incorporate the latest achievements of information technology into the educational teaching process and the right selection of the technology are being continuously conducted through various researches with combined experiments and studies. [3].

The use of information technology in education plays a key role in the process of introducing and developing information technology in the education sector. The use of information technology in education is related to new

demands or concepts related to the growing knowledge and skills for learning technology in the data and information society we live in today.

The program means intended for the training purposes such as give certain level of computer knowledge to students, learn to make the optimal decision in real perplexed conditions, work independently, especially obtaining skills to process data, control oneself, to correct one's mistakes and get the skills of proper use of the information received.

Students who use the information will be able to get and provide the information they need for their training, use it in their lessons, assignments, tasks and homework, and watch movies and videos they need, in return, it helps to express their views and opinions properly online or on social media.

Innovative aspects of this research work

It identifies the level of use of information technology by students at the School of Physical Education and Sports.

Practical significance of the research

As a result, the conclusions and recommendations of this research should have been included in the curriculum of sports schools, and have their implementation be made a clear contribution to the improvement of training activities, which of practical importance for this research work.

II. STUDY RESULT

Process and results of the information technology consumption

In this study, 36 males and 14 female or total 50 students of the *Mongolian National Institute of Physical Education* participated and the study was made by 8 surveys in selected methods.

The answer was given that 88% of the students answered "yes" and 12% of them said "no" when the question was asked from the students whether they are updated with the information technology enthusiastically. According to the study, it shows that majority of the students receive the information then processed it, interact with others and stay up to date about the news in the society. Nowadays lifestyle demands them to use the information technology based electronic devices and equipment in order to keep up with the technology development. Therefore, the students cannot imagine or limit the information technology only by phones and Facebook.

When the question was asked "How does information technology development influence your life?"; 96% replied

that it affects them well. However, 4 % replied that it was not in the level to affect. This is a huge indication that the students understand that the skills to work on the program use they need to obtain at the information technology & science subject are indispensable necessity for today's students.

According to the study, it shows that majority of the students use the Excel program which is designated to process the table information and to do accounting using the mathematics function. It shows that 8% answered that they use the programs fully and that means the students don't have necessary possession of the programs evenly. Therefore, it is crucial to make the information technology & science subject program more progressive [Fig.1]

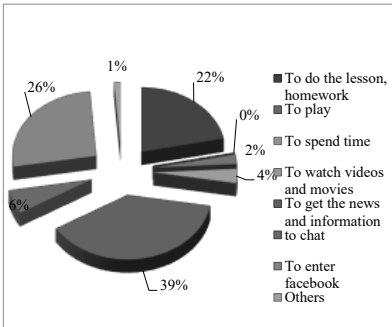


Fig. 1. In what purpose do you enter online electronic environment?

According to the study, it shows that most students get access to the online environment in order to get the news and information. However 1% of the students answered that they do not have access to internet, because of playing games or other reasons. This means it indicates it is a good sign, although it has been the not enough in this current data society. [Fig.2]

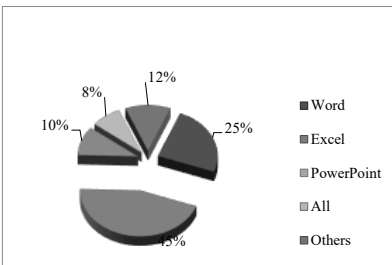


Fig. 2. Which one of the computer usage programs do you use more?

According to the study, most students communicate with one another through Facebook sharing the information. It has been observed that there are only a few students who use the online email. [Fig.3]

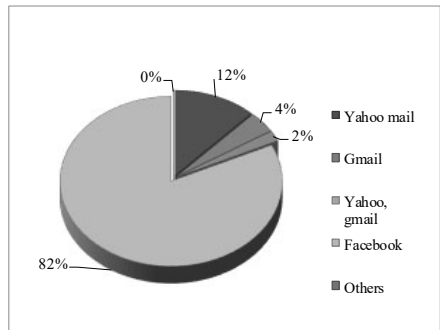


Fig. 3. Which email services do you use?

It shows that the information technology development has developed rapidly according to the above chart. The reason is the cellular phones were only used to speak and sms messages, to get access to the internet, to get the information they must find, to make connection with the organizations, to get the bank services such as making payments etc; time and all human actions have been conducted through the devices. Therefore it is clear that young students more likely to use the cellular phones. Tablet and Ipad etc; other equipment are used as well. [Fig.4]

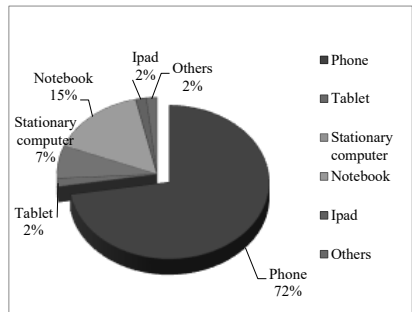


Fig. 4. What information technology equipment do you use more?

Time is not spent in cyber environment. According to the study it shows that the physical education students spend less time than other students means that they are busy with their training and educational activities. When the survey was conducted among the regular university's 242 students, 24% answered that they get 1-3 hours cyber environment or use internet. [4]. [Fig.5]

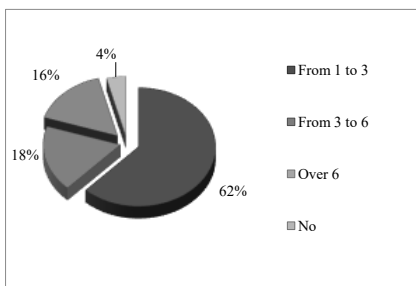


Fig. 5. How many hours a day do you get online electronic environment?

In this survey, through the information technology & science subject, most students obtain the knowledge on how to use the information technological electronic means. It was observed that the knowledge and skills to process the electronic means were increased. 2 percent answered that there was no improvement about the information technology knowledge and it shows that the information technology & science subject could not include and provide needs of some students when the analysis was made. [Fig.6]

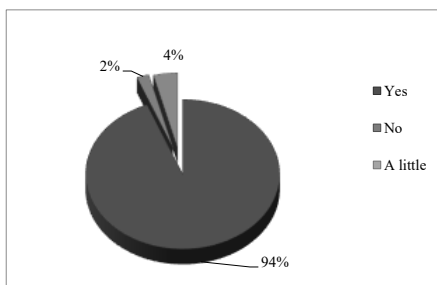


Fig. 6. Was there any improvement to your technology knowledge by having the computer lessons?

III. CONCLUSION

- The lessons and gains were analyzed and concluded on the basis of the summary for the study and research results taken from the students about how to improve and use the information technology knowledge, training on the use of electronic devices and equipment with greater results. As a result, we reached the conclusion that it would be appropriate

to make change to the subject program at the university for information technology & science subject.

- In the data era, when students want to study successfully, it is essential to find the information that is necessary for them as well as it is important to be able to use and organize it, to build-up information, to process, to distribute and to evaluate the electronic technology.
- This research work shows that we do not limit ourselves to using electronic tools and applications with only by computer lessons, but also we need to improve our knowledge and skills by receiving tasks, homework, getting news and information from professional sports sites, and to use information technology properly in our daily lives.
- In the future, it will be an issue to face us to choose the most proper ways to use e-learning materials, to have a student-centered teaching methods that are appropriate for the age-specific mentality, on the other hand it is important to improve the teaching and learning methodologies in such ways that learners have all the opportunities to learn independently.

BIBLIOGRAPHY

- [1] Information and communications technology (ICT), "Information technology white book", Ulaanbaatar, pp.185, 2014. (references)
- [2] D.Chimgee, J.Erdenechimeg, "Higher education", Ulaanbaatar, pp. 301, 2018. (references)
- [3] J.Davaa, G.Sarantuya, "University teaching technology", Ulaanbaatar, pp. 102-103, 2013. (references)
- [4] D.Chimgee, J.Erdenechimeg, "Higher education", Ulaanbaatar, pp. 303, 2018. (references)
- [5] N.Jargalsaikhan, Ts.Tavkhai "Computer self-study book". Ulaanbaatar, 2012.
- [6] Ts.Chimedlkham, B.Zolzaya, "Information science-1", Ulaanbaatar, 2006.
- [7] L.Davaasvren, "The beggner's guide book to use computer", Ulaanbaatar, 2009.
- [8] B.Zolzaya, "Computer", Ulaanbaatar, 2011.
- [9] Ts.Tserengavaa, "The importance of recognizing computer specification", Mongolian National Institute of Physical Education, "Physical education, sports theory methodology" Magazine Vol 2017-4 (58), Ulaanbaatar, pp. 37. 2017
- [10] D.Nasanjargal, "Computer studies" manual, Ulaanbaatar, 2013.
- [11] "Training manual to improve the Information science lecturers' profession", Mongolian National University of Education, Ulaanbaatar, 2005.
- [12] www.google.mn
- [13] www.msue.edu.mn
- [14] www.hicheel.mn

Blended Mentoring in Academic Internship Program

Ummay Ubaida Shegupta
Department of Computer Engineering
Chemnitz University of Technology
Chemnitz, Germany
ummay-
ubaida.shegupta@informatik.tu-
chemnitz.de

René Schmidt
Department of Computer Engineering
Chemnitz University of Technology
Chemnitz, Germany
rene.schmidt@informatik.tu-
chemnitz.de

Martin Springwald
Department of Computer Engineering
Chemnitz University of Technology
Chemnitz, Germany
martin.springwald@informatik.tu-
chemnitz.de

Wolfram Hardt
Department of Computer Engineering
Chemnitz University of Technology
Chemnitz, Germany
wolfram.hardt@informatik.tu-
chemnitz.de

Abstract—*Mentoring is considered as one of the best teaching methods based on the recent scientific evidences. Due to the ongoing digitalization in the learning environment, the traditional mentoring processes evolved to technology supported blended mentoring. In this paper, it is described how this blended mentoring strategy has been integrated into the academic internship program of computer engineering education with the objective of introducing students the scientific way of working. The students work intensively on their own topic, which in turn is a part of a complex system. Throughout the entire duration of the internship, the students are supported by the mentors in order to maintain the scientific way of working and to achieve their project goals. Various technical systems are used to support the students ensuring a lively support flow. The results show the effectiveness of the method.*

Keywords—*Blended mentoring, communication, virtual support, learning management system, scientific methodology.*

I. INTRODUCTION

Mentoring is one of the best didactic methods worldwide, as evidenced by the recent research that include a mentoring component mainly in the fields of science, technology, engineering and mathematics (STEM) [1]. Furthermore, particular application-oriented disciplines of computer science education are addressed in integrating mentoring to provide learners the necessary support to develop mastery [2], [3]. The mentor uses lessons characterized by a rich understanding of the cognitive process and the mentee's individual needs and interests to generate a mutual mentoring process [4]. On the other hand, internship as a form of experiential learning gives higher education students valuable opportunities to discover the work-life firsthand and to apply theoretical knowledge to practice [9].

In order to explore mentoring approaches, mentoring opportunities are created in the academic internship program. These are created by providing particular tasks for the students in the context of learning data extraction and processing. The large fraction of learning data is generated in the learning management system (LMS) "OPAL" of TU Chemnitz. It provides the ability to access the data to acknowledge student's learning experience and taking data driven decisions to improve the quality of education. This is known as learning analytics [5], which can give an in-depth insight about the implemented mentoring approach with

contrast to students' competence gain. For this reason, we are investigating possibilities to extract feasible data from the LMS "OPAL". Furthermore, the state of the art of data analytics using artificial intelligence methods needs to be analyzed compared to standard rule based approaches providing the basis of data usage approaches.

The mentoring objective is to bring students closer to the scientific way of working through close cooperation supported by technical methods increasing the interactivity and intensifying the mentoring process. This report aims to explore a blended mentoring approach in context of a workshop in combination with the video conferencing tool Big Blue Button [12] and the team communicator Slack [13] to ensure scientific working methodology during the project work of the students.

II. THEORETICAL FRAMEWORK

A. Pedagogy of Mentoring

Mentoring has already been proven effective to provide support to university students to facilitate their learning and to provide guidance [6]. When situated within the context of a complex real-world task like internship, mentoring has already been proven as one of the ways to foster the inner growth of the individuals [7]. The pedagogical key of academic mentoring is its use of modeling to help a student explore the inner craft of the intellect [8].

In this academic internship program, a group of students has been supervised and facilitated based on the pedagogy of mentoring. All the three mentors have tried to illustrate and transmit meta-cognitive strategies, techniques for scaffolding the students' own thinking and learning process. Mentoring focuses on relationship that is supported by the sociocultural theory of human learning by Russian psychologist Lev Vygotsky [8]. Vygotsky emphasizes the social interaction in the development of cognition [8]. An aspect of this theory is that the potential cognitive development is limited to a "Zone of Proximal Development" (ZPD) [6]. The student learns by participating in challenging activities with a "more competent other" who supports the elements of the work that the student cannot do individually. Gradually the student takes over direction and moves toward independence [8]. The scaffolding techniques of the mentor helped them to get

gradual support of consultation, instructions, motivation along with providing continuous feedback to their learning activities [7]. Afterwards, the mentoring process steered the students to take over the ownership of their own learning, as it is supported by ZPD [8].

B. Blended Mentoring

Upholding the great promise of traditional mentoring, it has been expanded to E-mentoring and blended mentoring with the evolution of E-learning and Web 3.0 technology [10]. Blended mentoring process has more than one means of communication including face-to-face mentoring sessions accompanied by communication or mediation through e-learning tools [10]. Previously, mentoring used the benefit of email to maintain the virtual communication between the mentor and mentee [1]. The development of various user-friendly technologies used for communication and as teaching aid in e-learning has paved the way to practice and apply the theoretical knowledge of mentoring [3].

As scaffolding in the ZPD was followed in this mentoring process, it had helped to easily realize the blended mentoring support via e-learning tools. This enables the mentee to keep track of his or her respective implementation tasks with the minimum possible guidance from the mentors.

In the above-mentioned framework, it indicates that the mentoring process combines traditional and online sessions; it can be called blended mentoring approach accordingly [8]. This blended approach has enabled the mentor to provide task related continuous feedback and to facilitate the students to sustain their motivation to complete their assigned tasks.

C. Research Objective

Mentoring in internship is defined as the degree to which the supervisor or mentor assigns the challenging tasks to the mentees, and provides proper guidance in accomplishing the tasks and purposefully helps to develop the mentee's cognition and skills for real life implication. Reasonably, the mentees' view of the applied blended mentoring approach is necessary to continue this support in the academic research internship program. Besides, the student's task oriented goal, which will be described in the task description section, the research objectives are to explore the mentees' perception about the mentoring support, about their cognitive, affective and skill development, their preferences of the mentoring modes, mentor's roles and the effectiveness of different consultation media. Along with these, finding out the shortcomings of the mentoring process to improve it in future is an underlying objective of this research.

III. RESEARCH METHODOLOGY

A. Student Background

There are six students registered to this academic internship. They are all Master students of Chemnitz university of Technology (TUC). They are mainly from two faculties – Faculty of Computer Science and Faculty of Electrical Engineering and Information Technology. The gender ratio can be considered as balanced with 4 men and 2 women. Two of the students are enrolled in first semester whereas the other students are enrolled within a range of 3 to 7 semesters.

The six students registered have chosen 5 of the following topics. The voluntary chosen topics are:

1. Analysis and Implementation of Methods for iCal Calendar Data Extraction
2. Analysis and Implementation of Methods for ONYX Test Evaluation
3. Data Acquisition and Generation of Statistical Data from Log Files
4. Implementation of a GUI for Data Visualization
5. AI for Automatic Test Data Evaluation

Two students with individual solution strategies have chosen topic 4.

B. Scaffolding through Blended Mentoring

In this academic internship program, the higher order learning is facilitated via metacognitive scaffolding techniques [9]. The phases of planning, monitoring and evaluation of this technique [9] were incorporated in the applied blended mentoring approach.

In the planning and monitoring phases, the students got incremental mentoring support at the beginning of the internship. Two face to face residential workshop session occurred which were respectively three days and five days long. The aim of these sessions were to provide intensive mentoring support. The students completed the task of understanding the requirements of the internship, state of the art analysis and developed their first plan of implementation in these sessions. Formal presentations of the mentees in these sessions were realized as formative evaluation, rendering the scope of continuous development in their respective internship tasks.

In between, these sessions and the communication at the later period of this internship between the mentor and the students were maintained via Email and SLACK [13]. Whenever the students needed in-depth support, the online meeting tool Big Blue Button [12] had been used.

Finally, in the summative evaluation phase, the last official online workshop the students were able to show their implementation individually by themselves. Here they were expected as competent individuals, who could perform the difficult tasks by their own as stated by the "Zone of Proximal Development".

C. Internship Task Description

The objective to bring students closer to the scientific way of working, therefore 6 Tasks in the context of learning data extraction has been defined, based on working fields identified in cooperation with the 'tech4comp' project. Reasoned by data protection law conditions, the person data cannot be made available to students. For this reason an evaluation course in OPAL has been created, which contains all necessary course elements. The students can use it freely to generate all necessary data as examples for artificial data generation following the given data structure. This course has mainly 6 types of elements: Registration-Element, Upload-Folder- Element for the files from supervisors, 6 types of Calendar-Elements, two types of Blog-Elements, five types of Checklists-Elements and five types of ONYX Test-Elements. Log data can be acquired from all course elements and these different types of elements provide different types

of learning experience data of the students. For conducting learning analytics, these data needs to be exported from the data archiving tool and exported function from the "Course evaluation" and "Statistics" functions of the course. The data are exported as XLS Files. To perform Learning analytics it is necessary to extract and evaluate the data providing the particular task basis. The Task description are as follow:

1) Analysis and Implementation of Methods for iCal Calendar Data Extraction

Opal offers the possibility to integrate iCal calendars into courses. For data analytics, it is necessary to automatically read the data of the calendar and store it in a database. Therefore, the learning outcome of this task is that, the intern will be able to develop a script or program, which reads all information of the calendar, prepares it and stores it in a database.

In the first step, the data must be understood and the information that can be extracted has to be identified. On this basis, the database design is to be jointly defined and implemented in cooperation with the other team members. The data will then be automatically extracted and prepared for database storage. Finally, the data will be automatically stored in the database.

2) Analysis and Implementation of Methods for ONYX Test Evaluation

Opal offers the possibility to integrate ONYX Tests into courses. These tests can be extracted by the archive function from Opal as Excel files. For data analytics, it is necessary to automatically read this data and store it in a database. Therefore, the learning outcome of this task is that, the intern will be able to develop a script or program, which reads all information of the exported data file, prepares it and stores it in a database.

In the first step, the data has to be analyzed as preparation for information extraction. On this basis, the database design is to be jointly defined and implemented in cooperation with the other team members. The data will then be automatically extracted and prepared for database storage. Finally, the data will automatically be stored in the database.

3) Implementation of a GUI for Data Visualization

The data exported from task 1 to 4 stored in the database are to be visualized in this task. Therefore, the learning outcome of this task is that, the intern will be able to design a database together with the team members.

Afterwards, the data should be presented as web components on a website. For this purpose statistics have to be created to visualize the temporal evolution (e.g. by semester) and the current state of the semester.

4) AI for Automatic Test Data Evaluation

Knowledge tests are very important in the blended learning environment. However, a lot of data has to be processed. One goal of such data processing is the generation of individual feedback for the respective pupil/student. To create a good feedback it is necessary to understand the connections between tasks and to be able to draw conclusions about the actual misconceptions. At this point artificial intelligence should be used to identify such misconceptions. Therefore the learning outcome of this task is that, the intern will be able to conduct a systematic literature survey (with evidence), to analyse concepts for the identification of misconceptions and, if necessary, to extract the required

conditions. On this basis, guidelines should be developed enabling AI-based evaluation and feedback generation.

5) Data Acquisition and Generation of Statistical Data from Log Files

For data analytics, it is necessary to automatically read the log data of the course providing the access time and usage frequency of different course elements and store it in a database. Therefore, the learning outcome of this task is that, the intern will be able to develop a script or program which reads all information of the exported data file, prepares it and stores it in a database.

In the first step, the data must be understood and the information that can be extracted has to be identified. On this basis, the database design is to be jointly defined and implemented in cooperation with the other teams. The data will then be automatically extracted and prepared for database storage and statistical analysis. Finally, the data will automatically be stored in the database.

D. Basics of Task Completion Strategy

The first step is to recognize the data and filter the information. On this basis, the database should be defined and implemented as team across all members and filled manually with artificial data once. Afterwards, the data has to be automatically extracted and prepared for database storage and statistical evaluation. The exported data has to be visualized in the fourth task using the manually data of the database for the prototyping process. Subsequently, the data has to be presented as components of a website. For this purpose, statistics on the temporal evolution and the current status of the semester have to be conceptualized in advance.

Knowledge queries are very important in a mixed learning environment, but a lot of data has to be processed. One goal of data processing is the individual feedback from the pupils. In order to give good feedback, it is necessary to understand the connection between tasks and draw conclusions about possible misunderstandings. Task five required that a systematic literary survey has to be carried out, with clues for the analysis of concepts that serve to identify misunderstandings. With the help of the results, it should be possible to generate ratings and feedback with the help of an AI.

E. Data Collection and Analysis

In this study, mentors overall experience has been captured via unstructured interviews. Whereas, a close ended questionnaire is used to gather data of mentees' overall experience of blended mentoring support in this academic internship. Since, the sample size is small (Mentor =3; Mentee/Intern =6), the data has been analyzed as qualitative data. Narrative analysis is conducted for the unstructured interview data. The questionnaire responses have been analyzed by the combination of thematic analysis and descriptive statistics.

IV. RESULTS & DISCUSSION

A. Mentor's Perspective

The mentoring process conducted through the mentors has been based on the aspect of sociocultural theory of Zone of Proximal Development (ZPD). The interns have been mentored intensively during the first stage of the internship.

According to ZPD, the scaffolding techniques have been used during these intensive consultation sessions. The mentors have tried to model similar examples of their assigned tasks and answered all the possible queries of the mentees to clarify the confusions of the tasks. The mentees have got frequent direct constructive feedback for the first three months of their internship. Then they have been working on the theoretical basis and conceptual development of their assigned task, as these are fundamental for the implementation of the technical part.

Overall, the mentors are satisfied with the guidance that they provided. All the mentee have been able to complete their internship tasks. Since all the mentee have to works in whole groups, it has been found out that all of them are supportive to each other. They have been successfully worked in the team because of their sound communication and social skills. As they have to finish their task with less possible guidance during the last months of the internship, there has been a reduction in the role of 'Instructor' as mentor.

In course of mentoring, the mentors have realized that most of the mentees lack in programming experience resulted in lower quality of the implementation part. The implementation have been successful though the mentors had higher expectation.

B. Mentee's Perspective

The responses of the mentees from the close-ended questionnaire about the mentoring support shows diversified prospect about the provided mentoring process. All of them reported about being mentored via face-to-face meetings, online synchronous and asynchronous communication media.

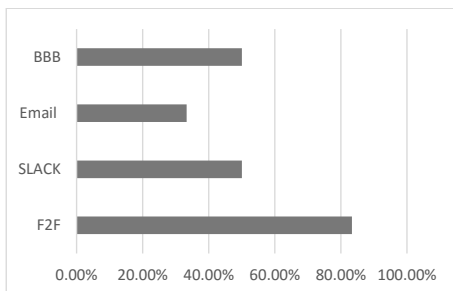


Fig. 1. Effectiveness of the blended mentoring media for face to face meetings (F2F), Workspace Chatroom Slack (SLACK), E-mail contacts (Email) and Online meetings via BBB (BBB)

They have opined that the face-to-face meetings provided the most effective mentoring support (See Fig.1). Among the other modes of communication, Slack and online meeting room Big Blue Button have been reported as effective mentoring tool. Their responses show that they have been most benefited by the mentoring support in increasing their self-confidence. Figure 2 shows their perception that their problem solving skill and presentation skill have been improved following their self-confidence.

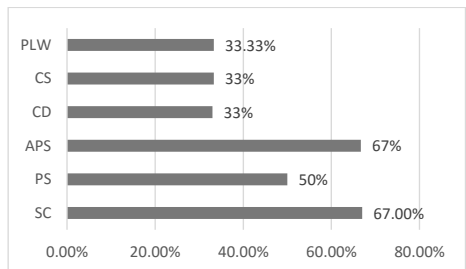


Fig. 2. Mentee's improvement via mentoring support with [SC] Self Confidence [PS] Presentation skills [APS] Analytical/ problem solving skills [CD] Career development [CS] Communication skills [PLW] Personal attitude towards learning and working

Figure 2 shows their affective and skill development in this whole mentoring process. As one of the mentee stated in the open ended response,

"I was challenged to discover new horizons in a field I initially knew nothing about, and in this process gained profound, non-trivial depth of advantageous knowledge. This has helped me both on academic and career levels."

This statement indicates the improvement in the self-confidence as well as in their problem solving skills of the mentees. However, the mentees have realized the differentiated mentor's roles according to their needs shown in figure 3.

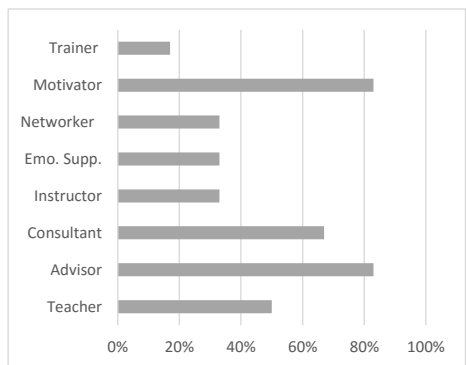


Fig. 3. Roles of Mentor

Figure 3 above shows that the mentors have been realized mostly the role of advisor and motivator in all through the internship period. The other significant roles that the mentors have played are consultant and teacher. The mentors have also performed the role of networker, emotional supporter (Emo.Supp.) and instructor. The role that the mentor have played the least is as the trainer. This supports the theory of ZPD in rendering the scaffolding support via mentoring as motivator and advisor and less as a trainer.

They have also been asked about their competency achievement according to the Information Technology Competence Model (Fig.4).

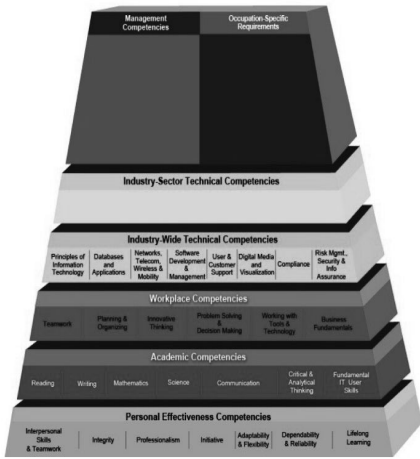


Fig. 4. Information Technology Competency Model [14]

The reported responses show an average group-wise gain of ‘Industry-Wide Technical Competencies’ 37.5%, whereas the ‘Workplace’ and ‘Academic’ competencies are respectively 61% and 40.5%. Most of the mentee’s about 61.9% have reported their ‘Personal Effectiveness Competencies’ gain. This result shows altogether the cognitive, affective and skill development from mentee’s point of view. In addition, it is according to our objective to bring the academic working style closer to the students.

In this process of mentoring, the mentors’ characteristics have been one of the crucial criteria that was asked to the mentees. Among those, the following Tab. I shows the most significant ones from mentee’s responses.

TABLE I. MENTEE’S OPINION OF THE MENTORS’ CHARACTERISTICS

Mentor’s Characteristics	Opinion in Percentage
Approachable	83%
Accessible	50%
Supportive	83%
Encouraging	83%
Provides Constructive feedback	42%
Provides guidance	42%
Provides timely response	33%
Provides comprehensive response	33%
Suggests appropriate resources	50%

The mentees have responded towards agreement of the statement shown as a summary in Tab. I. The mentors have been accessible whenever they needed and recommended them supplementary resources as stated by 50% of the mentees. To 83% of the mentees the mentors have been easily approachable, supportive and encouraging while only 42% of them reported that their mentors provide guidance and constructive feedback. Lastly, 33% have responded that they have had timely and comprehensive response from their

mentors. This finding indicate the role of mentors mostly as motivator and advisor that is in line with previous result.

Another important finding from the recommendation of the mentees are that they have needed more support in their technical skill development. This result is in line with the above mentioned mentor’s perspective that the mentees have less programming experience.

Above all, the findings of both the task related results and mentoring questionnaire indicate that the mentees have received adequate mentoring support. However, some amendments are needed in the next round in terms of considering the individual needs of the mentees. Otherwise, the blended mentoring support has helped the mentees to complete their assigned tasks.

V. CONCLUSION

In conclusion, the mentoring process has been a success based on the results. Nonetheless, the insufficient programming skills of the students, the mentors have been able to help the students finishing their programming tasks. The findings indicate that the mentees are introduced with the scientific way of working in this mentoring process. Moreover, the mentees’ have realized their inner improvement in analytical thinking. Skills like this represent the key competences essential to achieve in the field of Computer Engineering.

Due to the small sample size, the findings can not be generalized for all the internship program in computer engineering. Even though, this process of blended mentoring has been successful reasoned by well-chosen technology.

ACKNOWLEDGMENT

The authors gratefully acknowledge the funding by the BMBF (tech4comp 16DHB2106).

REFERENCES

- [1] H. Stoeger, X. Duan, S. Schimer, T. Greindl, and A. Ziegler, “The effectiveness of a one-year online mentoring program for girls in stem,” *Computers & Education*, vol. 69, pp. 408–418, 2013.
- [2] J. McCarthy, “International design collaboration and mentoring for tertiary students through facebook,” *ustralasian Journal of Educational Technology*, vol. 28, no. 5, 2012.
- [3] E. H. Trainer, A. Kalyanasundaram, and J. D. Herbsleb, “E-mentoring for software engineering: a socio technical perspective,” in 2017 IEEE/ACM 39th International Conference on Software Engineering: Software Engineering Education and Training Track (ICSE-SEET). IEEE, 2017, pp. 107–116.
- [4] A. Ziegler, “Mentoring: Conceptual basics and effectiveness analysis,” “Mentoring: Theoretical Background, empirical Findings and Practical Applications, pp. 7–29, 2009.
- [5] KD Mattingly, MC Rice and JL Berge, “Learning analytics as a tool for closing the assessment loop in higher education,” *Knowledge management & e-learning: An international journal*, vol. 4, no. 3, pp. 236-47, 2012.
- [6] G. Crisp, I. Cruz, “Mentoring college students: A critical review of the literature between 1990 and 2007”, *Research in higher education*, vol. 50, no. 6, pp. 525-45, 2009.
- [7] L. Akin and J. Hilburn, “E-Mentoring in Three Voices,” *Online Journal of Distance Learning Administration*, vol. 10, no. 1, 2007. [8] E. Gleibermann, *A Pedagogy of Mentoring*, 2014.

- [8] W.M. Murphy, "From e-mentoring to blended mentoring: increasing students' developmental initiation and mentors' satisfaction", *Academy of Management Learning & Education*, vol.10, no. 4, pp. 606-622, 2011.
- [9] I. Roll, N.G. Holmes, J. Day, and D. Bonn. "Evaluating metacognitive scaffolding in guided invention activities", *Instructional science* vol. 40, no. 4, pp. 691-710, 2012.
- [10] Y. Liu, J. Xu and B. Weitz, "The Role of Emotional Expression and Mentoring in Internship Learning", *Academy of Management Learning & Education*, vol.10, no. 1, pp. 94-110, 2011.
- [11] E. Argente-Linares, M. C. P'erez-L'opez, and C. Ord' o'nez-Solana, "Practical experience of blended mentoring in higher education," *Mentoring & Tutoring: Partnership in Learning*, vol. 24, no. 5, pp. 399-414, 2016.
- [12] "BigBlueButton Foundation", Jul.12, 2010. Accessed on: Aug.14, 2020. [Online]. Available: <https://bigbluebutton.org/2010/07/12/bigbluebutton-foundation/>
- [13] "SLACK Features". Accessed on: Aug.14, 2020. [Online]. Available: <https://slack.com/intl/en-de/features>
- [14] Employment and Training Administration United States Department of Labor, "Information technology competency model," September 2012. [Online]. Available: www.careeronestop.org/competencymodel/info_documents/it-industry.pdf

The Evaluation of Distance Teaching During COVID Quarantine at MUST

Uranchimeg Tudevagva
Faculty of Computer Science
Chemnitz University of Technology
Chemnitz, Germany
utu@hrz.tu-chemnitz.de

Tsooj Shambaljamts
Department of Mechanical Science
Mongolian University of Science and
Technology
Ulaanbaatar Mongolia
tsooj@must.edu.mn

Delgermaa Senden
Department of Mechanical Science
Mongolian University of Science and
Technology
Ulaanbaatar Mongolia
deegiisenden@must.edu.mn

Abstract—This paper describes the evaluation of distance teaching during COVID-19 quarantine time at Mongolian University of Science and Technology, public university, Mongolia. Due the corona virus almost all universities must be to change teaching type from traditional face to face to distance, electronic and digital teaching and learning. Many educational institutions have no preparation for such us unexpected change. The Mongolian University of Science and Technology has developed own learning management system for e-learning since 2007. Therefore, e-learning and distance teaching was not so new for our faculties. But, from bachelor to doctor, all level to teach from distance in whole faculties was not really ready. All faculty members and IT center did what could to fit appeared situation.

The "Patent studies" course usually teach in traditional way, in classroom for graduate students. The course has one credit including sixteen hours lectures and eight hours for self studies. The exam of course is the test exam for 30-40 minutes. All this standard must be adapted to distance teaching. For the distance teaching we developed sixteen hours' video lesson, and spend sixty-four hours in Unimis LMS, Teams 365 software and FB social networking to communicate with our students.

For evaluation of distance teaching applied the structure oriented evaluation model (SURE model). Together with SURE model we developed structures for evaluation. For data collection we used Google form and collected data processed by the SURE model online calculator.

Keywords—evaluation, e-learning, distance teaching, SURE model.

I. INTRODUCTION

The Mongolian University of Science and Technology (MUST) is the one of basic public university. Most portion of engineers graduated at MUST. The MUST has 1003 teaching staff and 20518 students in 2019-2020 academic year. There are 47 faculties offers 294 study directions.

School of Mechanical Engineering and Transportation is one of the biggest school of the MUST. Today, the school has been conducting its activity with over 100 faculty members and 2300 students. Department of Mechanical Science is the one of main faculty of SoMET, established in 1964, which offered engineering fundamental courses for undergraduate and graduate students. Since 2016, after the implementation of the CDIO initiative at MUST, professors from the Department of Mechanical Science have been organized courses more effectively and taught core courses for graduate students with new teaching methodology and technology such as blended and a flipped classroom learning [1-4].

II. THE COURSE DESCRIPTION

A. Traditional way to teach course

According to university statistical information totally 1264 students studied graduate program of MUST in 2019-2020 academy years. The course "Patent studies" is one of the core course for all graduate students, which has one credit. This course offers an overview of national and international patent law, and a basic concept of patents, trademark, and copyright. Also, the course more focuses on national patent, trademark, and copyright practice and is designed to improve the student's skills like formulate and draft a patent and trademark application. Throughout the semester each student will assess their knowledge with two questionnaire tests.

B. Adaptation of Course for Distance teaching

Due the COVID-19 situation the course "Patent studies" was deliver from distance. There was not much time for adaptation of traditional course. However, first of all, we converted lecture material into video materials step by step. After that, all of students have invited into Facebook social networking group so that explain and discuss the topics of course. Later on, after discussion and course materials, we provide a 15-20 questions self-assessment test using the QR code. The QR code is directly connected to Google form that collects all test scores in real-time. End of the semester, those test scores influence the total score. Throughout the semester, the students were divided into groups and each group was assigned the task of drafting a patent, trademark, and copyright application which related to their work and research. Also, each team introduced to a broad range of patent-related topics via Facebook. End of the semester, leading presenters lead a discussion for their topics using Microsoft Teams 365 software.

III. THE EVALUATION MODEL

There are different evaluation approaches and models are developed for educational evaluation. But, evaluation models which developed for e-learning evaluation is not so various. The selected evaluation model is the structure oriented evaluation model for e-learning [5]. This model originally developed for evaluation of e-learning process, therefore fit to our evaluation interest.

A. The SURE Model

Main concept of structure oriented evaluation model (SURE model) is based on a multidimensional

understanding of evaluation process and a corresponding analysis [6].

B. Steps of Evaluation Process

- Step 1. Definition of key goals. We are defined five key goals: Teaching materials, Learning environments, Skills of lecturer, Assessment types and Acceptance of distance teaching.
- Step 2. Definition of sub goals. To reach key goals we can define corresponding sub goals. By our definition, first key goal defined through eight sub goals, second key goals by four sub goals, third key goals by five sub goals, fourth key goals by six sub goals and fifth key goals by five sub goals respectively.
- Step 3. Confirmation of goal structures. Fig.1 shows structures of evaluation goals. The structures developed in cooperation with SURE expert and lecture who teaches course.

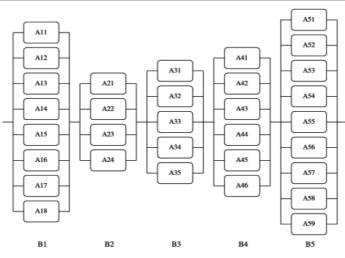


Fig. 1. The structure of evaluation goals.

- Step 4. Creation of Checklist. Based on the sub goals adapted checklist is developed (Fig. 2).

N	Sub goals	Disagree	Neutral	Agree <=50%	Agree 51-75%	Agree 76-100%
1.	Teaching materials fit to course description					
2.	Amount of teaching materials fit to course duration					
3.	Teaching materials type and format engaged to learn					
4.	Teaching materials delivered in pdf format and it was easy to download					
5.	Lectures delivered in video type. It was very helpful to review in own learning speed.					
6.	Learning materials for self study fit to course content and additional materials.					
7.	Online discussion during self study was helpful for learning.					
8.	Duration of videos was 15-40 minutes and it was exact time for study.					

Fig. 2. The checklist for key goal 1.

- Step 5. Confirmation of Checklist. Both side: lecture of course and SURE expert confirmed adapted checklist.
- Step 6. Data collection. For data collection used Google form (Fig. 3).

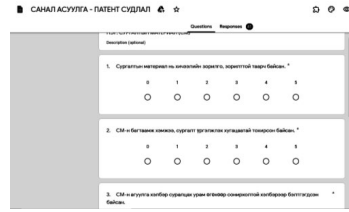


Fig. 3. Questions of sub-goals added to Google form

- Step 7. Data processing. Collected data processed by online calculator of the SURE model [8]. Original data collected by Google form (Step 6). To use online calculator collected data have to enter into calculator in comma separated vector (CSV) form (Fig. 4). After input of data in corresponding format evaluator should select view of the results. There are three group of selection is possible:
 - Color scale type. In this group evaluator can select one of four different versions. In default mode red-yellow-green version is selected. That means evaluation scores will show more in red color if scores are less than 0.5 and more green if they are higher than 0.5. This kind of view is important to stakeholder to understand and get impression about evaluation result in short time. Greener table confirms that evaluation results are more positive and good. Opposite more red shows that object evaluated more worst.
 - Checklist data display format. In this group evaluator can select one of three different versions. In default mode non-normalized version is selected. That means collected data will appear in evaluation table in original scale. If select normalized version, then collected data shows in evaluation table all from 0 to 1.
 - Evaluation table. In this group evaluator can select one of two different versions. In default mode empirical evaluation scores version is selected. That means in evaluation table will show only final evaluation scores as empirical values.

SURE model evaluation

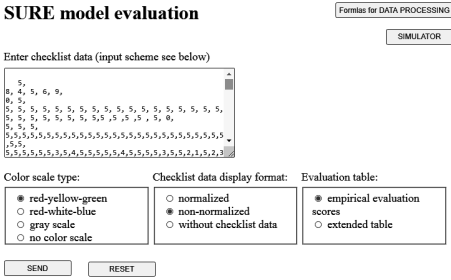


Fig. 4. The online calculator of SURE model

- Step 8. Report of evaluation. The result of evaluation process reported to faculties as feedback of unplanned distance teaching period.

IV. STATISTICS PROCESSING

A. Short Statistics

The course "Patent studies" offers each semester for approximately 280-350 freshmen graduate students from all of graduate programs of MUST.

B. Responce Data

Throughout the semester, 68 students were studied in my group. The checklist was send to all learners. After the final exam, approximately 41 students have responded to all questions within a week via Google form.

C. Processed Data

Collected data processed by online calculator of SURE model [7]. Figure 4 shows basic window of online calculator. Evaluator should put collected data in CSV format into the edit field. The online calculator computes all evaluation scores and return results in table (Fig. 5).

Empirical evaluation score $Q_e^*(C)$

$$Q_e^*(C) = 0.977272$$

Asymptotic confidence intervals $[q_{e,0}^*, q_{e,1}^*]$ for $Q_e(C)$ at confidence level $1 - \alpha = 0.90, 0.95, 0.99$

and sample standard deviation σ_e^* with $\sigma_e^* = \sqrt{\frac{1}{n-1} \sum_{k=1}^n (Q_{e,k}^*(C) - Q_e(C))^2}$.

$1 - \alpha$	$q_{e,0}^*$	$Q_e^*(C)$	$q_{e,1}^*$	σ_e^*
0.90	0.9585		0.996	
0.95	0.9549	0.9773	0.9996	0.0729
0.99	0.9479		1.0066	

Sample size $n = 41$

Fig. 5. Part of result screen of online calculator.

V. SHORT ANALYZE ON EVALUATION RESULT

The advantage of the SURE model is evaluator can receive many evaluation scores from evaluation table after

data processing. Let us do short analyze on calculated evaluation scores.

- Main result of the evaluation process is 0.97. This is very high score and by this value we can conclude that our unplanned distance teaching run almost excellent. Because highest possible value is 1 and we have 0.97.
- Next analyze can focus on key goals. How good we reached our key goals?
 - $B_1 = 0.97$
 - $B_2 = 0.99$
 - $B_3 = 0.97$
 - $B_4 = 0.98$
 - $B_5 = 0.98$

By evaluation scores we can summarize that all key goals are reached very positive its target. Highest values received second key goal. Aim of this sub goal was identify learning environment of distance learning. Throughout the semester, Unimis Learning Management System, Teams 365 software, and FB social networking systems had been used simultaneously to communicate with our students.

- One more deep analyze can do on sub goals evaluation. In total we had 32 sub goals. There are distributed not linearly by key goals. The fifth key goal has most many sub goals: 9, that means we did 9 different activities to reach this key goal. In this level we can look to detailed result of sub goals. Worst evaluation value got sub goal A59. This sub goal was focused on the Lecturer responsible for distance learning. 30% of total students were accepted lecturer is not so important the distance learning.

VI. CONCLUSION

The aim of this evaluation was to measure result of distance teaching and learning methodology. The main evaluation score calculated as 0.97. This score shows that unplanned distance teaching run sacksful in this semester. All 32 sub goals are evaluated bigger than 70%, means satisfaction of students are very positive. It gives many power to faculty to keep and continue distance and online teaching for our courses.

While the results of the evaluation surveys and the mean responses of the key goals were obtained from 60% of total students, it is clear that distance teaching was significantly influenced students' ability to learn online and self-study and digital learning skills. The improvement confirms the fact that students were adapted online learning methodology and, thus, learn the self-study by doing.

In the end we would like to add that to this structure oriented evaluation checklist we added two open ended questions. "What are some ways to increase student engagement?" and "What are the first thing you would like to improve in connection with the lesson?". We received interesting different response to these two questions and actually we are working on reflection and analyze on those questions. We plan to include analyze and comparison of results in our next work.

REFERENCES

- [1] Delgermaa S. "Opportunity to organize a workshop on "Theoretical mechanics" using "Case study" technology", ICE 2012. 114 p. Deajeon, Korea, "Proceedings of The International Conference on Engineering"
- [2] Delgermaa S., Tsozolmaa D. "Study of Opportunity to Check Out the Student's attendance Online", ICKI 2011. 349 p, Ulaanbaatar, Mongolia, "Proceedings of International Conference on knowledge Based Industry"
- [3] Batbayar D., Delgermaa S., Tsooj. "Evaluating the quality of core courses of Mechanical engineering program" National conference on Outcome based education 2019. pp 105. Ulaanbaatar, Mongolia
- [4] Ganbat D, Delgermaa S "Some experiences of using ICT in active learning" ISCSET 2017. Berlin, pp 104-110
- [5] U.Tudevdagva, "Structure Oriented Evaluation Model for E-Learning", Wissenschaftliche Schriftenreihe Eingebettete Selbstorganisierende Systeme, Universitätsverlag Chemnitz, July 2014. pp. 123. ISBN: 978-3-944640-20-4, ISSN: 2196-3932.
- [6] U.Tudevdagva, & W.Hardt, "A new evaluation model for e-learning programs", Technical Report CSR-11-03, Chemnitz University of Technology.
- [7] U.Tudevdagva, "Structure-Oriented Evaluation An Evaluation Approach for Complex Processes and Systems", Gewerbestrasse 11, 6330 Cham, Switzerland, Springer, 2020, pp.92, ISBN 978-3-030-44805-9 ISBN 978-3-030-44806-6 (eBook), <https://doi.org/10.1007/978-3-030-44806-6>.
- [8] Online calculator of the SURE mpdel, <http://uranchimeg.com/sure/eva.php>