

# Robotik: Ball Throwing

Dr.-Ing. John Nassour

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## 1 The Goal

The task is to throw a ball at a target. Figure.1 illustrates the robot system that is configured to accomplish this task. The goal of this task is to help you to understand and use the velocity kinematics techniques acquired in the lecture (forward and inverse models).



Figure 1: Nao initial position for throwing.

## 2 Task Description

Move the robot left arm into the home configuration for throwing. It is recommended to perform the motion with considering intermediate poses to avoid collision with the head. You can also manually move the arm into the desired position before start sending the motor command into the robot.

The recommended home position for throwing is:

- LShoulderPitch: 119 Degree

- LShoulderRoll: 0 Degree
- LElbowYaw: -90 Degree
- LElbowRoll: -85 Degree
- LWristYaw: 90 Degree
- LHand: (open)

Three joints are involved in this task: LShoulderPitch, LElbowRoll, and the hand. The throwing motion will be performed by controlling the first two joints that bring the robot end-effector into a desired position with linear and angular velocities.

Include the detailed mathematical discretion for each step.

## 2.1 Step.1

Work out the Jacobian matrix for the robot (only consider the involved joints in the throw).

## 2.2 Step.2

Perform throwing into different targets (A and B, see Fig.2) and figure out the Jacobian columns at each time step during the throw.

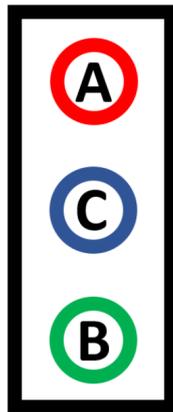


Figure 2: Targets' panel.

## 2.3 Step.3

Using the analytical technique for calculating the Inverse Jacobian work out joints velocities for throwing into a target C located in the middle between target A and target B.

Check your results by performing the throw at the target C.

## 3 Results to Submit

- A PDF report containing description, comments of each subtask. Please use the template.
- Source code and the project directory. Not the binaries, etc.
- Note: Comment your code. Also, write your names at the beginning of the source code file.
- Make a demo video showing the results of step.3.
- Compress all the required results into a .zip or .tar.gz file.
- Naming convention: LastName1\_LastName2\_GroupNo\_TaskNo.  
Example: If two students from group "Y" Franz Müller and Peter Maier work together on task 2, then they submit the file Müller\_Maier\_GY\_T2.zip or Müller\_Maier\_GY\_T2.tar.gz.  
Don't send the video file if it is too big. You can send a link on it [max size 20 MB].  
Submit the file containing your results before the deadline to:  
john.nassour@informatik.tu-chemnitz.de

## 4 Deadline

Feb. 5th 2015