A Simple VR-Control Device Using Marker-Based Tracking of the Human Hand

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Abstract

In this paper we describe a novel method for controlling and navigating in virtual worlds without using any commonly used input device. Usually expensive, not very intuitive input devices that are designed for a special purpose are used for interacting with virtual environments. Assuming that recent VR installations use marker-based optical tracking systems we simply replace commonly used input devices by some markers. This results in a virtual input device which can be used context sensitive.

1. Introduction

Recent research of our institute deals with the development of a 3D user interface [1]. Known methods for controlling 2D GUIs cannot be used in an immersive 3D environment. So it was challenging to develop several facilities for interaction with such a system.

Controlling a virtual world is mostly done by purpose-built 3D devices. This comprises spacemice, flysticks and datagloves. These devices have some disadvantages. Some of them are designed for right hand usage. Further the hand where such a device is attached to is blocked for other intentions. Mostly such devices are unwieldy and need some practice to use. Especially datagloves still have a separate cable which compensates the advantage of the wireless optical tracking.

So the idea is to create a virtual input device that does not have these disadvantages.

2. Tracking

We use an optical tracking system from Advanced Realtime Tracking GmbH called DTrack. Currently our installation consists of three cameras, but it is expandable depending on the application’s requirements. Using more cameras will improve accuracy and reliability.

It is necessary to track some positions to determine the gesture currently represented by the user’s hand. We actually use three thimbles attached on the thumb, the index finger and middle finger to avoid the usage of traditional targets. This is a low budget approach. The thimbles can be easily attached to both hands. Each thimble is coated with a retro-reflecting material used for all markers of the DTrack system. So it is possible to locate every actually visible thimble. Of course we cannot evaluate the rotation of each individual marker.

Taking into account in which way the three fingers are usually positioned and moved we can determine which marker represents a particular finger.

Tests show that it makes no sense to fix auxiliary thimbles to the pinky and the ring finger, because human anatomy prohibits accurate movements of these
two fingers. The only purpose of attaching thimbles to the pinky and the ring finger may be the fact that additional information can be acquired. This would result in higher reliability of the tracking results for the thumb, the index finger and the middle finger.

3. The Virtual Devices

Using all available information about the three different markers it is possible to distinguish between several poses. So the device can be adapted depending on the context of the application. This means there is no fixed device. For instance we can provide a jog-dial if the fingers are positioned as in figure 2 or we can provide a slider if the three fingers are positioned in one line. In both cases it is possible to edit a value.

When using optical tracking the common way to track a special gadget is the mounting of a target on it. Such a target consists of four to ten fixed markers. Each target which can be potentially used has to be calibrated. This means the tracking system measures the relations between the markers and saves this data to be able to identify a target. After this process every target can be located in all six degrees with an excellent accuracy. In contrast to this it is not possible to identify a particular marker or determine it’s rotation. Only the marker’s position is available.

The following conditions are analyzed to identify the finger positions as “jog-dial position”.

1. three markers have to be located within a sphere of predefined size
2. the marker with the greatest distance from the other two markers is the thumb
3. analyzing the two vectors between the marker attached to thumb and the two other markers will result in separating between middle an index finger

4. additional assumptions can improve the behavior

After a successful recognition of the jog-dial pose it is possible to calculate the gesture’s rotation around the depth axis. This represents the basic functionality of a jog-dial. By using the rotation angle the user is able to edit a single value in an intuitive way.

Further on it is advantageous that the virtual device appears on the same position in the world where the user’s hand is located. Immediately after detecting the “jog-dial”-gesture the system shows this device and allows the user to do the adjustments. No picking is needed which sometimes is a frustrating task in a 3D environment.

During the controlling phase (e.g. the user rotates the jog-dial) the system is able to compensate occluded or otherwise invisible markers. If only one marker is visible for a while the device disappears. Short invisibilities are countervailed by using the last position.

4. Future Work

Currently only the jog-dial gesture is supported. The virtual device should be adapted to the application context and the recognized gesture. Further the error correction for occluded or missing markers should be improved based on the motion history of every single marker as well as the relations between markers. The evaluation of a second rotation axis or the linear movement of the whole hand can be used for other input issues. Note, the more data is used to control something the less data can be used for error correction.

The usage of three additional markers for the second hand should be considered. Then the system has to distinguish both hands which leads to some extra calculations.

5. References