HEAD ORIENTATION & POSITION TRACKING IN VIRTUAL ENVIRONMENTS

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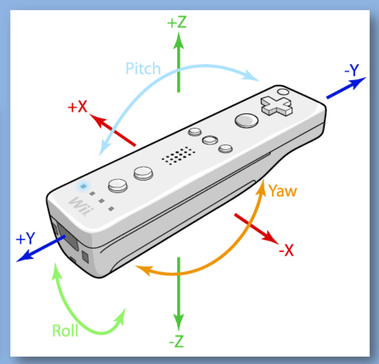
Introduction

Virtual Environments are computer generated simulations that are presented to a user in an immersive manner. These simulated worlds are interactive in real-time based on the actions of the user. Research within virtual environments explores how the computer-generated images can be effectively traced back to the user's actions to improve the user's immersive experience.

Objective

The purpose of this research is to discover an alternative method to track head movements using inexpensive Nintendo Wii's controls including the main controller (WiiMote) and the Wii MotionPlus add-on. By capturing orientation information using the device's built-in tuning fork gyroscope and Bluetooth capabilities, the WiiMote and MotionPlus provides a more mobile, cost-effective alternative to previous hardware used in research and real-world implementations in virtual environments.



Methods

Communication between WiiMote & Computer

•WiiMote libraries needed configuration with Bluetooth technology

• Various LED light clusters tested for effectiveness with WiiMote's limited perspective

Location & Orientation Calibration

•Convert physical location into virtual space through custom calibration matrix for differing viewing planes

•Minimize drift from MotionPlus data for roll, pitch, and yaw for head calibration

Interact with Virtual Environment

•Connect virtual room with streaming positional data from WiiMote using C# implementation

Environment Setup

One WiiMote was used to track positional information. Although one WiiMote limits accuracy at larger distances and decreases viewing area, our implementation:

- Increases the mobility of environment
- Simplifies perspective transformation (described below)

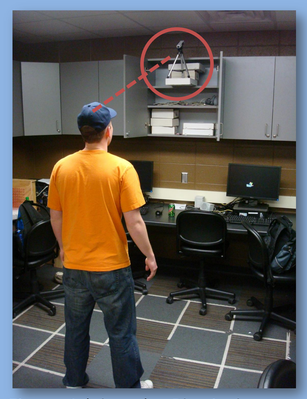
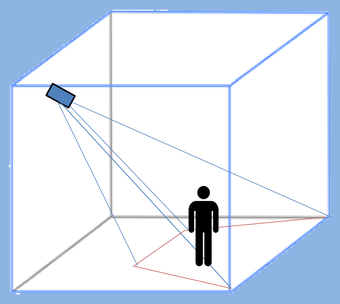


Figure 1 (above) – Physical setup with WiiMote camera facing user

Figure 2 (left) – WiiMote stationed on stand (camera facing user) with adjustable viewing angle

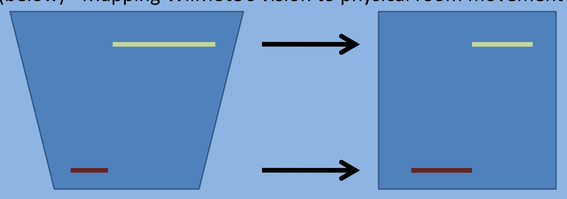
Figure 3 (right) – Hat outfitted with LED light cluster for WiiMote's camera viewing

Position Tracking



The WiiMote is outfitted with an camera in front that detects infrared lights and reports their location from its perspective. When placed slightly above the walking area, the viewing angle looking down creates a trapezoidal shape (outlined in red above) instead of a desired square for the specified movement area. The reported information needs to be remapped using a calibration matrix on all positional data. The positioning of the WiiMote affects how similar movements of the user display differently depending on the distance from the controller's camera (shown below).

Figure 4 (below) - Mapping WiiMote's vision to physical room movement (aerial view)



Acknowledgements

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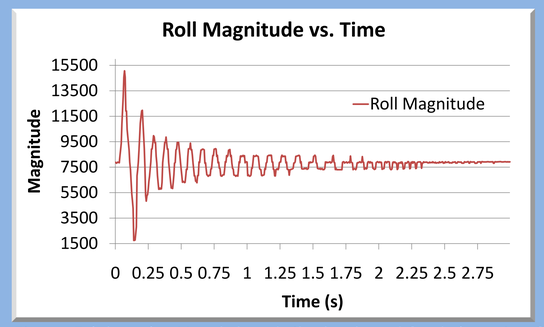
Head Orientation

The WiiMote MotionPlus attachment uses a gyroscope device to measure angles and rotational motion for head orientation. The MotionPlus measures the **rate of change** in orientation as a user looks around the virtual scene. Mounting a WiiMote and MotionPlus to a user's head provides the capability. Below are some of our results.*

*Note the MotionPlus reports approx. 7800 at equilibrium.



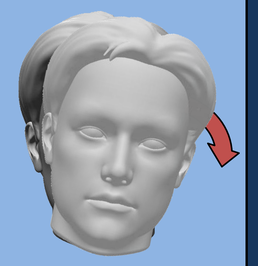
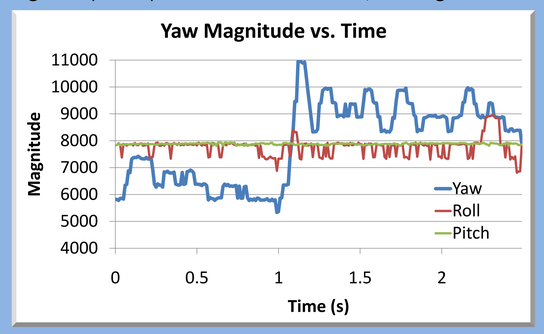
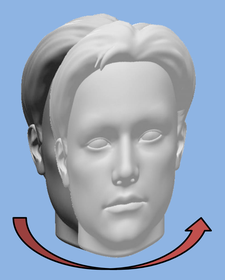


Figure 5 (above) – User's head tilts back and forth (starting fast and slowing down)

Figure 6 (below) – User's head looks left, then right





Results

The WiiMote can be used as a cost-effective alternative to creating interactive virtual environments for users. With the growing number of applications of virtual environments in various academic fields, the WiiMote brings reliable position tracking technology with little overhead in setup and supplies. Despite minor setbacks in data accuracy from drifting with the MotionPlus, our research found it as a feasible option for orientation, but difficult to maintain reliable head positioning due to sensitivity.

Discussion

- Could multiple WiiMotes provide greater accuracy for position tracking?
- What filters could be used to minimize the gyroscope's drift in the MotionPlus?
- How could a virtual environment support full range of motion including crouching and 360˚ turning motion?