EE 267 Final Project Proposal: Extension of HW6 Positional Tracking

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Problem Statement

The planar diode arrangement of the VRduino limits the range of motion of the user by requiring that the entire plane remain in line-of-sight from the lighthouse. To mitigate this restriction, we propose to use two VRduinos, slightly off-angle from one another, to increase range of motion. In addition, when more than four photodiodes are within line-of-sight, we will use the additional data to improve the robustness of the Levenberg-Marquardt positional tracking.

Background and Industry Approach

Our project uses the HTC Lighthouse tracking system and builds off the Levenberg-Marquardt postional tracking from Homework 6. In current practice, the use of lighthouse tracking is confined to highly localized environments which can be set up ahead of time. Another major tracking system (which we briefly considered for this project) is a camera based system which analyzes the movements of the real world to calculate and render the movement in the virtual world.

Our Approach

Our project consists of three major components:

1. Adjust the homography and LM calculations for a 3D configuration.
2. Integrate data from all diodes to provide optimal performance from all diodes in line-of sight (with a minimum of four). This will require linking two Teensys together. The master will do all computation, and the slave Teensy will only record photodiode ticks.
3. Add positional tracking into the rendering pipeline.

We intend to place the technical focus of our project on the first two points and implement rending purely for demonstration purposes.

A Possible Extension

If time and resources permit, we will extend our approach to three VRduinos. This extension will allow us to use both lighthouses simultaneously to provide motion tracking across 360 degrees.

References:

- Camera Calibrations, University of Freiburg: http://ais.informatik.uni-freiburg.de/teaching/ws10/robotics2/pdfs/rob2-10-camera-calibration.pdf
- EE 267 Lecture Slides– Homography, Stanford University: http://stanford.edu/class/ee267/lectures/lecture11.pdf
- EE 267 Lecture Slides – Levenberg-Marquardt, Stanford University: http://stanford.edu/class/ee267/lectures/lecture12.pdf
- R. Szeliski ”Computer Vision: Algorithms and Applications”, Section 6.2, Springer, 2010

Timeline

Weekend 1:

1. We will speak with Keenan to figure out how to best integrate data from two separate VRduinos (or if we should add additional photodiodes)
2. We will modify the homography and Levenberg-Marquardt mathematical derivations to account for more photodiodes and a 3D configuration.
3. We will describe an algorithm to use a variable number of photodiodes.
4. We will test the rotational range of a single board thoroughly.
5. We will CAD model the mount.

Week 1:

1. We will talk to Professor Wetzstein and the course TAs to finalize our model and algorithms.
2. We will 3d print our mount and attach the VRduinos.
3. We will connect the Teensys through SPI or Serial to integrate the data from all 4 sensors.
4. We will begin algorithm implementation.

Weekend 2:

1. We will finish implementation and testing.
2. We will create a demo, using the HW5 demo as a starting point.

Week 2:

1. We will debug as needed.
2. We will polish and finalize our demo.