EE267 - Virtual Reality
Project Proposal
Recognizing Head Gestures for Head-mounted Displays

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1 Introduction

Virtual Reality is on the rise. As building high-fidelity virtual environments becomes easier and easier finding an intuitive user interfaces for users to interact with their surroundings becomes a crucial step on the path to designing a truly immersive virtual experience. For this project we want to explore the idea of using different head gestures (like nodding yes or shaking your head no) as a natural way to interact with the virtual environment. Our first goal is to use IMU sensor data to train a classifier that can recognize head gestures. The second part of the project is building a small interactive demo that utilizes head gestures to interface with the user.

2 Related Work

Gesture recognition has become increasingly prevalent as a research topic since the onset of body-tracking devices such as the KINECT. However, it seems there are only a few examples of open source gesture recognition systems for HMDs. The only example of existing code that we came across used hard-coded differences over a set time-interval [1]. We think this leaves room for substantial improvement in the realm of HMDs.

Most work we have found on hand and head gesture recognition does not use only IMU sensor data as input. Instead, [5] uses Kinect sensor data, [2] uses infrared pictures and [3] combines EMG data with IMU sensor data.

As far as algorithms to detect and classify a gesture are concerned: [3] trains a simple SVM to classify different hand gestures. [5] uses Dynamic Time Warping in conjunction with Nearest Neighbor Classification and Hidden Markov Models as their learning algorithms of choice. Another time-series comparison algorithm that seemed appropriate is one SpADe: "The algorithm finds out matching segments within the entire time series, called patterns, by allowing shifting and scaling in both the temporal and amplitude dimensions. The problem of computing similarity value between time series is then transformed to the one

of finding the most similar set of matching patterns." However, over a wide set of datasets, Dynamic Time Warping performed just as well as SpADe [4].

3 Milestones

To finish the project in the limited time available, we have set the following milestones to measure our progress.

Week 1: 05/09 - 05/15 Make first design decisions about the classifier and collect dataset

Week 2: 05/16 - 05/22 Train and evaluate classifier

Week 3: 05/23 - 05/29 Build interactive demo that uses head gesture recognition

References

[1] Karen Bryla. Riftgesture. `https://github.com/kbryla/rift_unity_scripts/blob/master/RiftGestures/RiftGesture.cs`. Accessed: 2016-05-05.

[2] Rudi Lindl Frank Althoff and Leonhard Walchshausl. Robust multimodal hand and head gesture recognition for controlling automotive infotainment systems. `http://far.in.tum.de/pub/althoff2005vdi/althoff2005vdi.pdf`. Accessed: 2016-05-06.

[3] Marcus Georgi, Christoph Amma, and Tanja Schultz. Recognizing hand and finger gestures with imu based motion and emg based muscle activity sensing. In *International Conference on Bio-inspired Systems and Signal Processing*, 2015. BIOSIGNALS 2015.

[4] Hui Ding, Goce Trajcevski, Peter Scheuermann, Xiaoyue Wang, Eamonn Keogh. Querying and mining of time series data: experimental comparison of representations and distance measures. *Proceedings of the VLDB Endowment*, 1(2):1542–1552, 2008. `http://dl.acm.org/citation.cfm?doid=1454159.1454226`.

[5] S.J. Park J.H. Baek S.J. Hwang, J.P. Na. Ada-boost based gesture recognition using time interval window. `http://www.atlantis-press.com/php/download_paper.php?id=22306`. Accessed: 2016-05-06.