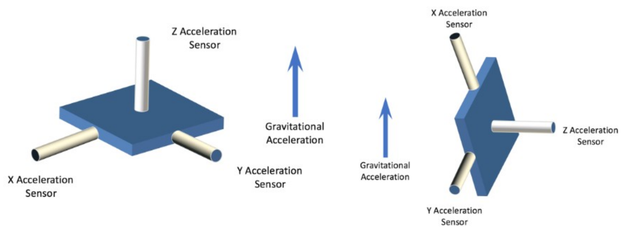
Detecting and Analyzing Physical Movements Using Machine Learning

Rachel Hayes, Electrical Engineering B. S. E.
Mentor: Dr. Chao Wang, Senior Lecturer
Arizona State University

Introduction

- The goal of this project is to analyze movement patterns using acceleration and gyroscope sensors.
- This research is conducted in hopes of improving physical therapy through the application of machine learning.



Background

- Machine learning in the health industry has increased in popularity and is being recognized as a potential solution to an overwhelmed healthcare system.
- Previous research used data imported from infrared scanners in order gather data using machine learning[1].
- Tracking movements by monitoring acceleration and angular acceleration could create a cheaper alternative to regular medical visits and would be more convenient to the patient[2].

Research Process

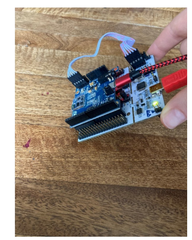
The STMicroprocessor board used in this project was assembled, and its ability to detect any simple change of position in the x, y and z axis was tested with each direction individually.

Axis	R (Magnitude)	Phi (azimuth)
X ≈ 1000	1014.5	90.57
X ≈ -1000	986.2	-90.12
Y ≈ 1000	5.830	-121.0
Y ≈ -1000	9.000	121.9
Z ≈ 1000	99.40	1.596
Z ≈ -1000	1017.2	-1.796

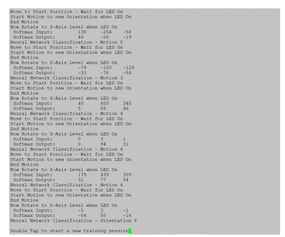
The code was then edited to recognize a specific movement based off of state change. Accuracy of the sensor was improved through increasing the sampling rate and drift-reduction filters. The machine learning algorithm was then used by training the software to recognize several basic motions where half the board was lifted 45 degrees in each direction, and testing if the algorithm can recognize movements as one of the motions.

Application

- Position, angle and acceleration has been monitored using STMicroprocessor software.
- To monitor movement in 3 dimensions, the code has been altered to detect movement along the z-axis.



Picture of STMicroprocessor board in position 1 and 3



Motion Pattern recognition output

Obstacles Faced

There was a long delay in shipping for some of the parts for this project, causing a delay in research. Because of this delay, there was not enough time to implement angular acceleration into the algorithm. Also, an IDE update changed some of the functions of the application. This problem was overcome by using a previous version of the software instead.

Future Research

- Decreasing percentage of uncertainty through further testing.
- Using gyroscope readings to recognize more specific motions.
- Expanding detection to define and categorize more complex movements by adding Inertial Sensing and Speed Recognition to the model.

References

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Venkataraman, Vinay. *Kinematic and Dynamical Analysis Techniques for Human Movement Analysis from Portable Sensing Devices*. Diss. Arizona State University, 2016.

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Ira A. Fulton Schools of Engineering
Arizona State University