Research Experiences for Teachers and Young Scholars in Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST)

csats
Center for Science and the Schools

Predicting Movement of Energy Harvester Based on Output Signals

Ben Martin[1], Xueqing Li[2] and Dr. Vijaykrishnan Narayanan[2] (mentors)

[1]Bellwood-Antis High School, Bellwood, Pennsylvania; [2]Department of Computer Science and Engineering, Penn State University

Initial Question

Can you compare a waveform produced by moving a piezoelectric energy harvester with previously gathered samples to tell how the harvester is being moved.

Goal

The ultimate goal of studying the energy harvester's output signals is to create a program that can predict how the user is moving based on the characteristics of the waveforms. The research that I did is to find out if different movements actually cause different output signals.

Beam #6   Beam #5

Beam #1   Beam #4

Beam #2   Beam #3
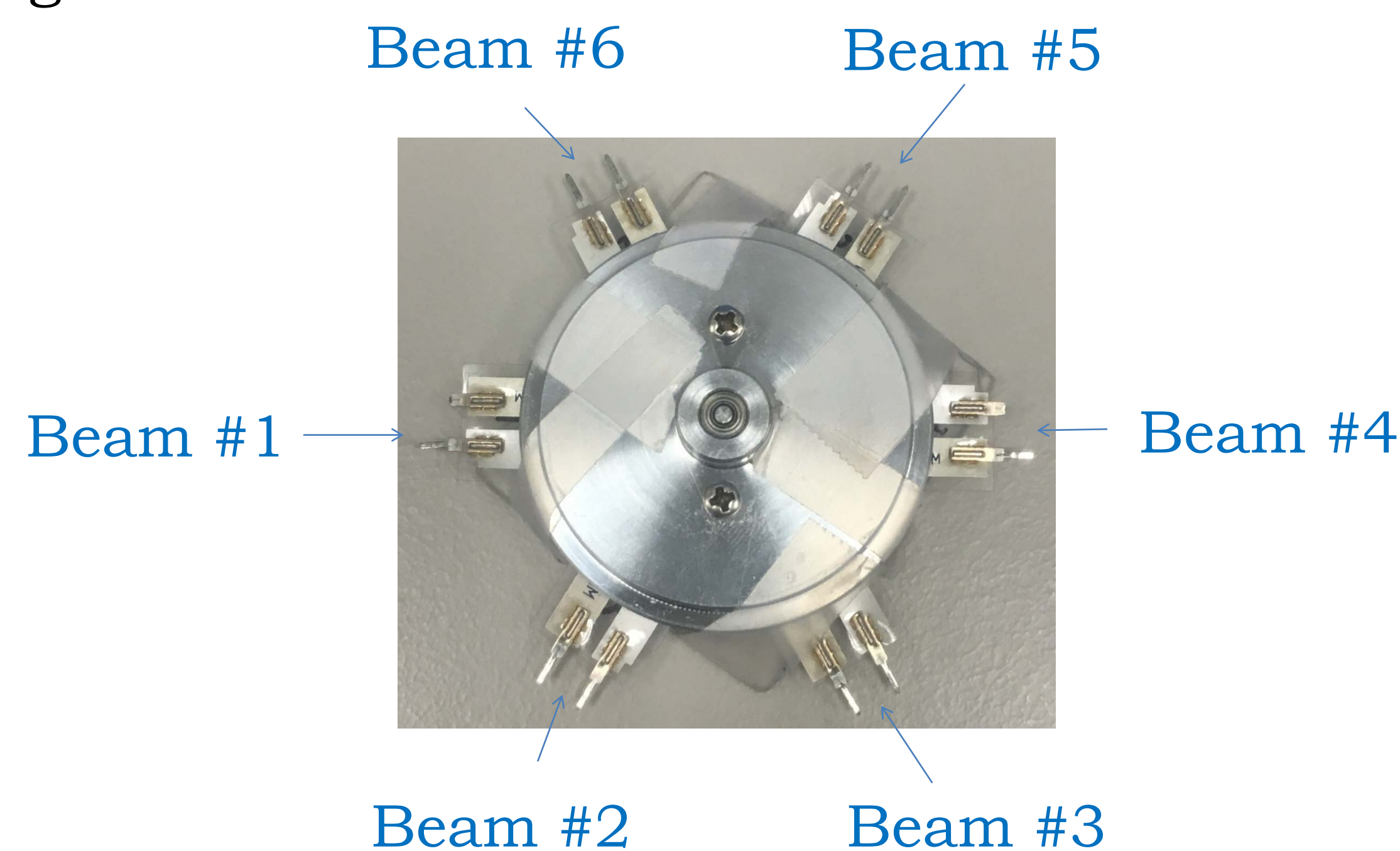
This particular project is also funded by the ASSIST program, a project whose hope is to create a band one can wear that will detect physiological and environmental factors. This project has many different thrusts, and studying the energy harvester will help to understand how much power the device will produce from normal movement as well as predict how the user is moving based on the output signals of the harvester.
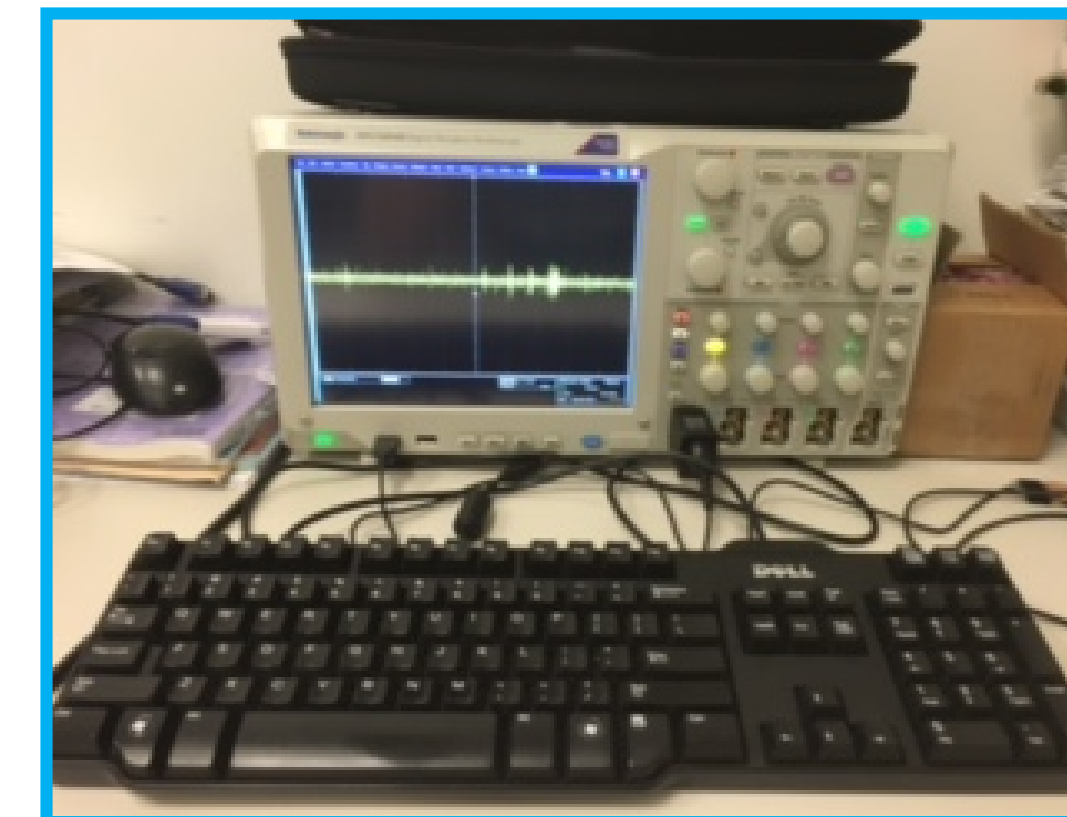
Energy Harvester Built by Prof. Shad Roundy, University of Utah
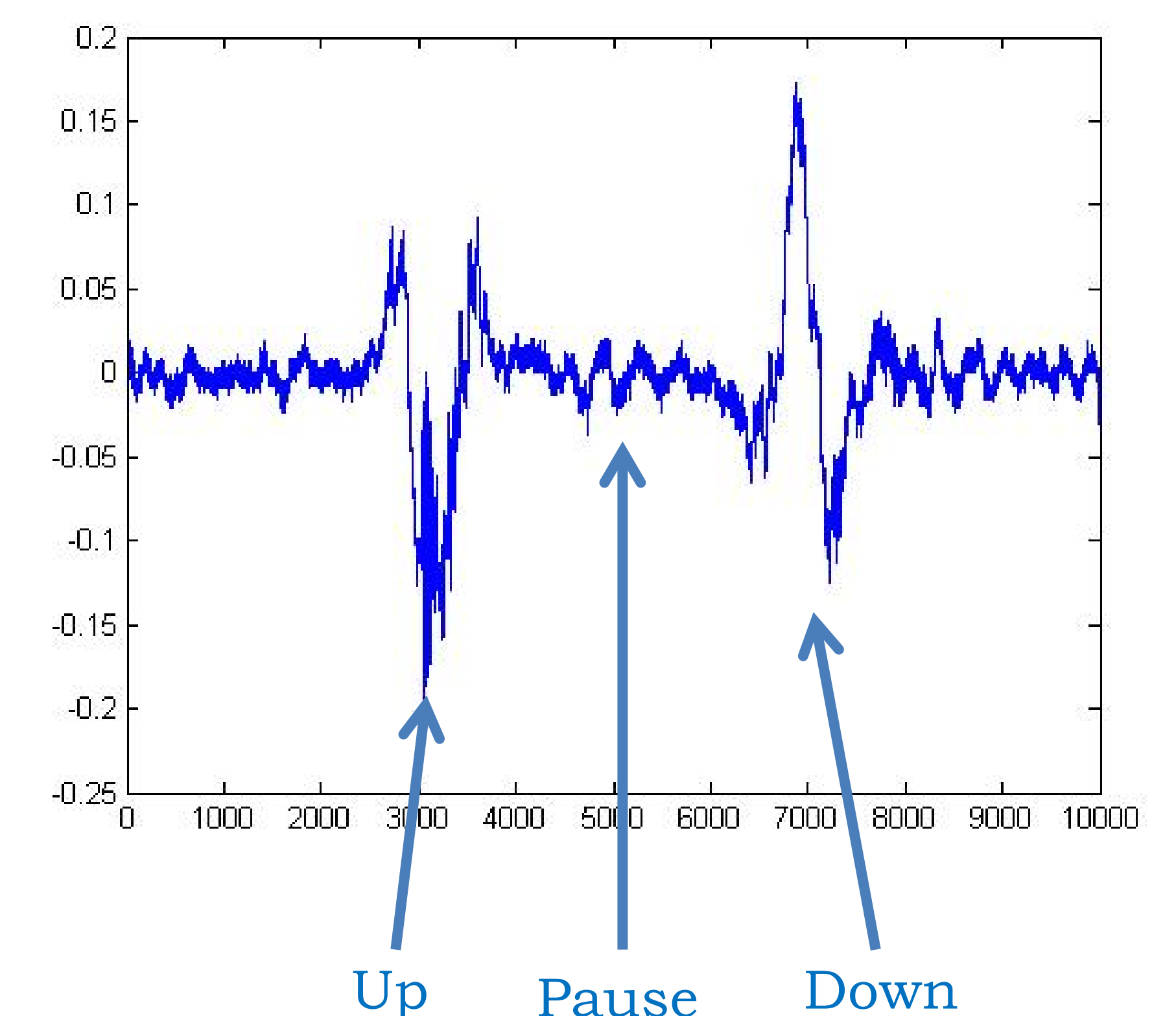
Gathering Data

To collect the data, the harvester was connected to an oscilloscope and each of the 6 beams was measured using the 8 movements. Each beam was tested 18 times for each movement, so this makes a total of 864 tests. However, beam #3 stopped working halfway through the tests so there are less results for this beam.

List of movements:
- Up
- Down
- Forward
- Backward
- Left
- Right
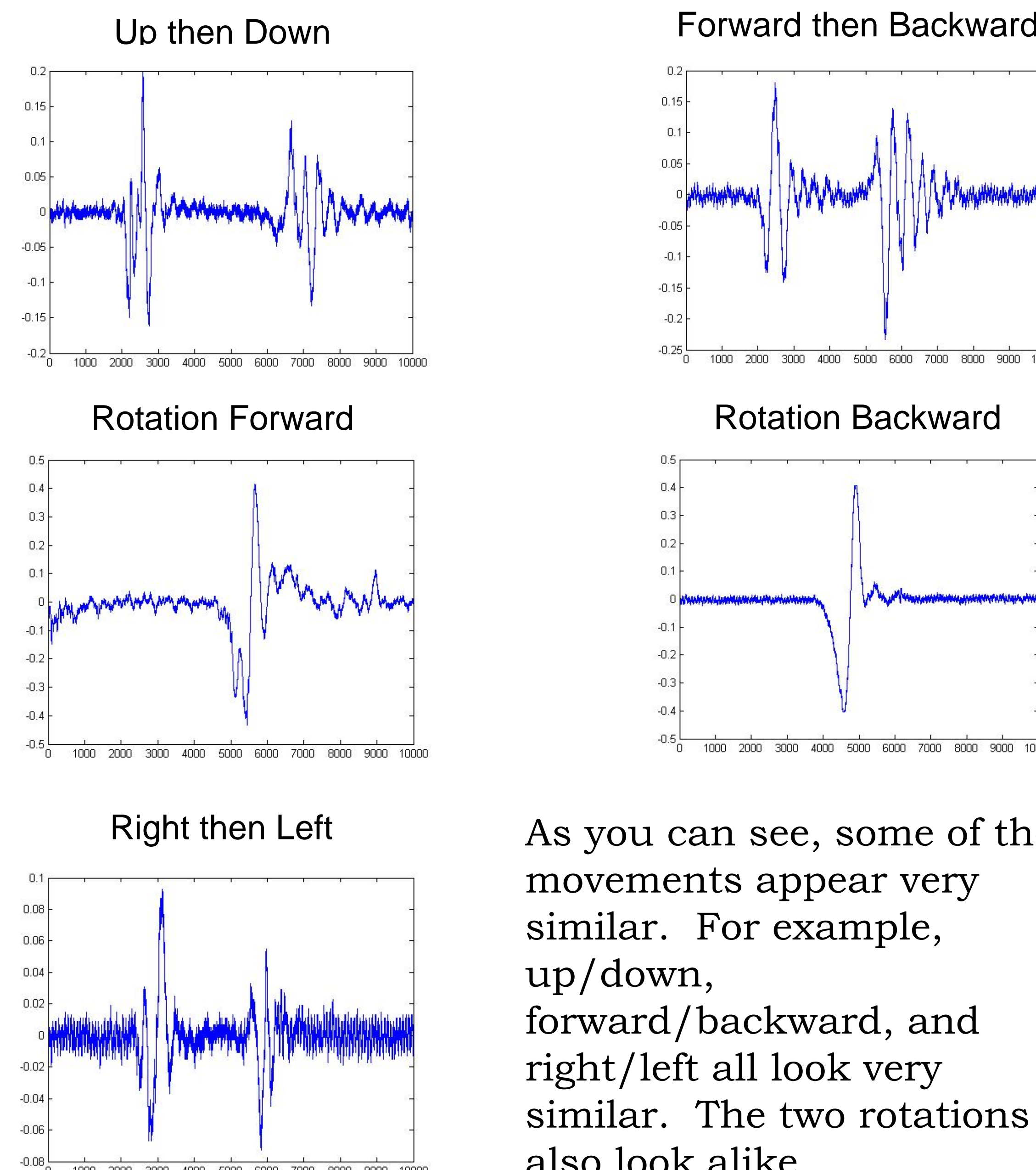- Rotation forward
- Rotation backward

Data Comparison

Up then Down

Forward then Backward

Rotation Forward

Rotation Backward

Right then Left

As you can see, some of the movements appear very similar. For example, up/down, forward/backward, and right/left all look very similar. The two rotations also look alike.

Important Finding

Up   Pause   Down

As you can see, there is a distinct difference between the up and down portion of this movement. "Up" begins with a positive slope then goes to a minimum value. "Down" begins with a negative slope then goes to a maximum value. This is an important finding because this energy harvesters beams are on a two dimensional plane, meaning they are all flat. If we could build a three dimensional beam structure, you could possibly tell the movement of the device based on the "up/down" waveforms.

Conclusion

In conclusion, I gathered a lot of data to be used with future testing of the energy harvester. The most significant finding is the difference in the up vs. down waveforms. This could be used to justify building a harvester with 3 axes in order to understand what direction it is moving based on the output waveforms.