EMP191 Lab 3 - Accelerometer Construction and Testing

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October 5, 2018

1 Abstract

In this lab we used the soldering techniques we learned in previous labs to build an even more challenging circuit board. From there, we programmed the chips on board to receive and store data, and to send it to a computer. We tested the accelerometer by throwing the device and recording and sending the data using a serial port. The data was used to create plots of acceleration and movement over time. Data was also used to answer some questions regarding accuracy and precision of the accelerometer.

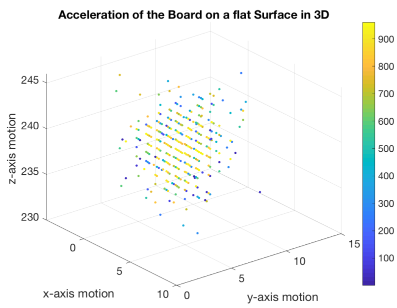
2 Introduction

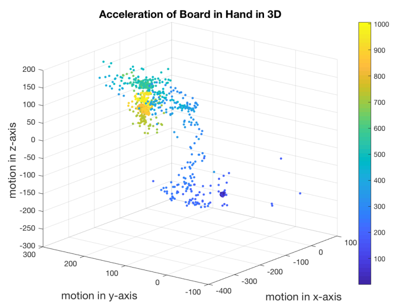
The goals of this lab were to prepare a circuit board that measures acceleration. This board will be on the rocket eventually so we must make sure it not only works properly, but records meaningful data.

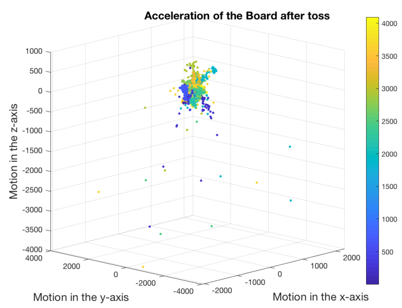
3 Measurement Procedure

I followed the Procedure given, correctly, and did not have to improvise. I used Matlab for downloading data from the serial connection, and for plotting the data points.

4 Plots of Data







5 Analysis Results

The measured frequency of the quartz crystal, using the oscilloscope was 32,766.9Hz, whereas the given Hz of the crystal was 32,768.

$$\text{Error} = \frac{obs - exp}{exp} = \frac{32,768 - 32,766.9}{32,768} = 3.3569 * 10^{-5} \tag{1}$$

Thus the clock is off by $3.3569 * 10^{-5}$ seconds. It is slightly faster than a second.

To find the mean and standard deviation of z during the up and down settings on the table we used Matlab : mean(ztop) = -18.884 and std(ztop) = 2.4837, mean(zflat) = 238.6545. The calibration constant is C where

$$\mathrm{S} = Ca + B \tag{2}$$

$$C = \frac{S - B}{a} = \frac{-18.884 \text{ counts} - 238.6545 \text{ offset}}{9.8m/s^2} == -26.2794 \tag{3}$$

Noise of acceleration, board on table: is confined in the bounds of x(-5,10), y(0,15), z(230,245). This means that the board naturally fluctuates enough to cause an added effect of $-0.5769m/s^2$

$$245 = -26.2794 * a + 230 \rightarrow a = -0.5769m/s^2. \tag{4}$$

Noise of acceleration, board in hand: is confined in the bounds of x(-400,100), y(-100, 300), z(-300,200) which naturally has more fluctuation because my hand cannot be perfectly still.

$$-300 = -26.2794 * a + 200 \rightarrow a = 19.0263m/s^2. \tag{5}$$

Accelerations measured in free fall: were approximately proportionally 1:1 for the x and y axis and changed for the z-axis, when it was a negative number for the z-axis, that is probably the acceleration caused by the chip hitting the peanuts, whereas the higher z-values indicate the throw and speed up as the chip fell, z(-500, 500)

$$-500 = -26.2794 * a + 500 \rightarrow a = -38.0526m/s^2. \tag{6}$$

6 Conclusions

This Lab was important for me because I struggled with soldering during the last lab. This time, I definitely did better, and because I had worked with serial ports over the summer, I also gained a better understanding of the serial ports when applied in this setting. I do think some of my calculations are off for the final calculation of the acceleration, and there is human and technical error for this lab.