BME 252 - Deliverable #1

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BME 252

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1.1 Identification of Noise Sources

Noise is classified as an unwanted energy fluctuation that degrades the interpretation and analysis of a desired signal. Occurring in both digital and analog systems, noise will inevitably be present in most signal captures which holds true for the data acquisition presented in this deliverable. To specify, the measurement device was subject to sudden and violent vibrations, as well as natural accelerometer and gyroscope drift.

The sudden and violent vibrations are a result of the device being located slightly superior to the ankle. With respect to normal gait, the heel is the first part of the body to strike the ground and, as such, it experiences the greatest amount of impact vibration. Limited by the lack of major joints to act as a shock absorbers, the impact is immediately recorded by both the accelerometer and gyroscope. Consequently, the error compounds with each step and acts as a major source of noise. Additionally, any movement of the device outside of inherent leg movement while rapidly scaling the stairs of E5 is also a noise source. As a clarification example, if the measurement device moved as a result of momentum despite the direction of leg movement, there would be data error.

Furthermore, natural sensor drift refers to the change of output over time and, by association, zero drift is the change over time with no input. As data is collected, the sensors will gradually move further from the zero-line due to the minor errors confounding on one another. Resultantly, a large bias is placed on the maximal / minimal data points; altering the averages and overall calculations. Thus, without compensation, drifting can result in drastically modified conclusions.

1.2 Identification of Stair Landings

There are several signals that could assist in determining the stair landings to varying degrees, including acceleration in the z-axis, angular velocity in the x-axis, and angular velocity in the y-axis. In E5, there are six flights of stairs, meaning that there are 9 intermediate landings between the first floor and sixth. These landings produce a distinctive pattern in the signal, that differs from the signal produced by a person simply climbing stairs.

This distinctive pattern is particularly evident when considering the signal produced by the angular velocity in the x-axis. At each of the landings, there is a local minima produced and thus, it is possible to identify a landing by searching for troughs in the signal.

2.1 Linear Acceleration

FIgure 1 demonstrates several distinctive characteristics in the signal recorded by an accelerometer when a person runs up the stairs. For example, the signal oscillates as a person climbs the stairs, but there are distinctive troughs at all landings for each of the accelerations in the varying directions.

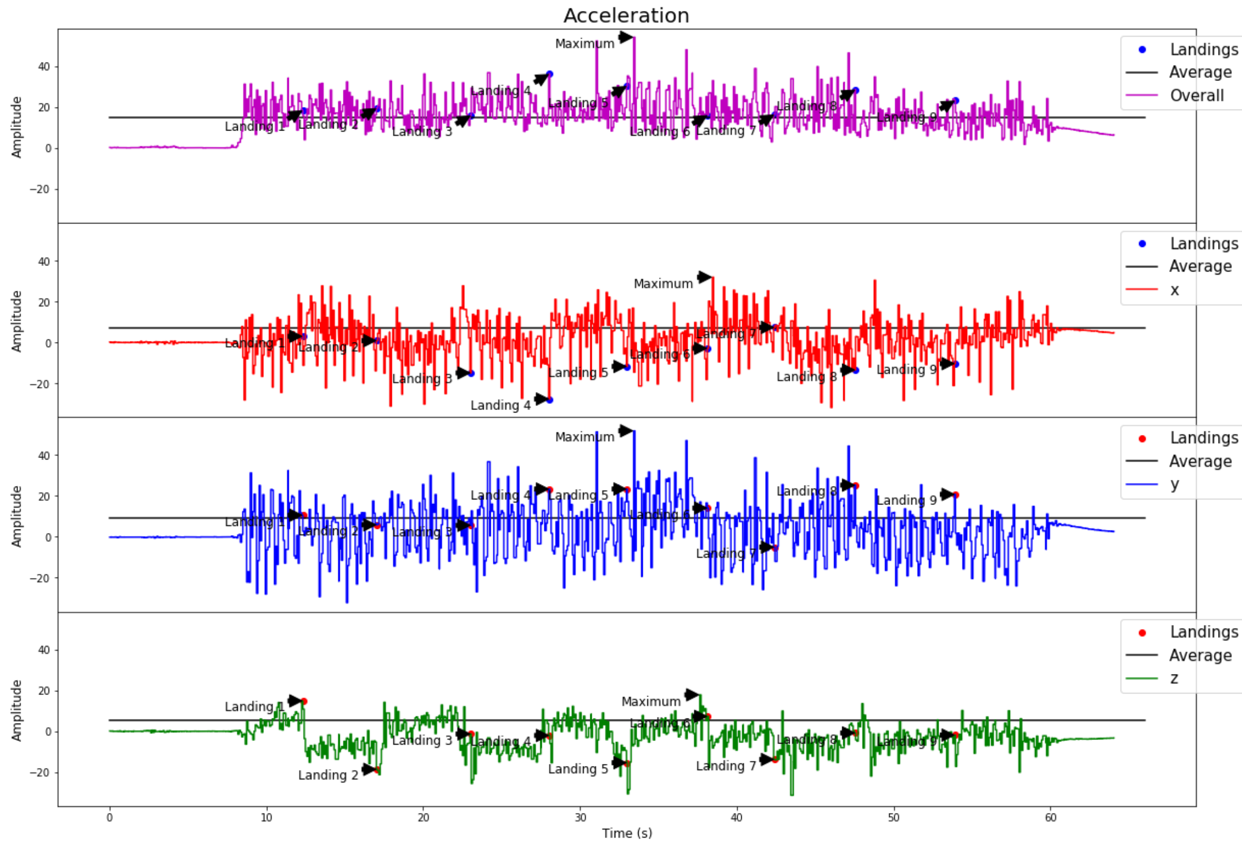

Figure 1: Acceleration plots from data collected by the accelerometer

2.2 Velocity

By analyzing the velocity plots in Figure 2, several conclusions can be drawn. For example, as a person scales the stairs, they have a slight increase their velocity in the the x-axis. The velocity in the y-axis increases to a greater degree, meaning that they progressively climb faster. On the other hand, there is a decrease in velocity in the z-axis as one climbs ups the stairs.

The overall velocity graph has a steady upwards trend due to the fact that all three signals corresponding to the velocities in each direction are diverging from the x-axis. As the overall velocity signal is examining the magnitude of the velocity, it looks at the absolute values of each and as such, the graph has a consistent increase.

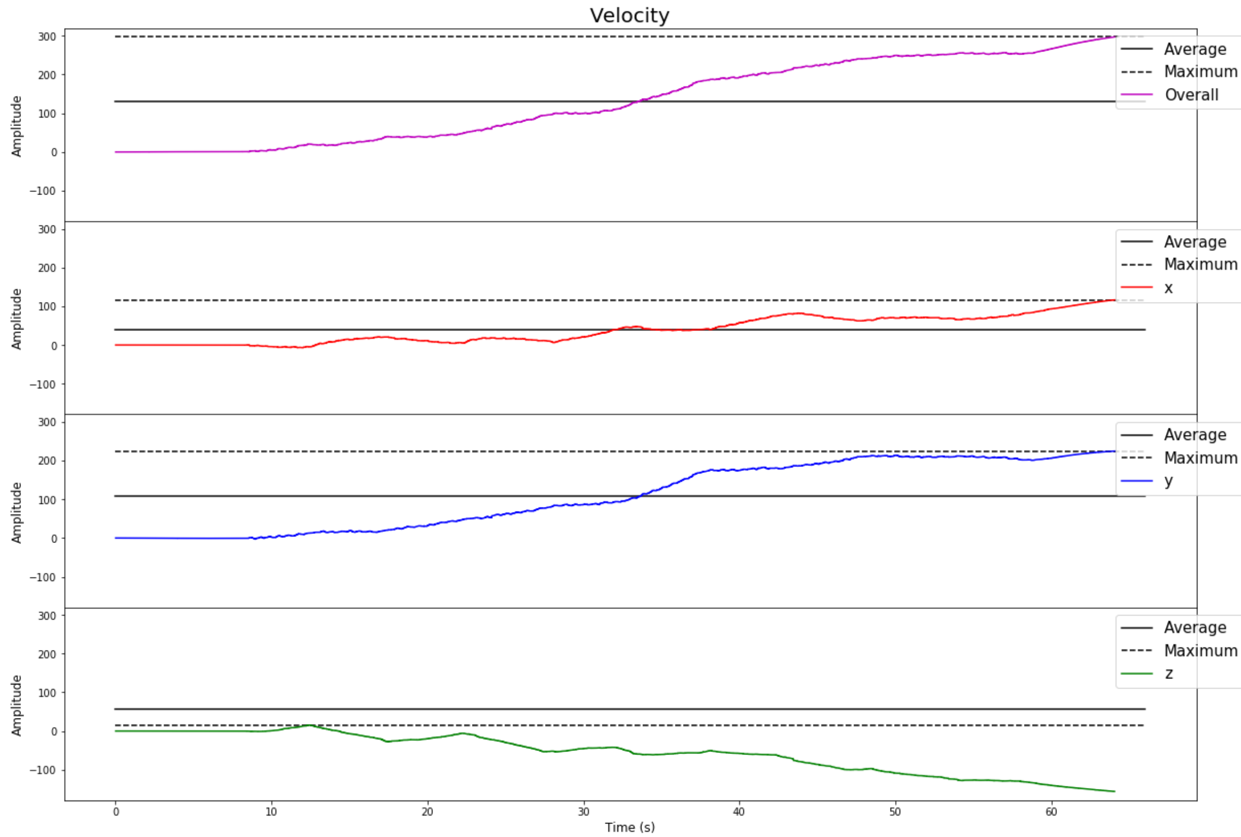

Figure 2: Velocity plots generated from integrating data collected by the accelerometer

2.3 Distance

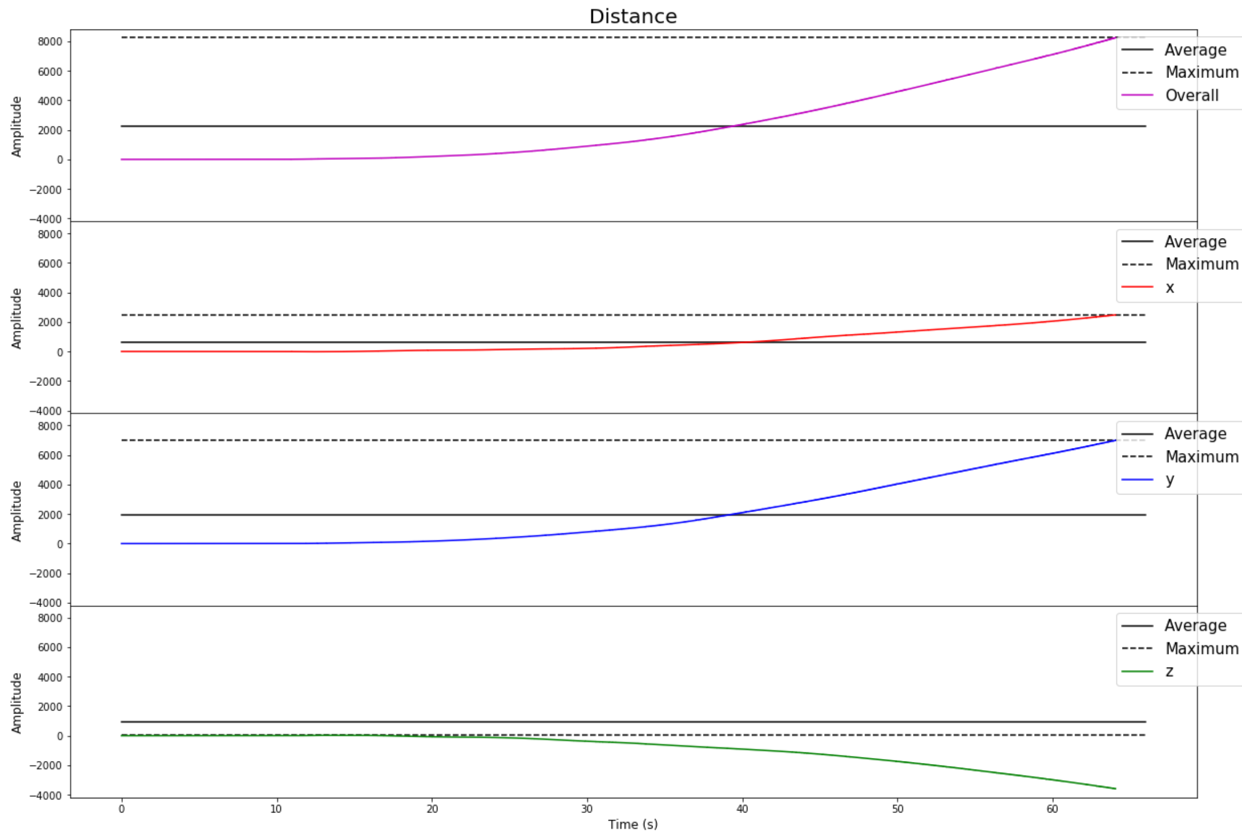

Figure 3: Distance plots generated from integrating data collected by the accelerometer twice

3.1 Angular Velocity

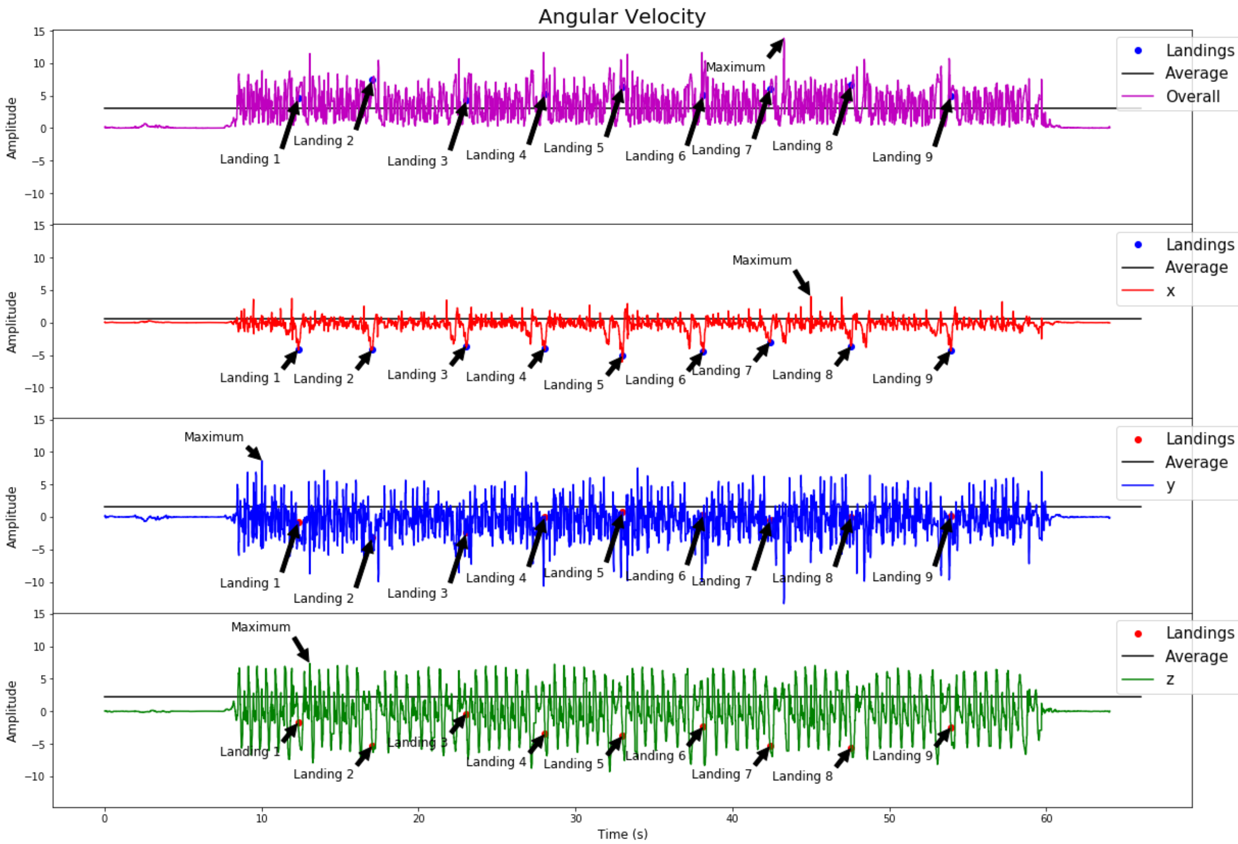

Figure 4: Angular velocity plots generated from raw data collected by the gyroscope

3.2 Angle

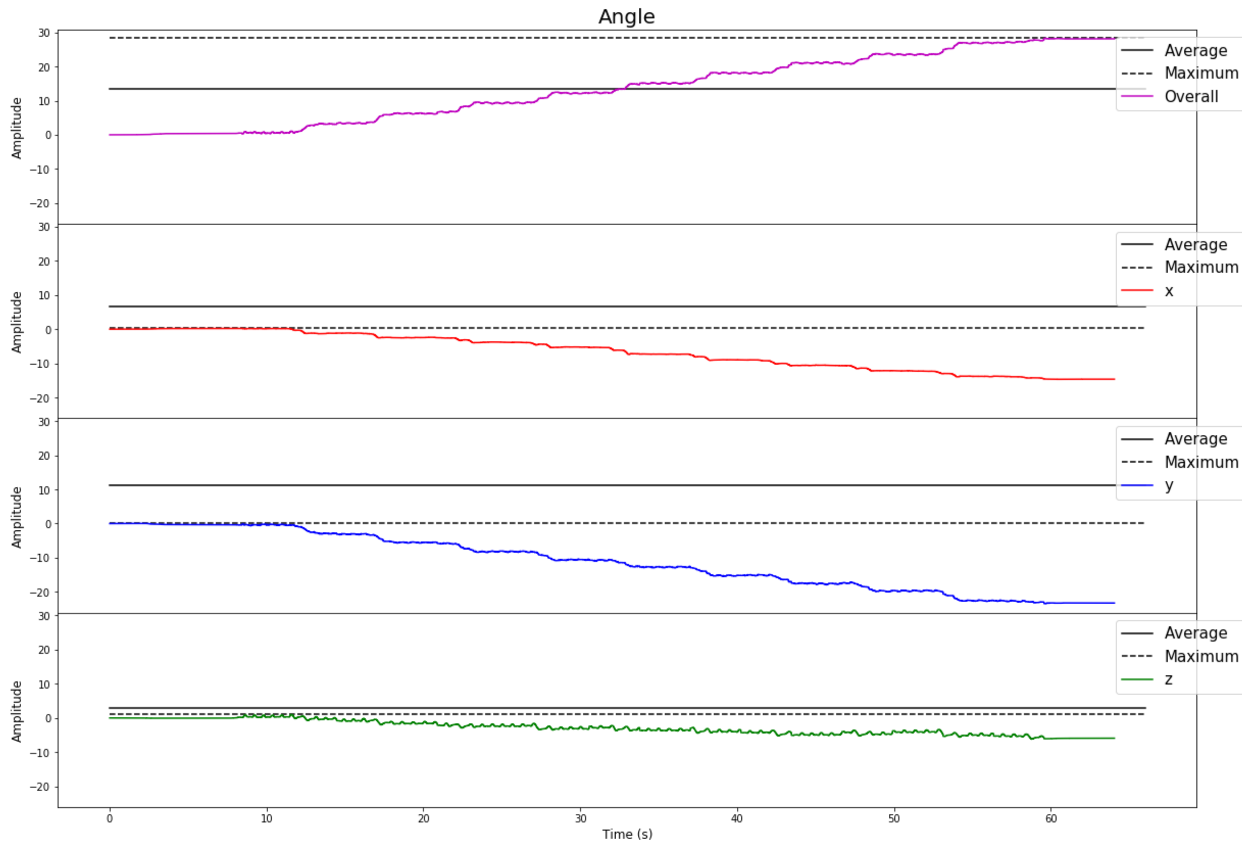

Figure 5: Angle plots generated from integrating raw data collected by the gyroscope