The following data was collected on top of a parking garage next to ISEC.

Stationary Analysis

The GPS data recorded at a stationary location is shown in Figure 1 below. The measurements were expected to follow a normal distribution centered on an appropriate expectation of global position, but it was found that each point appears closely correlated to the previous point. The winding and circling trajectories seen in Figure 1 suggest that the GPS position measurements are predictive based on the measured position and velocity of previous datapoints. Therefore, any source of noise that causes a slight variability in position has cascading effects on the following measurements. A similar effect can be seen in the altitude variability, where it follows seemingly arbitrary continuous paths. These sources of noise vary from multipath error from nearby buildings or overhanging trees, tropospheric/ionospheric interference, clock errors, or satellite dilution of precision.

At a stationary location, the position measurements varied by approximately 2.5m in UTM Northing and almost 1m in Easting. Contrary to expectations, the GPS data does not appear to be normally distributed about a central position, making it difficult to put bounds on the error. With more data collection, it would be expected that the GPS data would hover within 3 meters of the actual global position. These expectations vary based on location. For example, multipath effects from nearby buildings and trees will result in increased positional variability.

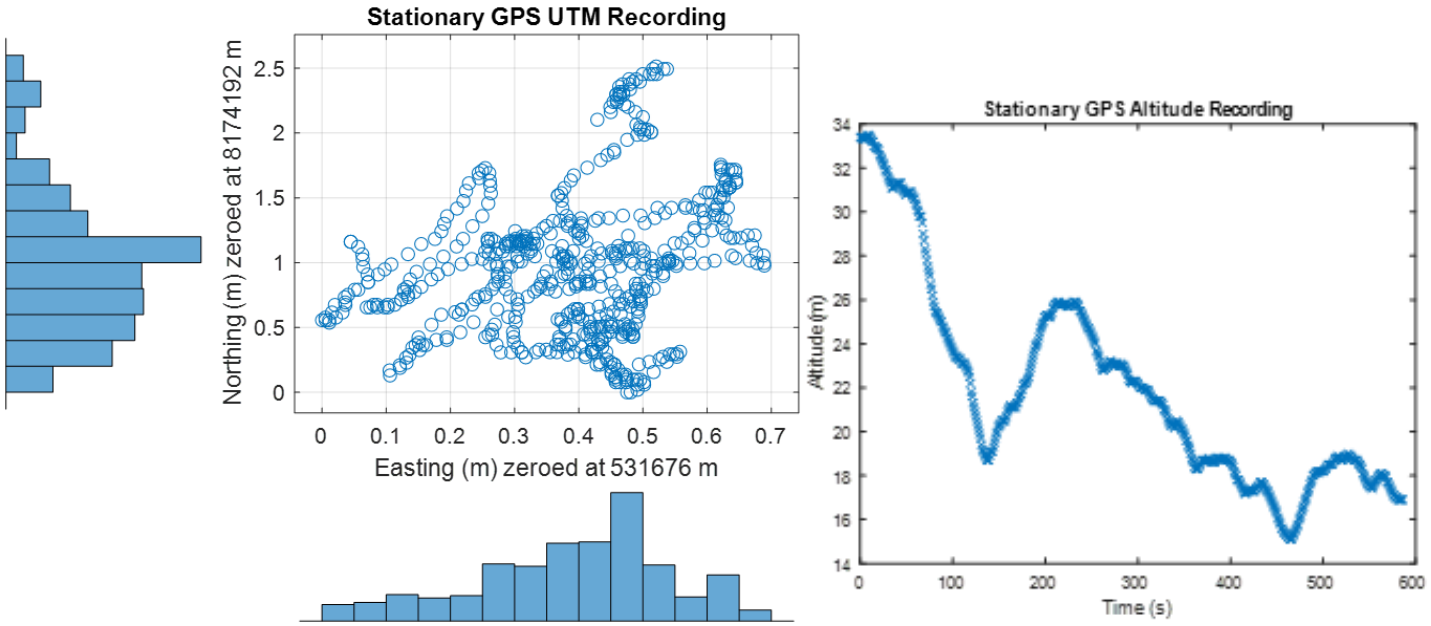

Figure 1: (left) UTM Northing vs. Easting measurements and Histogram from a stationary GPS receiver (right) Altitude measurement s from a stationary GPS receiver

Straight-Line Walking Analysis

With the expectation that the GPS is predictively measuring position, it follows that walking in a straight line would result in more accurate positional measurements. This is verified in Figure 2 below, consisting of data recorded while walking in a straight line. The plot of residual error relative to UTM Northing and the linear best-fit line is plotted beneath the data, showing a variability of plus/minus one meter. Additionally, the smooth trend on the residual plot suggests that these errors are more closely related to the nonlinearity of the walking path rather than to noisy GPS data.
Despite walking up an incline, the total elevation change measured while walking was approximately 4 meters compared to almost 20 meters in the stationary recording.

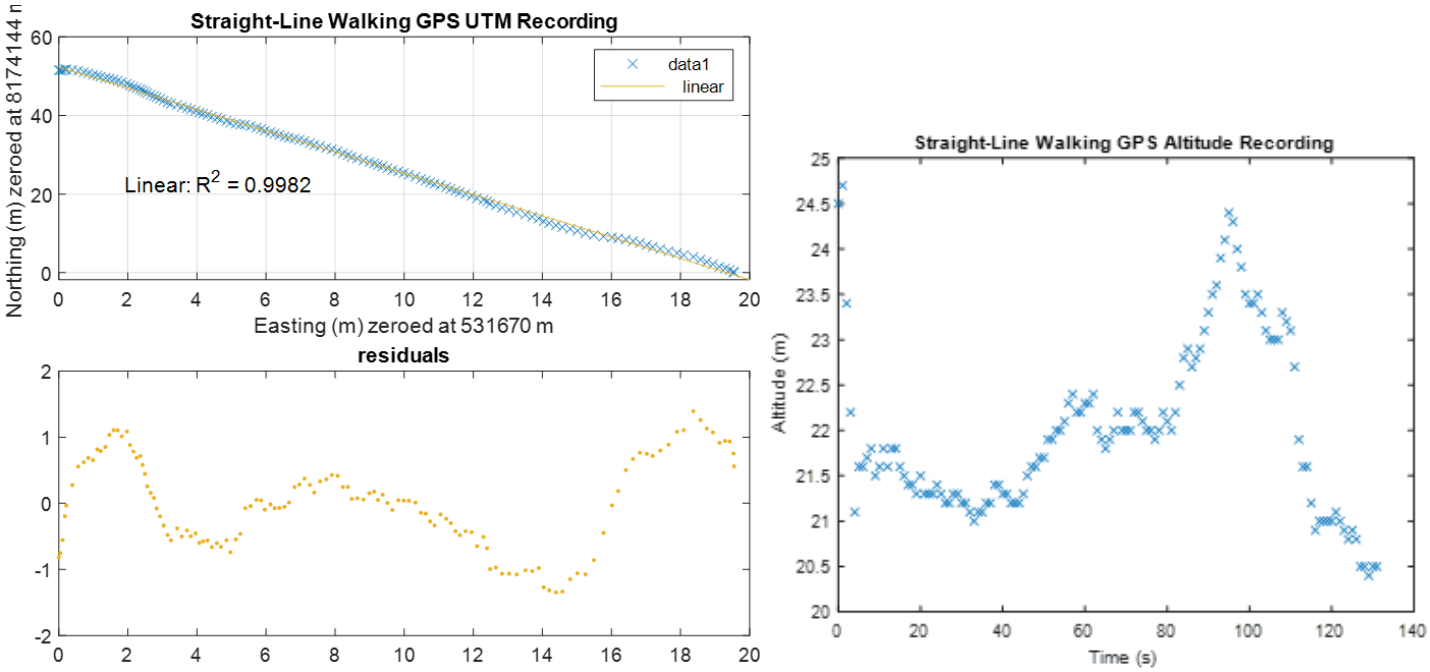

Figure 2: (left) UTM Northing vs. Easting measurements including a linear best-fit line and residuals from a moving GPS receiver in a straight line.
(right) Altitude measurements from a moving GPS receiver in a straight line

Conclusion

In conclusion, the impacts of small noises and disturbances are more pronounced in stationary GPS data recordings when compared to moving GPS recordings. This is expected to be the result of the receiver's predictive localization in which previous points and velocities are combined with incoming data.