Mohammad Abdul Razaq Khan (NUID: 002851185)   EECE5554   Lab 2 Report

RTK (Real-Time Kinematic) is an advanced satellite navigation method that significantly refines the accuracy of position data from standard GPS systems. By utilising a stationary base station with a known position and a mobile receiver, RTK corrects positional errors in real-time, elevating accuracy from metres to centimetres. This precision is especially beneficial in industries like agriculture (for precision farming), surveying, and construction.
The error or deviation provides an indication of the accuracy of the RTK GNSS navigation system. In this case, the error or deviation decreased a lot as compared to the normal GPS puck. The smaller the error or deviation, the more accurate the RTK GNSS navigation system.

Analysis of stationary and moving data in open field:

The data was collected next to Orton field in West Broadway for OPEN FIELD by moving in a rectangular ‘L’ path in an open area. The Root Mean Square Error (RMSE) was calculated by subtracting the actual values from the best-fit line values, squaring the result to avoid nullification due to positive and negative values, and finding the mean for each division and average was taken.

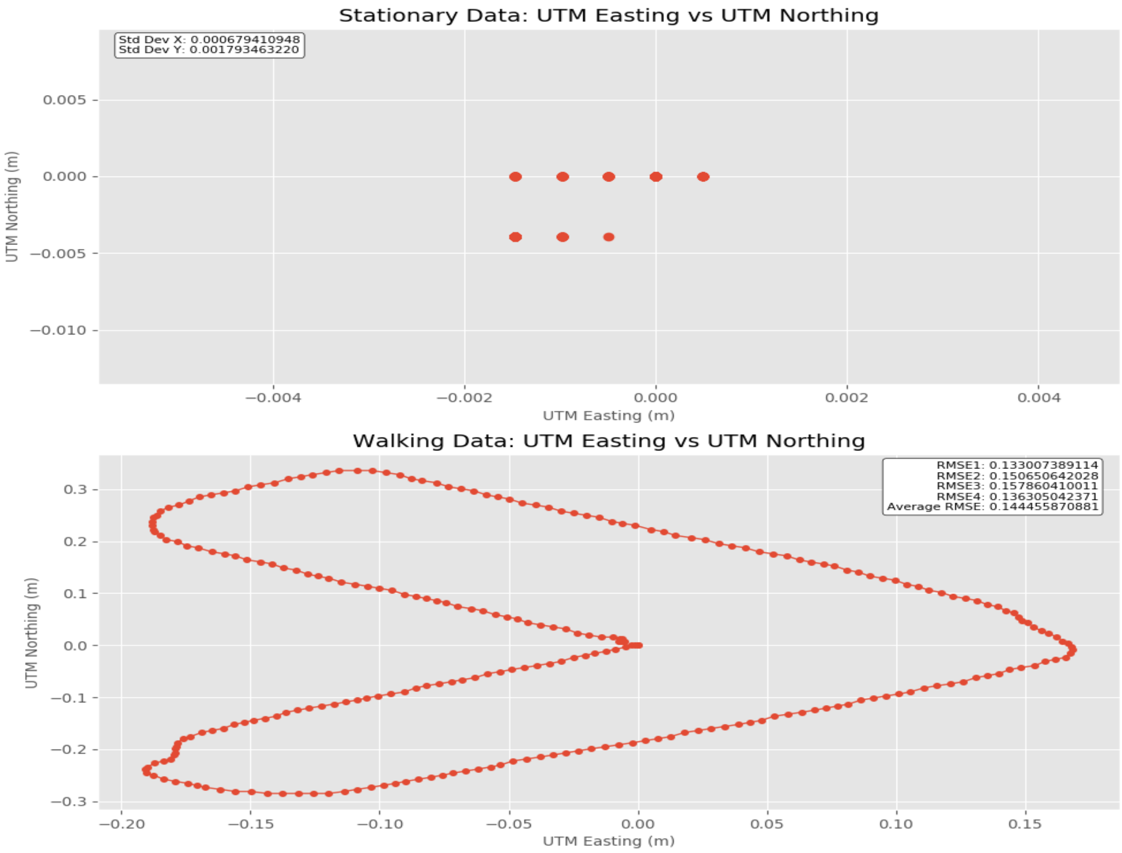

Figure_1.1 : UTM Easting vs UTM Northing (open_field)

The graphs clearly indicate that the open field data is highly accurate, with minimal deviations (std. dev on x = 0.000679, y = 0.00179) observed during both stationary and walking phases. Notably, while walking, the average RMSE was only 0.144m. Despite some inconsistencies during motion, this data still surpasses the accuracy of the GPS puck used in Lab 1.

From Figure_1.2, it's evident that the mean deviation is smaller during stationary periods (with mean deviations in easting and northing being 0.0006 and 0.0016, respectively) compared to when walking (mean deviations in easting and northing are 0.0883 and 0.1561, respectively). This observation aligns with expectations, as satellite positioning is more likely to fluctuate during movement than when stationary.

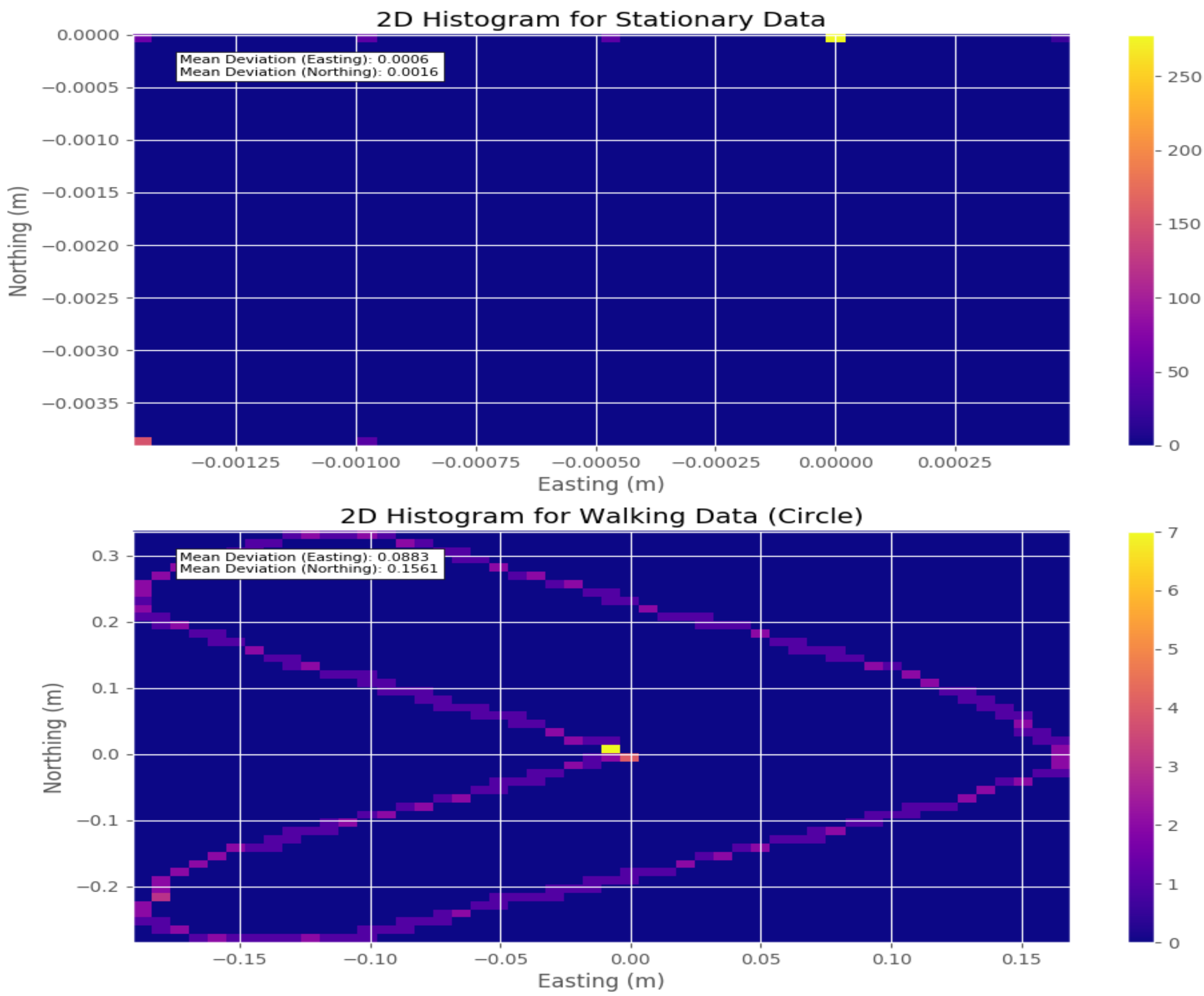

Figure_1.2 : 2D histogram of UTM Easting vs UTM Northing (open_field)

Contrary to our initial expectations, Figure_1.3 reveals a different perspective. It indicates that the quality factor remained consistently at 5 (GNSS fix) during data collection while walking, while occasionally dropping to 4 (GNSS float) during stationary periods. This suggests that there might have been more satellite signal variations during stationary moments compared to when walking.

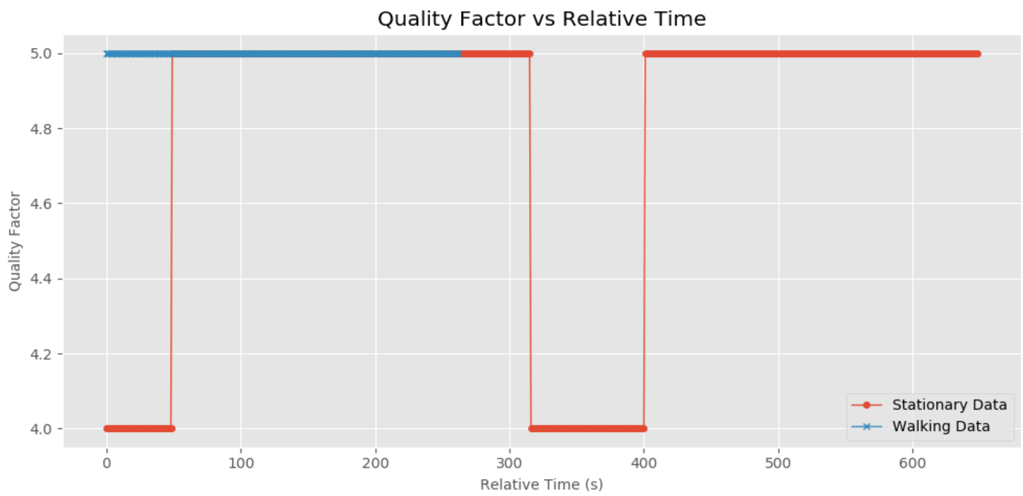

Figure_1.3 : Quality factor vs time (open_field)

In summary, the results obtained from the data collection appear highly promising, as demonstrated by the impressive visual representation on Google Maps in Figures_1.4a and 1.4b.

Figure_1.4a : Data collected while walking and plotted on Google maps (open_field).

The red line traced on the map indicates the path taken around the open field, which discloses the remarkable accuracy of the collected data. This success owes much to the RTK GNSS system, where the base station continuously made corrections and transmitted them to the rover. The resulting shapes on the map are distinct from those obtained in LAB1.

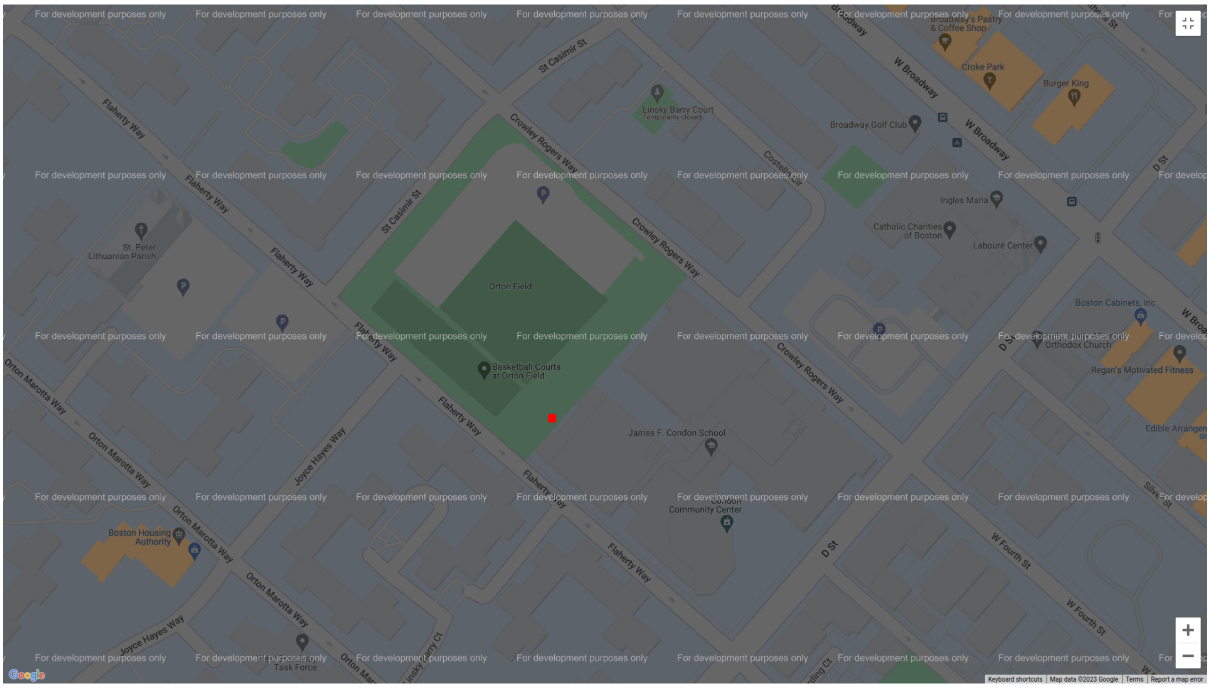

Figure_1.4a : Data collected while being stationary and plotted on Google maps.

Analysis of stationary and moving data in occluded field:

This data was also collected next to Orton field by moving in a rectangular path around the buildings and the similar RMSE was calculated.

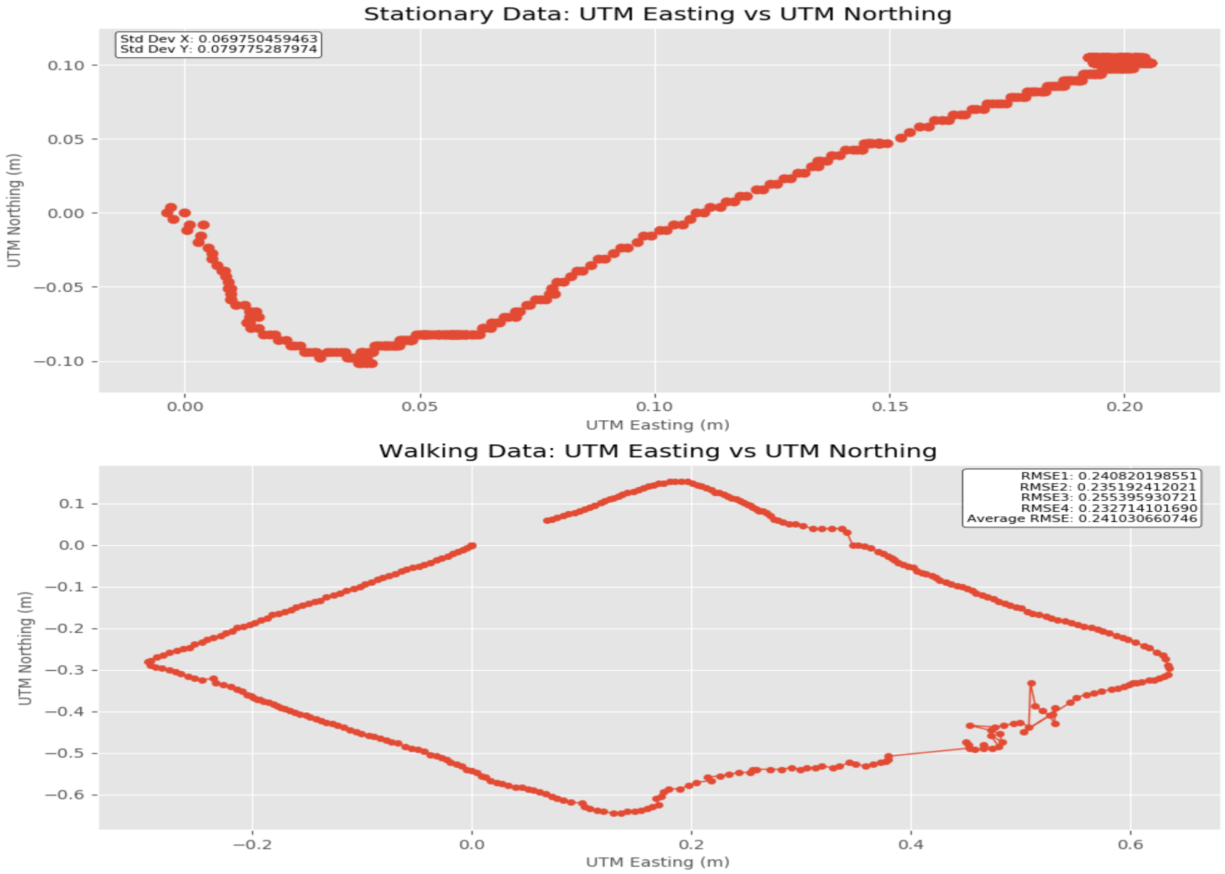

Figure_2.1 : UTM Easting vs UTM Northing (occluded)

The graphs indicate that the occluded data is not so accurate as that of the open field but is still more accurate than that of the GPS puck (std. dev on x = 0.069, y = 0.079) which was observed during both stationary and walking phases. While walking, the average RMSE was 0.244m. Despite some inconsistencies during motion, this data still surpasses the accuracy of the GPS puck used in Lab 1.

From Figure_2.2, it's evident that the mean deviation is smaller during stationary periods (with mean deviations in easting and northing being 0.062 and 0.072, respectively) compared to when walking (where the mean deviations in easting and northing are 0.23 and 0.209, respectively). This observation aligns with expectations, as satellite positioning is more likely to fluctuate during movement than when stationary.

Figure_2.3 provides valuable insights, particularly when navigating between buildings. It shows significant fluctuations in the quality factor, transitioning from 5 (GNSS fix) to 1 (No Fix) while walking and from 5 (GNSS fix) to 4 (GNSS float) while stationary (as expected). This variation suggests that the satellite signal experiences disruptions when passing through buildings, likely due to multipath interference and various errors. However, upon closer examination, it becomes evident that the system makes concerted efforts to maintain continuity by tracking previous points and incorporating corrections from the base station.

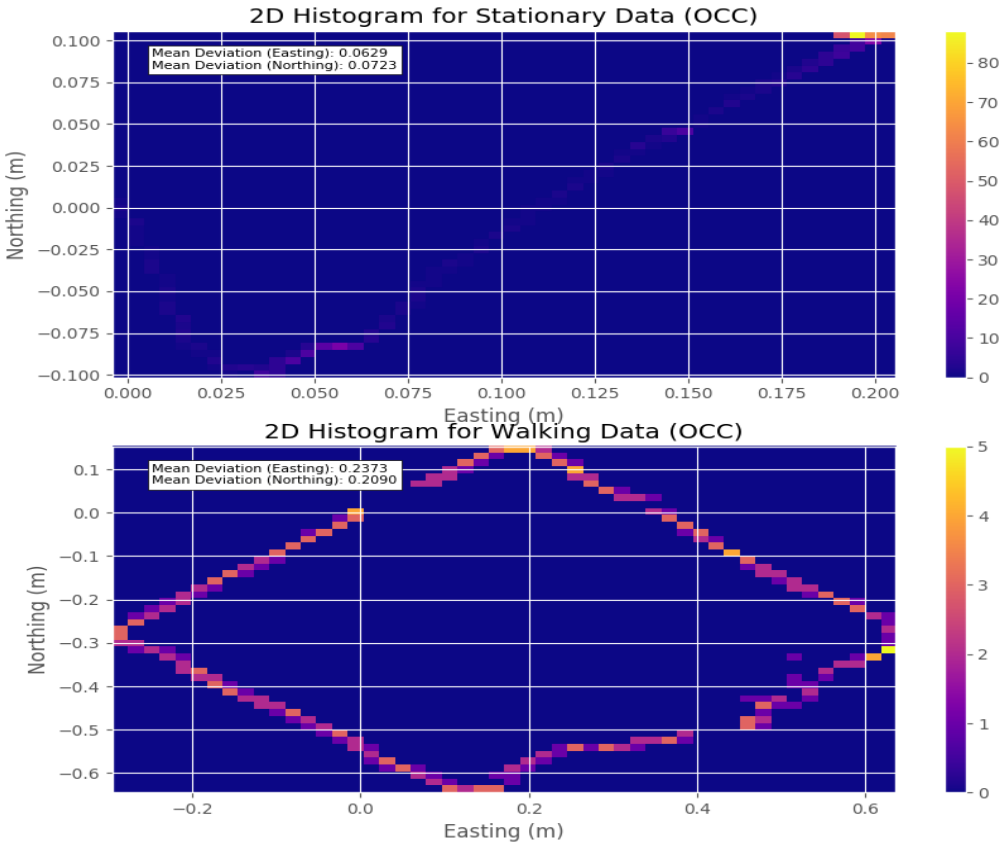

Figure_2.2 : 2D histogram of UTM Easting vs UTM Northing (occluded)

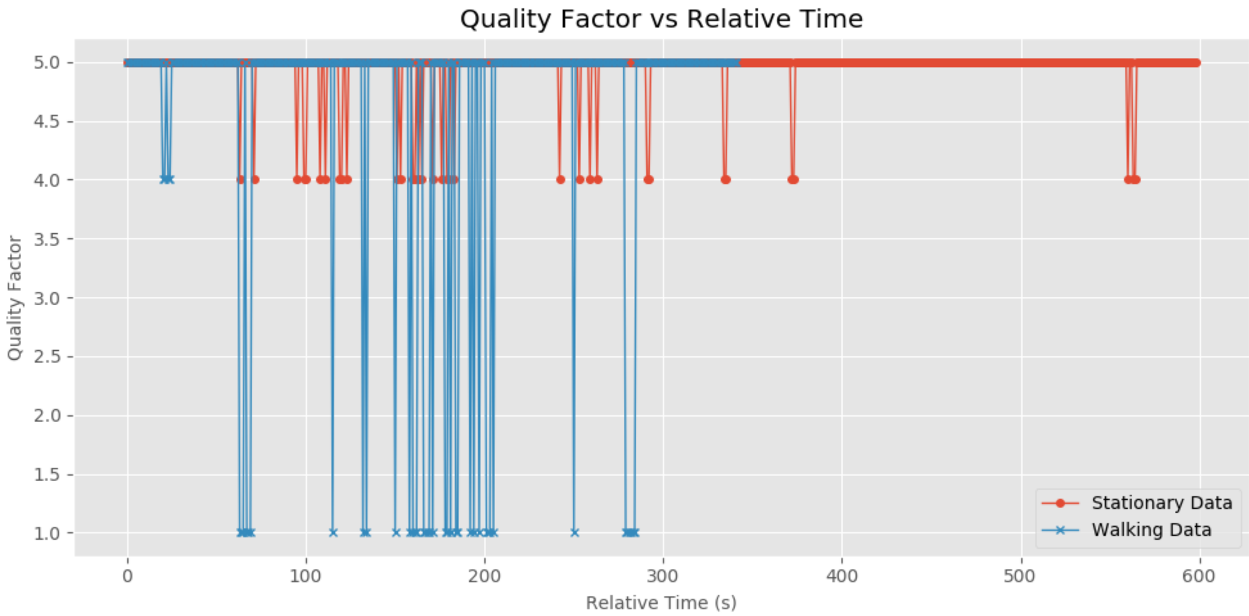

Figure_1.3 : Quality factor vs time (occluded)

The following images (Figure_2.4a and 2.4b) are plotted on Google maps.

Figure_2.4a : Data collected while being stationary and plotted on Google maps (occluded).

In this scenario, the shapes generated are not as precise as those obtained in the open field data. Nevertheless, it's important to note that the RTK data remains considerably more accurate than the data collected in LAB1. This underscores the reliability and effectiveness of the RTK technology, even when faced with challenging environments like urban settings.

Figure_2.4a : Data collected while walking and plotted on Google maps (occluded).

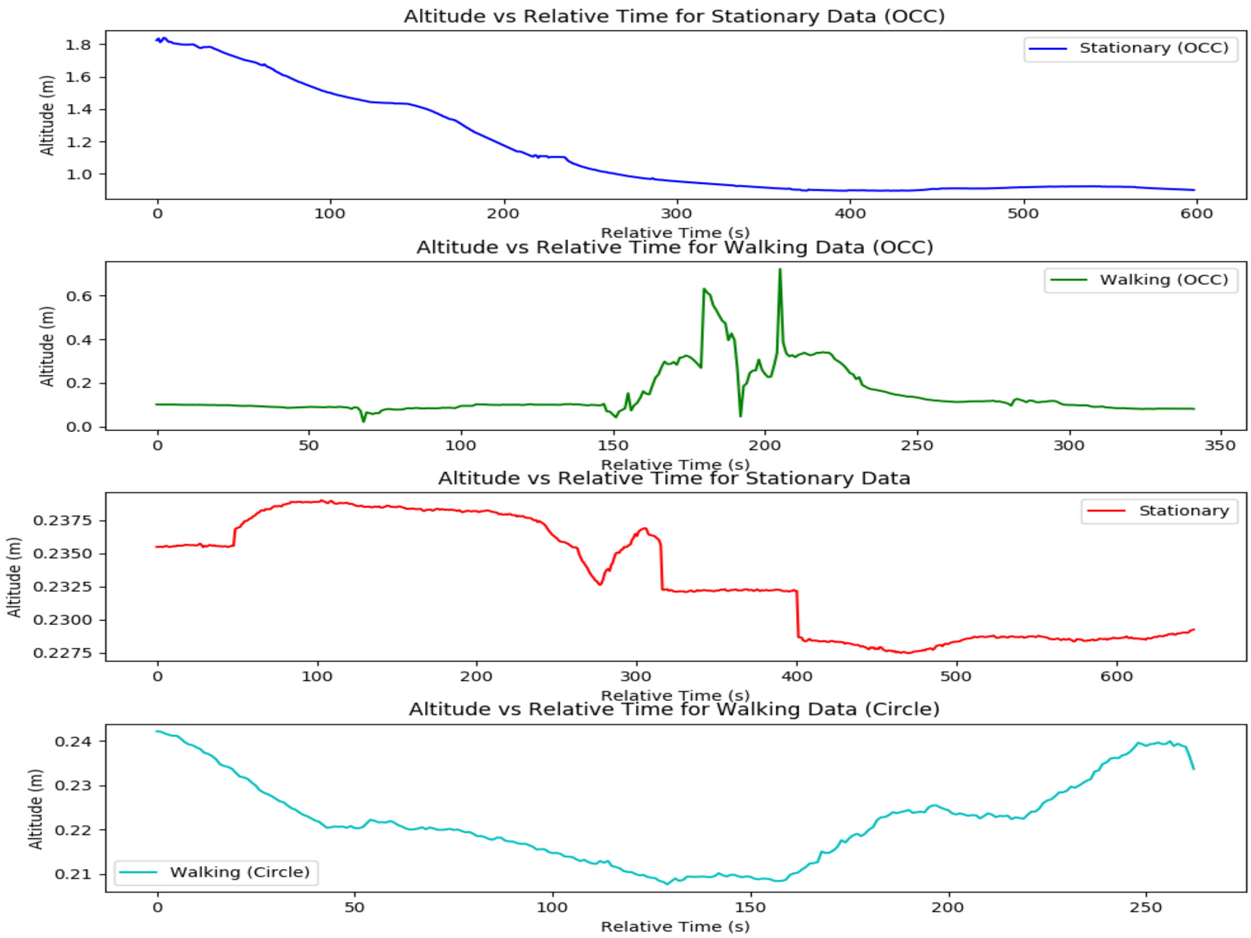

Figure_3: Altitude vs Time in each case.

Lastly, from the above graphs the conclusions drawn are clear.