Lab 1: Recording, Publishing, and Analyzing GPS Data

Shyam Sreenivasan

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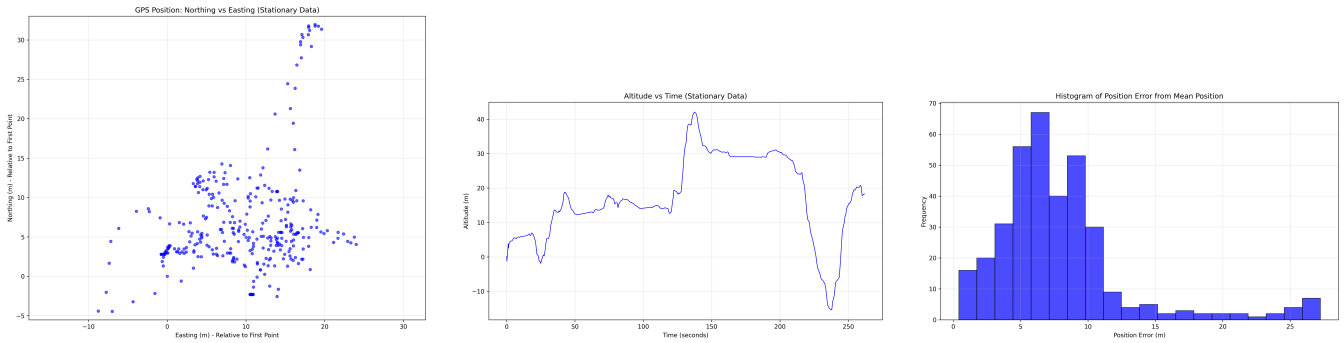
1 Purpose

The goal of the lab is to collect GPS data using a USB-based GNSS (GPS) puck and analyze the GPS data quality in different settings like stationary GPS position, motion in a straight line, indoors and open spaces, and observe correctness, errors, etc., and visualize the same. The process involves reading GPGGA strings from the serial port and parsing into nine fields: Header, Latitude, Longitude, Altitude, HDOP, UTM_easting, UTM_northing, UTC, Zone, Letter, and publish the data using a ROS2 publisher and then store the data using ROS2 Bag. Then, the data is analyzed through visualizations like scatter-plots, histograms, etc.

2 Plots

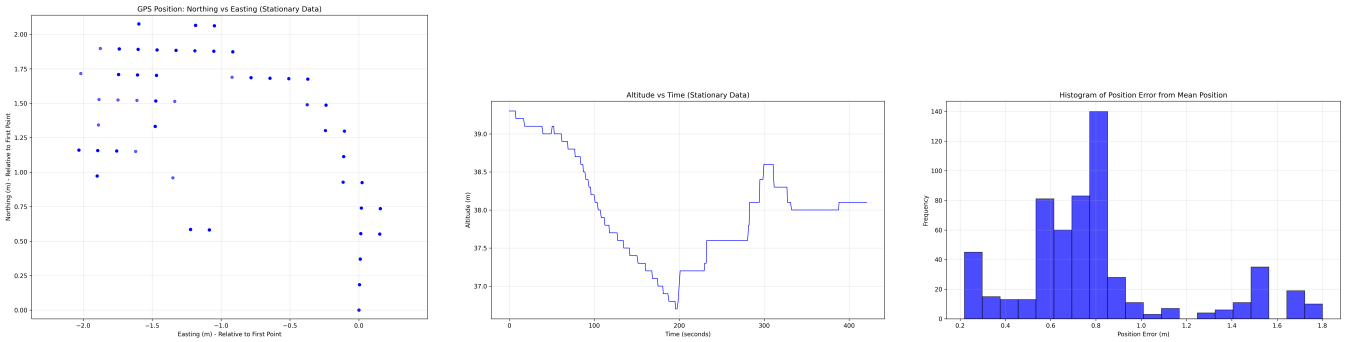
2.1 Stationary Open Space



(a) Northing vs Easting (b) Altitude vs Time (c) Error Histogram

Figure 1: Stationary Open Space GPS Data Analysis

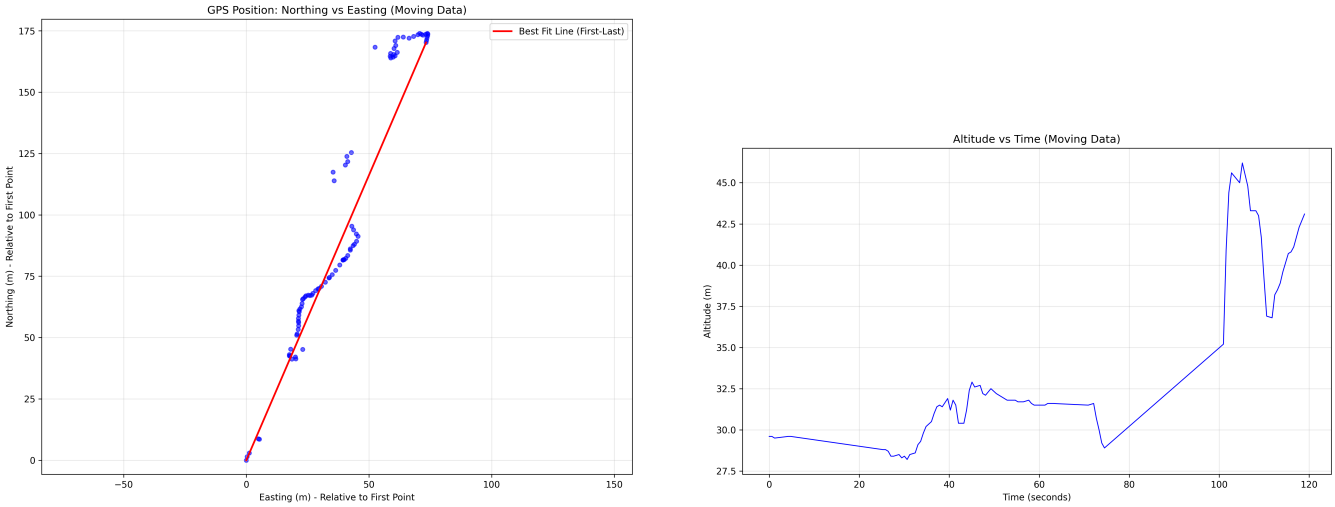
2.2 Stationary Occluded Space



(a) Northing vs Easting (b) Altitude vs Time (c) Error Histogram

Figure 2: Stationary Occluded Space GPS Data Analysis

2.3 Straight Line Motion



(a) Northing vs Easting (b) Altitude vs Time

Figure 3: Straight Line Motion GPS Data Analysis

3 Analysis and Results

3a) Known position: Latitude 42° 20’ 32” N, Longitude 71° 05’ 48” W
Error estimate: 0.79 m

3b) HDOP being greater than 1-2, the quality is actually pretty good.

5a) Mean error is 4.5295 m

6a)
For Straight line:

- Mean perpendicular error: 4.5295 m
- Std perpendicular error: 3.9244 m

For Stationary occluded:

- Mean error: 0.7979 m
- Std error: 0.3629 m

Estimated error increases with motion from the above stats.

6b) For stationary data, there are more sampled points around the true position which when averaged would lead to a value closer to the true position whereas when the GPS is in motion, the values are more scattered for a single instance of a position leading to a high error for a set of points connected by a straight line.

6c) Moreover, weather conditions, buildings, trees, environment could also produce inconsistent errors in the GPS measurement.

4 Additional Comments

The data collection was conducted under challenging weather conditions, including heavy snowfall and overcast skies. Despite these adverse conditions, the GPS measurements yielded reliable and consistent results, demonstrating the robustness of the GNSS system even in sub-optimal atmospheric conditions.