Lab 1 Report

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1 Introduction

Hardware Used for this Lab: USB Based GNSS puck, issued one per team.

The purpose of this lab is to perform an analysis of GPS readings in order to gain a deeper understanding of how typical GPS devices can determine the user's location, along with the typical sources and magnitudes of the errors produced by a typical device. In addition, this lab serves as practice utilizing the ROS2 library to write drivers for external sensors.

2 Stationary GPS

The GPS Readings below were taken at approximately: 42.3342032, -71.1017851

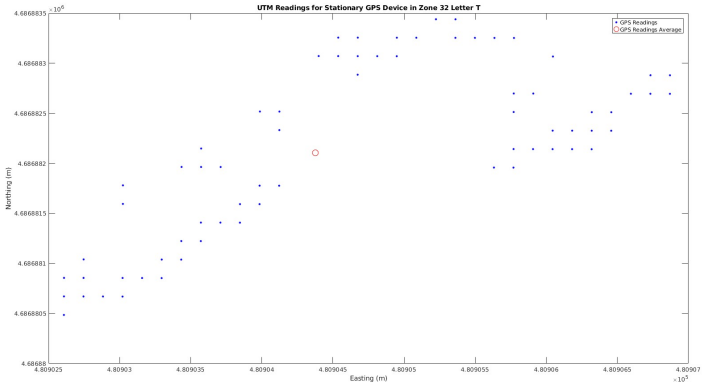

Figure 1: Stationary GPS Data in UTM

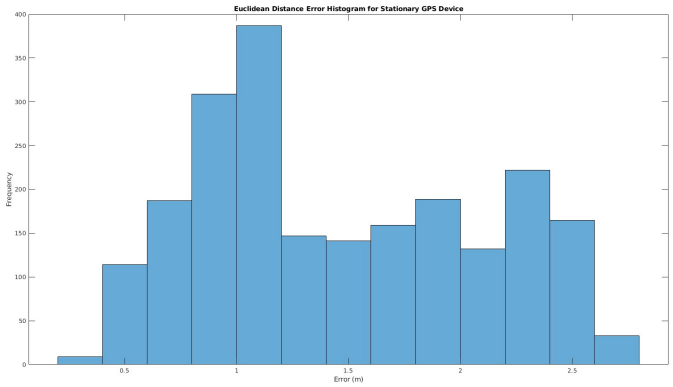

Figure 2: Stationary GPS Data Euclidean Error

2.1 What does this say about GPS Navigation?

The data shows that GPS Navigation provides a reading that can be used to approximate a person's location on Earth. It also shows that while GPS is fairly consistent, it does vary an amount that cannot be considered insignificant.

It is also worth noting that the longitude reading of the GPS device is incorrect by a consistent amount, indicating the device may not be calibrated correctly. For the sake of analysis in this lab, I am assuming the longitude readings are pointing to the correct location, however I cannot conclude that the readings have any accuracy.

2.2 What can you say about the distribution of the error in GPS?

The distribution of error in GPS is skewed right, with a high proportion of the errors being less than 1.2m.

The data collected from a stationary GPS device indicates that GPS Navigation is fairly precise. It can be expected that a GPS device that varies from the expected reading an average distance of 1.46m is sufficiently precise for commercial use.

2.3 What is a good error estimate?

For this distribution, a good estimate of error would be the mean absolute error of the euclidean distance from the average reading to each point.

2.4 Can we put bounds on these errors?

Yes, bounds can be placed on the errors. The lower bound must be 0, as the absolute error will never be negative. Since after 10 minutes of continuous data collection, the largest error seen was less than 3.5m, it is feasible to say that an upper error bound exists to determine the worst-case precision of a reading.

2.5 What is the source of these errors?

The errors the GPS Device displays can be attributed to a few sources, including: atmospheric effects, dilution of precision, and general interference from surrounding objects. The error in the longitude, however, is likely due to some fundamental difference between the assumed location of the satellites with respect to the earth's orientation, and the actual location.

3 Walking GPS

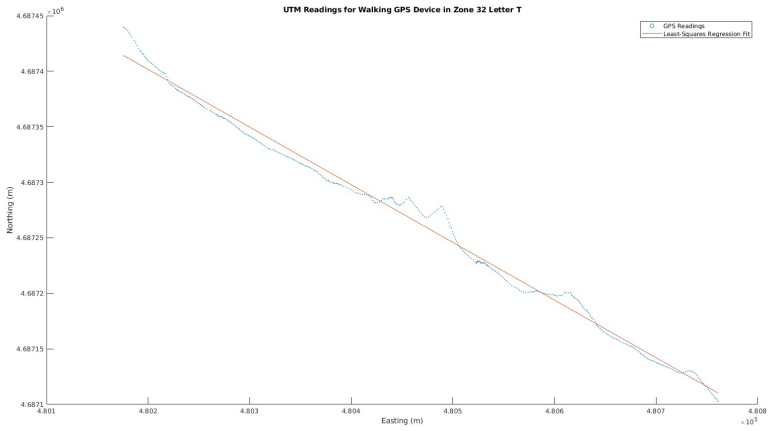

Figure 3: Walking GPS Data in UTM

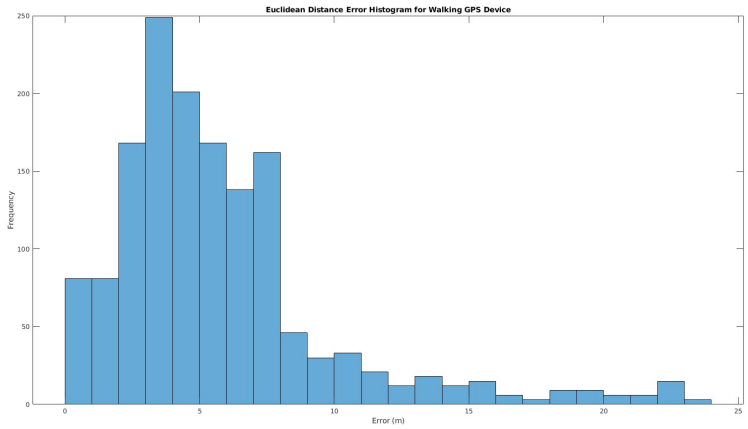

Figure 4: Walking GPS Data Error Orthogonal to LOBF

3.1 What does this say about GPS navigation when moving?

This data shows that GPS navigation is markedly less precise and less accurate when the device is in motion.

3.2 How does the error estimate change as you move as opposed to stay in a spot?

The error estimate increases significantly when moving, as the mean absolute error reaches 5.77m. The distribution of error is also more skewed right than the stationary distribution, with a much high upper bound.

3.3 What can you say about the distribution of noise in this case?

The distribution of noise in the walking case is similar to the distribution of noise in the stationary case, but exists on a larger scale. If the two cases were compared on the same scale, the walking noise would be much more spread out than the stationary noise.