Northeastern University

360 Huntington Ave, Boston, MA 02115

Report on
Data Acquisition of USB based GNSS puck and Data Analysis

LAB_1 - EECE 5554 Robotics Sensing and Navigation

Submitted by:
Pavan Rathnakar Shetty

Submitted to:
Hanumant Singh
Professor, Electrical and Computer Engineering

Procedure:

A package named gps_driver was created which has the device driver for data acquisition. It is a python file which is used to read the GPS raw data and parse it which is in $GPGGA format. Node talker is used to subscribe to rostopic gps_message. The recorded GPS data has longitude, latitude and altitude which needs to be converted to utm using the python package "utm". A custom ros message is defined with header, latitude, Longitude, Altitude, utm_easting, utm_northing, Zone, letter as fields.

The Data was collected at Clement Field, soccer field. It is an open field with no buildings anywhere near to its vicinity.

Run the following terminal commands:

Terminal 1: **$roscore**

Terminal 2: **$rosrun gps_driver gps_main.py** in your workspace

Terminal 2: **$rosbag record -a** in your workspace

Rosbag file is created once done.

https://github.com/AtsushiSakai/rosbag_to_csv

The above link has a package which converts rosbag to csv file.

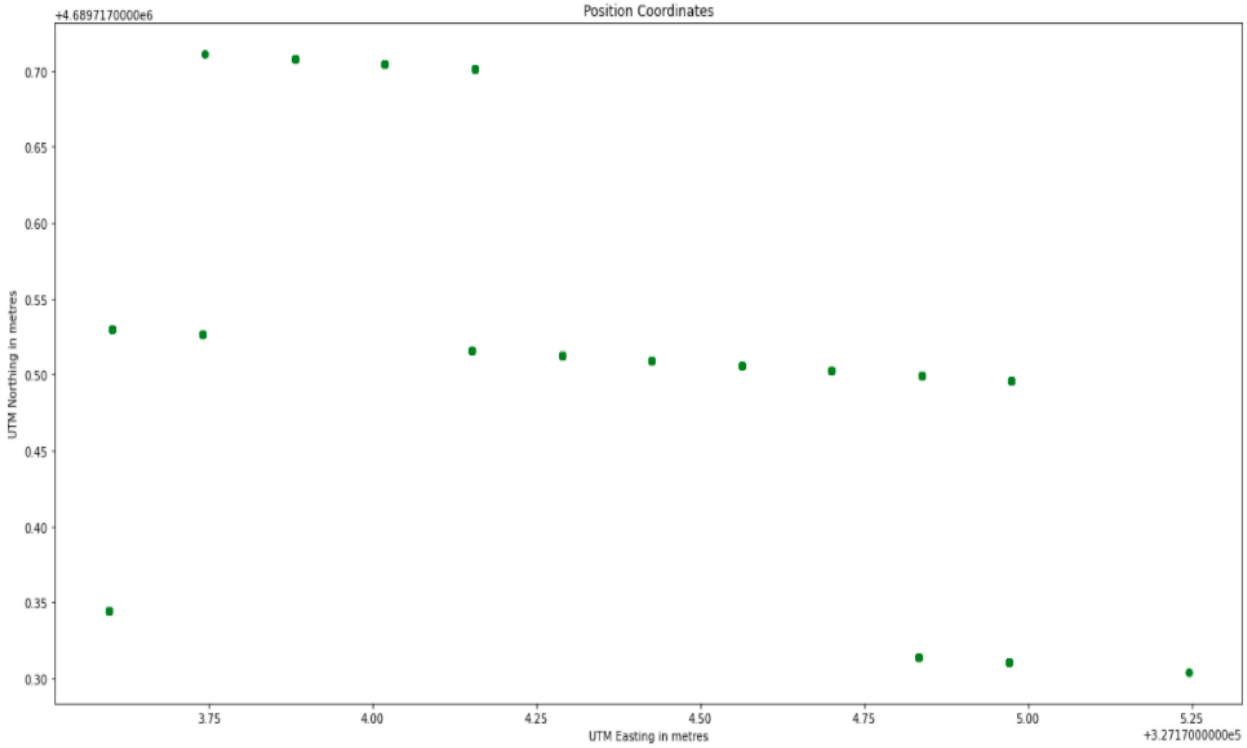
Detailed Analysis: Graphical plotting and Analysis of the csv file was done using Jupyter Notebook by using Python and libraries like Matplotlib, csv,Numpy, Statistics and Pandas as described in Data Visualization.ipynb

Stationary Data:

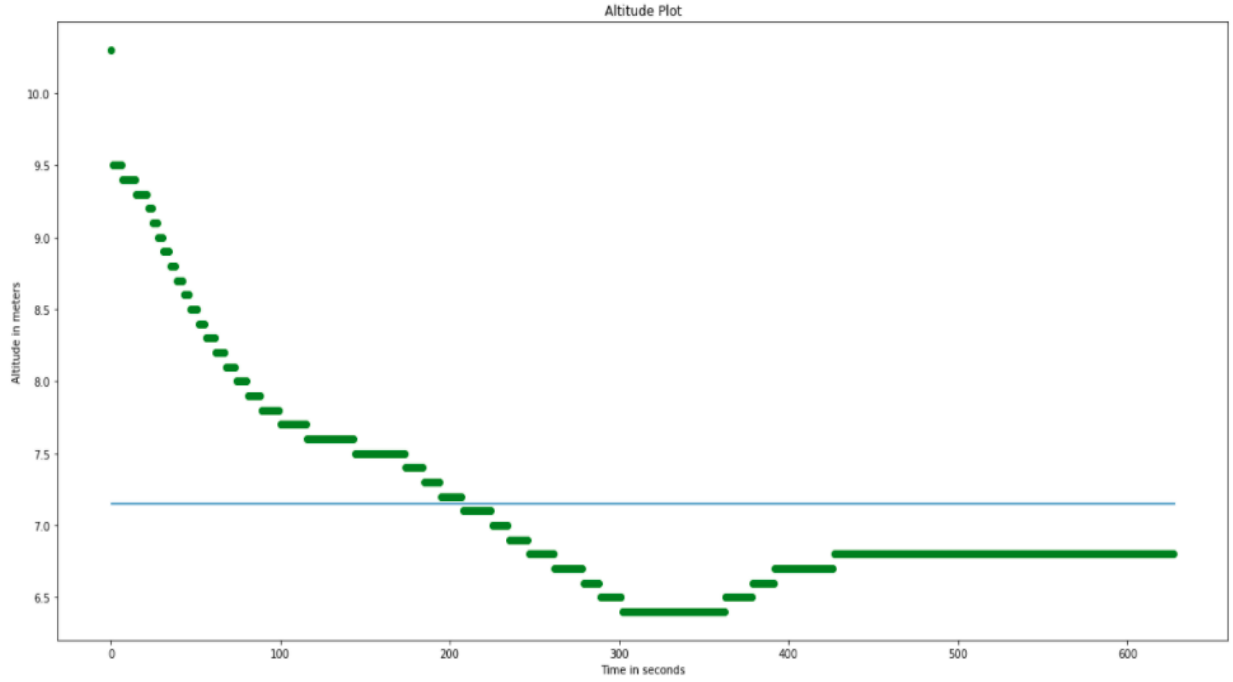
```
In [224]: SDE
Out[224]: 0.5317083379501736

In [225]: SDN
Out[225]: 0.1275429745767697
```

SDE: Standard Deviation of utm_easting
SDN: Standard Deviation of utm_northing

utm_easting vs utm_northing:



Altitude vs Time:

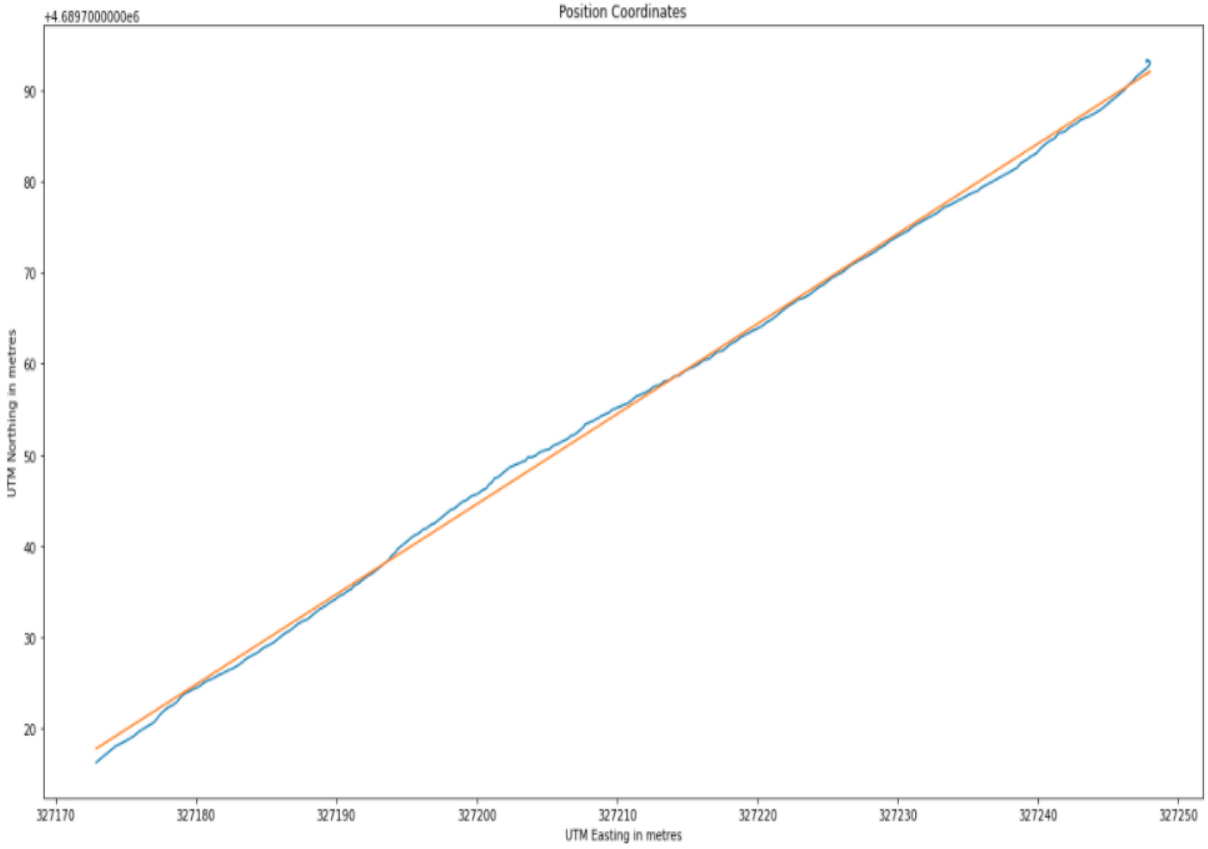


```
In [228]: SDA
Out[228]: 0.7445130748398329
```

SDA: Standard Deviation of Altitude.

Moving Data:

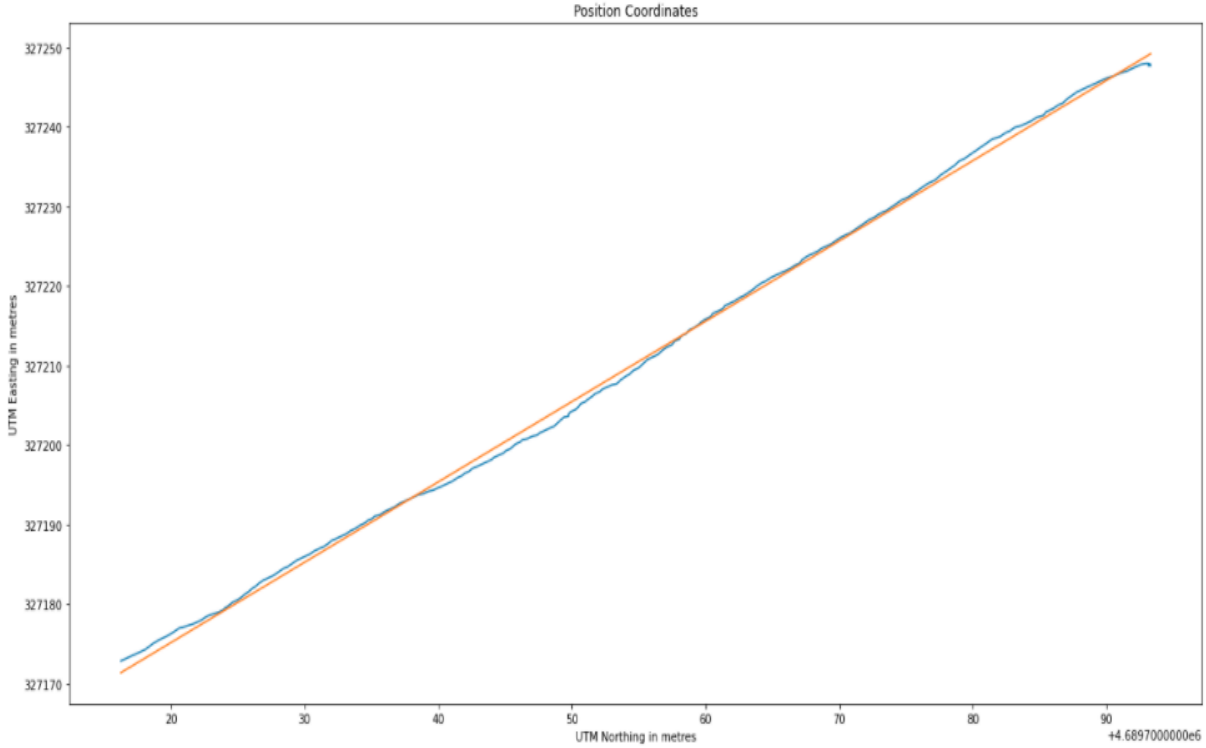
utm_easting vs utm_northing: (along with the best fit line)



```
In [239]: MS=np.square(np.array(new_y)-np.array(n1))

In [240]: sum = 0
          for i in MS:
              sum=sum+i

          MSE=sum/229

In [241]: MSE

Out[241]: 0.6045204815197256
```

MSE: Mean Square Error of utm_northing

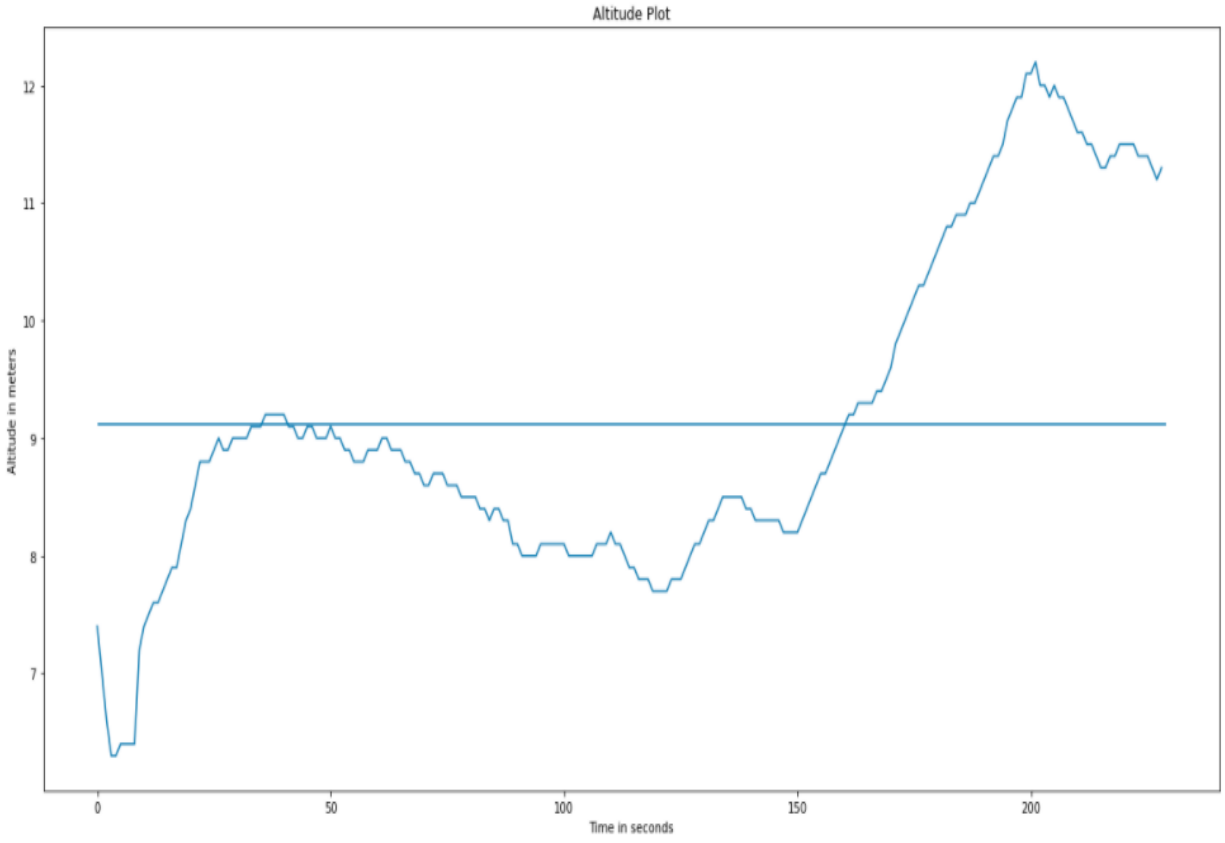
Utm_northing vs utm_easting : (along with the best fit line)



```
In [244]: MS=np.square(np.array(new_y)-np.array(e1))

In [245]: sum = 0
          for i in MS:
              sum=sum+i

          MSE=sum/229

In [246]: MSE
Out[246]: 0.617341103560727
```

MSE: Mean Square Error of utm_easting

Altitude vs Time:



```
In [112]: SDA=moveone_data['.altitude'].std()

In [113]: SDA
Out[113]: 1.4017926380775954
```

SDA: Standard Deviation of Altitude

Observation and Analysis:
From the data obtained Graphs were plotted and corresponding Standard Deviations were calculated. The value of Standard Deviation tells how spread the data is. The error in the measurement is due the following factors:

1) PDOP, HDOP and VDOP: DOP stands for Dilution of Precision. Dilution of Precision is a term used to describe the strength of the current satellite configuration, or geometry, on the accuracy of the data collected by a GPS receiver at the time of use. Thus, PDOP is Position of DOP and can be thought of as 3D positioning or the mean of DOP, and most often referred to in GPS; HDOP is Horizontal of DOP; VDOP is Vertical of DOP. If there are more satellites available spread evenly throughout the sky, the better our positional accuracy will be (*and the lower the PDOP value*).

2) Any kind of signal disturbance from external factors like Buildings or any signal Interference.
3) Gps unable to receive or communicate signals from required number satellites for better accuracy which results in inconsistency in measurement.

Stationary vs Moving Measurements:
1) Standard Deviation of utm_easting is 0.53 for Stationary Data while Mean square error of utm_easting for moving data is 0.617
Standard Deviation of utm_northing is 0.12 for Stationary Data while Mean square error of utm_northing for moving data is 0.604
In context and relevant to the data I collected I have lower noise for my stationary data because it was an open field without any disturbance.

2) Standard Deviation of altitude is 0.744 for Stationary Data while Standard Deviation of altitude for moving data is 1.4
In context and relevant to the data I collected I have lower noise for my stationary data because it was an open field without any disturbance.
The dilution of precision in height is more obvious than position says height measurement is much more sensitive to noise than the others.
3) If the measurement was taken within the city limits, I predict.the results would have been quite opposite as stationary measurements would have had more noise and moving data would be much better because of improved connectivity with more satellite signals.