Report on GNSS Training

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Team No: 09

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1.1. EXECUTIVE SUMMARY

In general, the use of handheld GNSS or low cost GNSS receivers for some surveying purposes is quite economical and effective but its usage is yet being restricted by its low accuracy due to its insufficiency in generating raw data in real time (Hussien, 2016) . At present the accuracy of a handheld GNSS is identified to be ranged between 5- 10 meters depending upon many factors such as the number of visible satellites, signal strength, period of observation and the geometry of satellites, which are determined by Dilution of Precision (DOP) or Geometric Dilution of Precision (GDOP). This insufficiency in handheld GPS receiver's accuracy is further affected when used for the purposes like extent calculation and hence the professionals are now facing a severe problem in finding an appropriate solution for this issue as the Survey Grade GNSS receivers are not affordable and the handheld GNSS receivers are incapable of providing the necessary accuracy. Yet, it was understood that these low cost GNSS receivers can be used for data collections and they can be made compatible for using appropriate post processing.

We are the representative person form the different countries interested in GNSS and here we are for the training. Training was really awesome and we got to know a much more information and got opportunity to enhance our knowledge and experience. This training lead us to understand the modern technology of the GNSS field along with the applications and concepts of GNSS. At the same time this training privileged us to meet with the international community and deal with them which was a great opportunity.

The training consisted of several sessions including lecture sessions which gave the trainees a prior knowledge about GNSS its different available systems and the applications. Also, the trainees were provided with the prior knowledge about the data logging devices and post processing software. Then the teams were given the opportunity to collect and post process the data. This report thus contains the data we accumulated and the post processed out puts with their comparison in the accuracy and precision.

1.2. TEAM MEMBERS

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1.3. Introduction

Global Navigation Satellite System (GNSS) refers to a constellation of satellites providing signals from space that transmit positioning and timing data to GNSS receivers. The receivers then use this data to determine location.

By definition, GNSS provides global coverage. Examples of GNSS include Europe's Galileo, the USA's NAVSTAR Global Positioning System (GPS), Russia's Global'naya Navigatsionnaya Sputnikovaya Sistema (GLONASS) and China's BeiDou Navigation Satellite System.

The performance of GNSS is assessed using four criteria:

1. **Accuracy**: the difference between a receiver's measured and real position, speed or time;
2. **Integrity**: a system's capacity to provide a threshold of confidence and, in the event of an anomaly in the positioning data, an alarm;
3. **Continuity**: a system's ability to function without interruption;
4. **Availability**: the percentage of time a signal fulfils the above accuracy, integrity and continuity criteria

This training included static and kinematic data collection using low cost GNSS receivers and the post processing criteria. The RTKLIB software was used for the post processing. Our project included comparing the kinematic data we collected using several methods. For example, the data only with GPS signals are compared to the data with GPS ang QZSS. The low-cost u blox receiver was for the data collection was used and me managed to log the data to our laptops as well as to our mobile phone. For this particular process we had to have the u center software in our laptops. The prior training given to us about the software and the android app was a huge guidance when collecting and logging the data.

This collected data were then postprocessed and analysed by the RTKLIB software. The outputs and the comparison of the processed data are given below.

1.3.1 Sample Data (Zero Baseline Data)

SPP Results of the M8P Receiver

- Q= 5 (100%)
- Standard Deviation of the Coordinates

$e_{x=}$ 1.414135

$e_{y\,=}$ 1.035504

$e_{z=}$ 1.082677

- Difference with the known coordinate

$e_{x=}$ 0.892

$e_{y\,=}$0.802

$e_{z=}$ 1.286

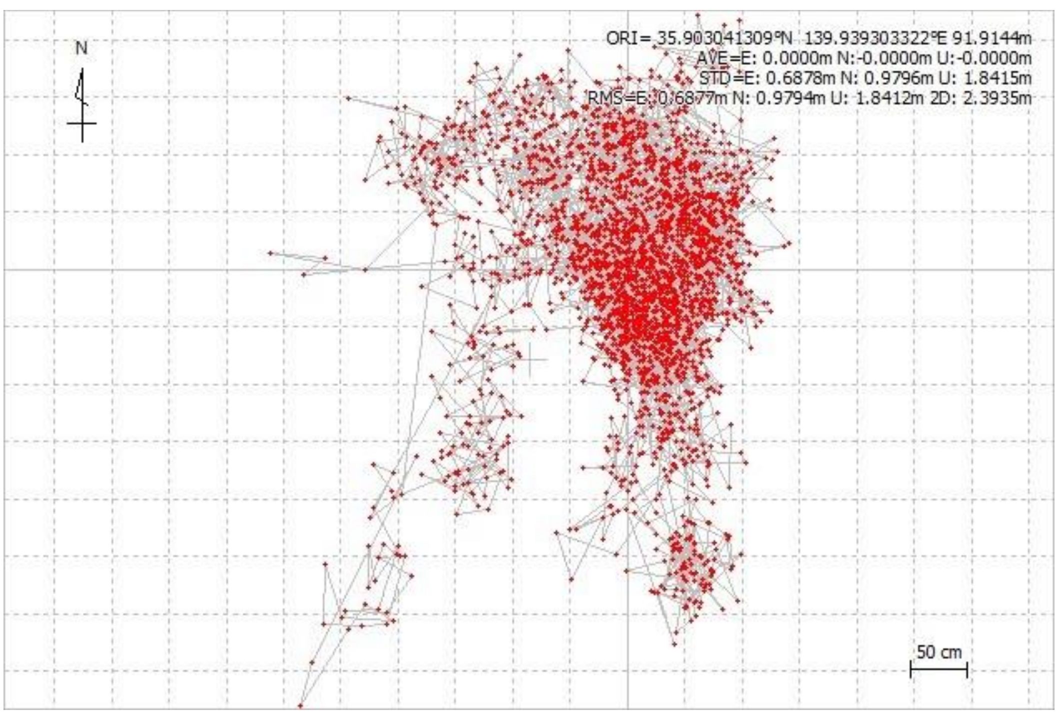

Figure 1: SPP Results of M8P

SPP Results of the NetR9 Receiver

- Q= 5 (100%)
- Standard Deviation of the Coordinates

$e_{x=}$ 1.414135

$e_{y\,=}$ 1.035504

$e_{z=}$ 1.082677

- Difference with the known coordinate

$e_{x=}$ 1.157

$e_{y\,=}$0.64

$e_{z=}$ 1.297

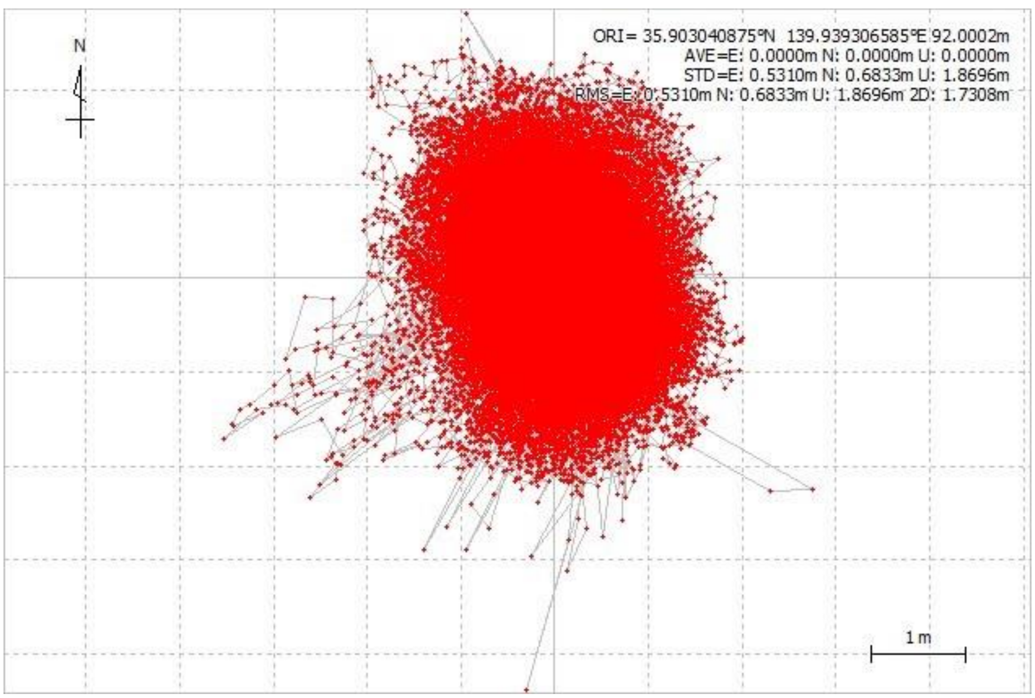

Figure 2: SPP Results for NetR9

RTK Results for NetR9 Base and M8P Rover

- Q= 1.85233 (99.7%)
- Standard Deviation of the Coordinates

$e_{x=}$ 0.02225

$e_{y=}$ 0.01935

$e_{z=}$ 0.02117

- Difference with the known coordinate

$e_{x=}$ 0.0008

$e_{y=}$0.0009

$e_{z=}$ 0.4495

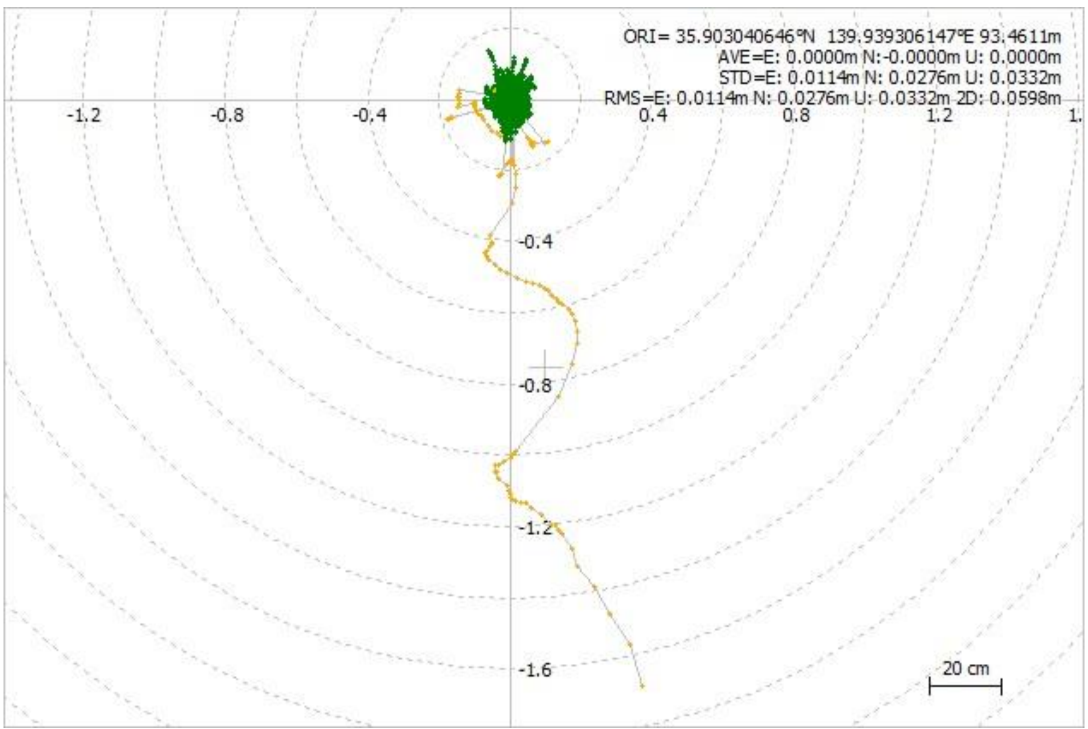

Figure 3: RTK Processing Results

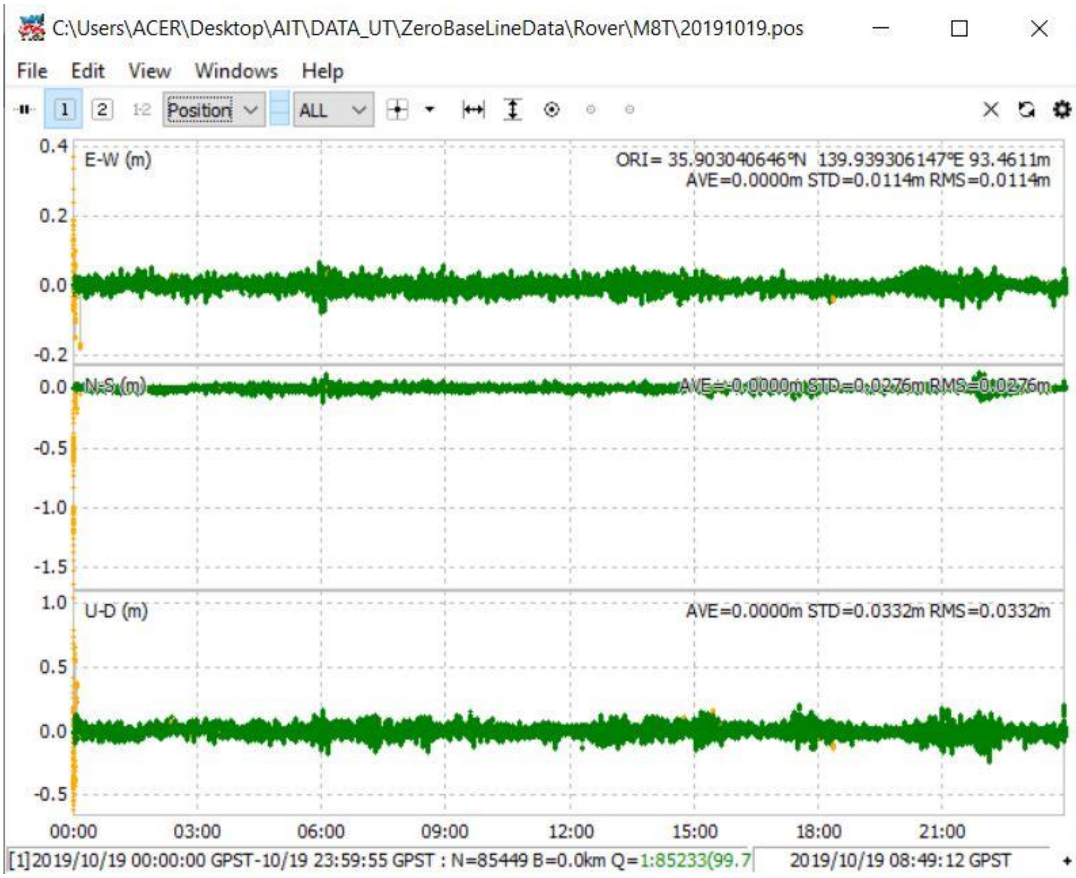

Figure 4: Positional Data

DGPS Results for NetR9 Base and M8P Rover

- Q= 4.85449 (100 %)
- Standard Deviation of the Coordinates

  $e_{x=}$ 1.30768

  $e_{y\,=}$ 0.98413

  $e_{z=}$ 1.09548

- Difference with the known coordinate

  $e_{x=}$ 0.0868

  $e_{y\,=}$0.0638

  $e_{z=}$ 0.4162

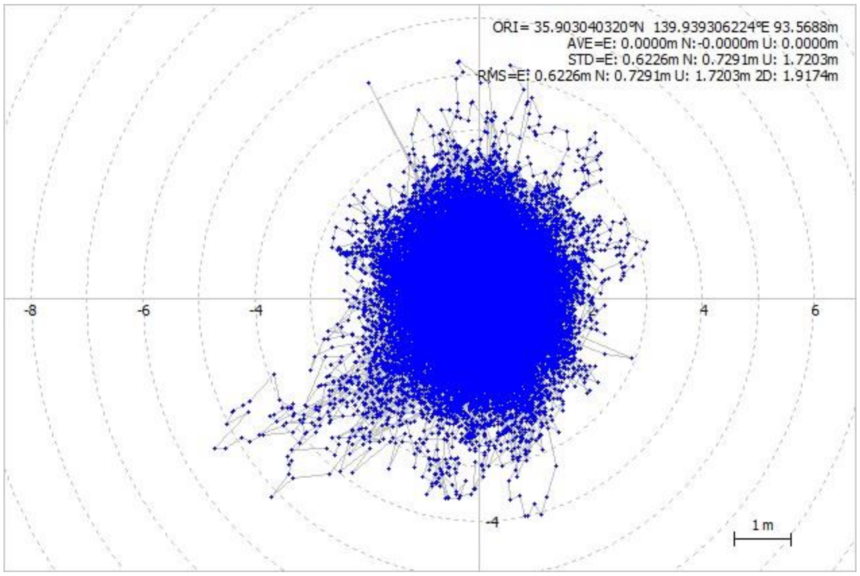

Figure 5: DGPS Processing Results

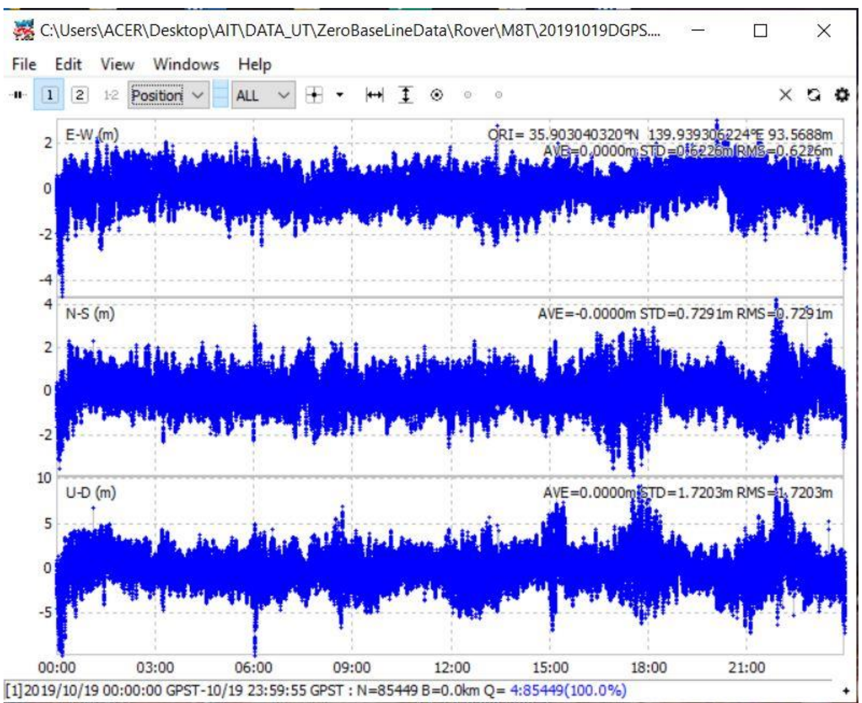

Figure 6:Positional Data

1.3.2 Data Collected Through the F9P Receiver

Data were collected using the F9P receiver and were processed with RTKLib with many configurations. The following table shows the change of the results obtained using different configurations like allowing different types of satellites.

SN SYSTEM	Q=1 %	Q=2%	REMARKS	POSITIONING MODE
GPS ONLY	27.7%	72.3%		Kinematic
GPS+QZ+GAL+BDU+GLO	10.8%	89.2%	Minimum Fix %	Kinematic
GPS+QZ+BDU	14.1%	85.9%		Kinematic
GPS+QZ+GAL+BDU	21.2%	78.8%		Kinematic
GALLILEO ONLY	40%	60%	Maximum Fix %	Kinematic

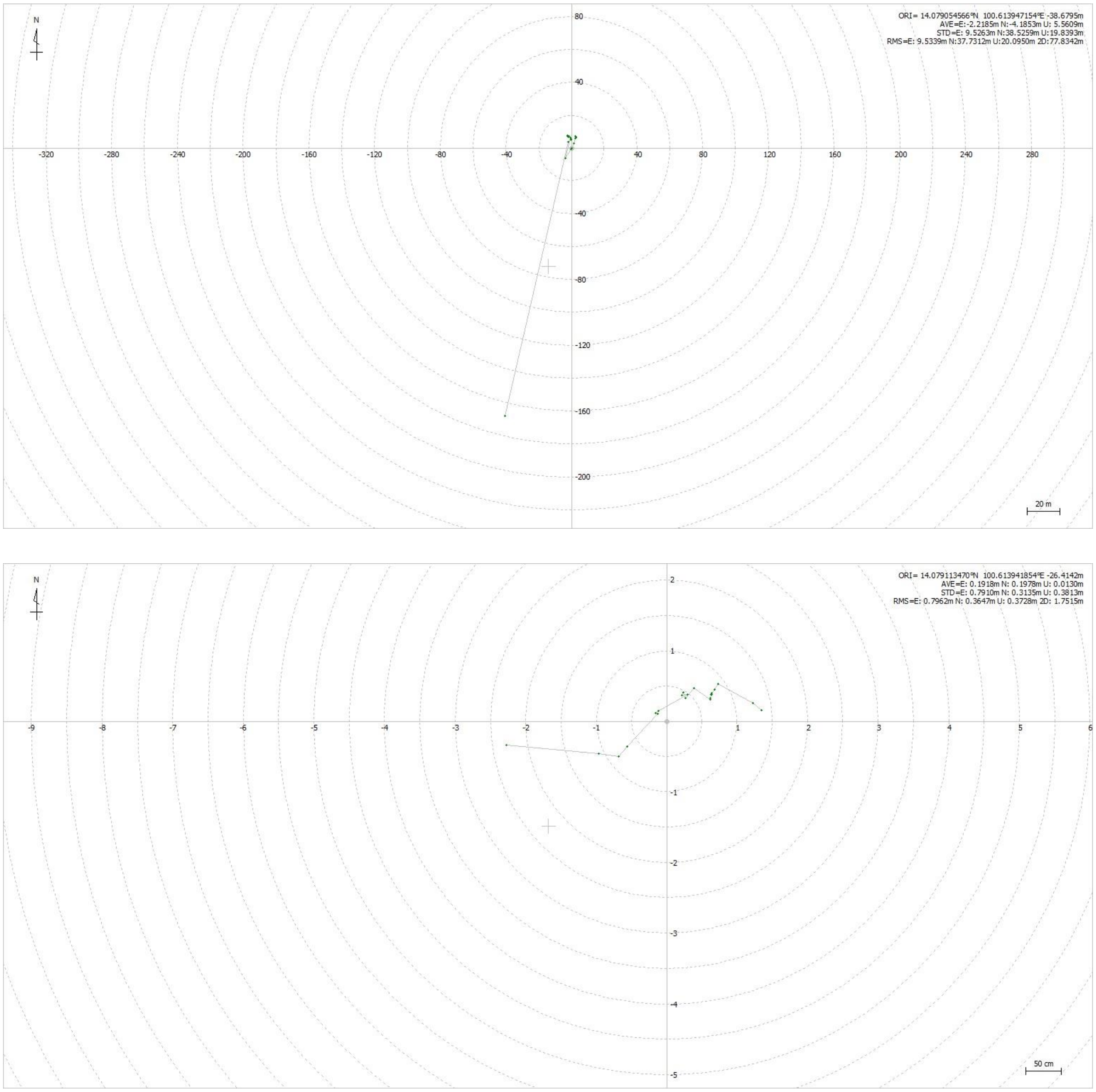

Figure 7: Fixed Coordinate Plot

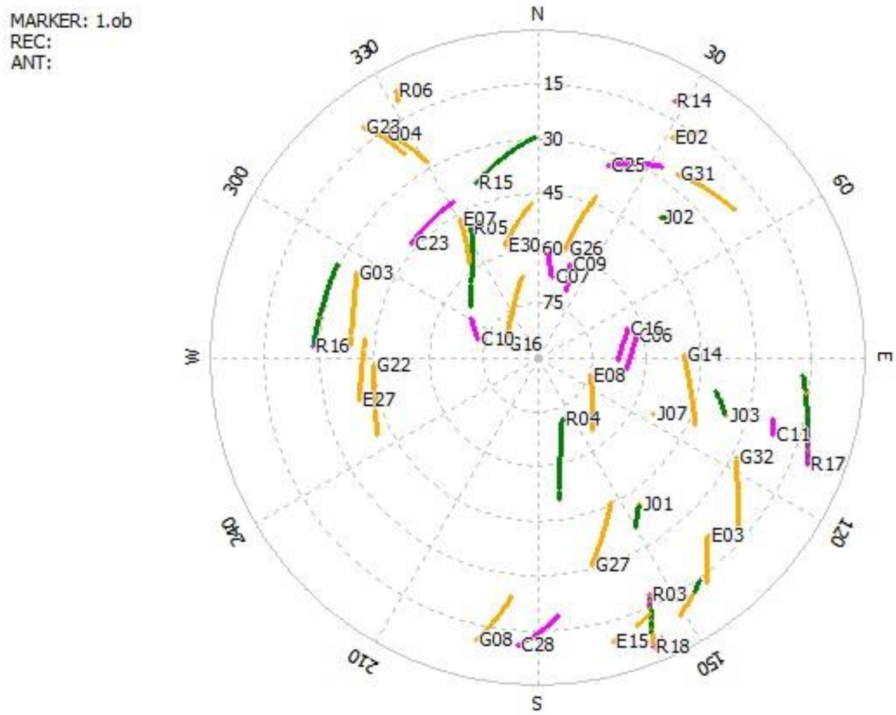

Figure 8: SkyPlot

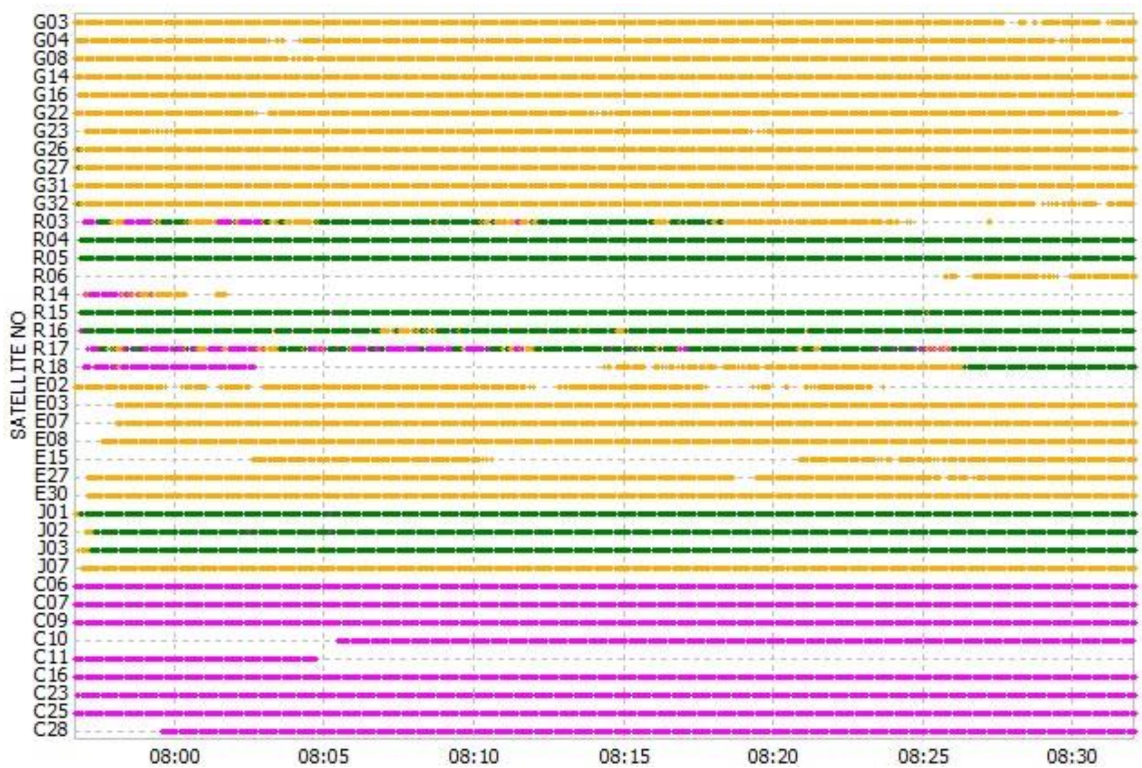

Figure 9: Satellite Visibility

1.4. SUMMARY

The main purpose of GNSS is determination of ground positions which is now being used in many applications including navigation, defence and surveying. As far as the use of GNSS for surveying is concerned, it should be noted that the use of GNSS receivers for surveying purposes have emerged rapidly through the past decade due it's efficiency and effectiveness over the conventional survey techniques. GNSS has shown a clear reduction in the man days required to fulfill a project which increases its efficiency along with the minimum wastage of the available resources. Thus, it allows the professionals to harvest the maximum output in surveying and related engineering projects. As the use of GNSS for surveying purposes is being discussed, the Survey Grade GNSS and the Handheld GNSS receivers should be taken into consideration where the Survey Grade GNSS provides the user with an accuracy up to a millimeter. Yet due to the higher expense and needed experience handling the use of Survey Grade GNSS is limited to precise purposes and hence the use of Handheld GNSS is becoming common among the professional surveyors as well as general public. Unlike the Survey Grade GNSS receivers, the handheld GNSS receivers require less technical knowledge to operate and are located in an affordable price range.

During our project we practically experienced the Errors and other possible mistakes happened in the data collection and post processing using low cost hand held GNSS receivers. Logging data in places with much buildings and tree canopies practically gave us the multi path error which we had only experienced through theories. Thus, it was quite clear to us the errors and the methods of minimizing and rectifying understood errors such as

- Multipath Error
- Ionospheric Error
- Tropospheric error

Our project only included the instantaneous data and this report only contains that information. But this project could also be done for the static data. Being on the context of our project and its outputs we came into the conclusion that the low cost GNSS receivers can be used for data collection and the data can be compromised for use from the post processing