Evaluating the applicability of Open Source GNSS Post- Processing Software for Applications of Surveying

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Abstract— *Global Navigation Satellite Systems (GNSS)is a widely used approach for many applications including the applications of surveying. 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 fulfil 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. Yet its applications get limited due to the experience handling, skill involvement and the highly expensive hardware and software. The GNSS systems require a felicitous system of software for the data post processing in both static and Real Time Kinematic approaches in order to obtain a reliable result for the application. The post processing software in any GNSS receiver is equally vital as the receiver, because any observation without post processing cannot be held as accurate without compensating the errors that are feasible in data accumulation. The higher expense for the purchase and the renewal of the licenced post processing software have thus contrived the users reluctant to use GNSS for surveying purposes. By comprehending the above fact into consideration many open source software have been developed in the industry and yet their applicability for precise surveying applications are hardly known. Thus, the ultimate objective of this research is to study about the readily downloadable open source GNSS post processing software to asset their applicability and the reliability to be used for the purposes of surveying in comparison with a licensed version of a Post Processing system to understand the pros and cons of each system.*

Keywords: *Open Source, Real Time Kinematic, Post Processing*

I. INTRODUCTION

Global Navigation Satellite systems (GNSS) is the standard generic term for all the navigational satellite systems present around the world. This indebtedly include the globally operational systems like GPS, GlONASS and Galelio along with the regionally operational Beidu, Qzss, Gagan and other systems. GNSS is vitally being used for many applications in the technological field apart from the basic navigation purposes. These applications incorporate the military applications, precise time calculations and the applications of surveying. This study is built upon the applications of GNSS in the field of surveying and mapping whose ultimate intension is finding precise locations.

As far as GNSS is concerned, with the use of precise instruments and rigorous observation techniques they are forenamed to deliver pin point accuracies of the locations. It should be hence 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 fulfil 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. Comprehending all these essentials in mind, it draws our attention to the crucial query that *"Why GNSS is still not popular among most of the surveyors?"* The justification for this question in my point of view is the required experience handling which makes the surveyors reluctant to adhere and the higher cost for the receivers and the post- processing software.

The post processing software in any GNSS receiver is equally vital as the receiver, because any observation without post processing cannot be held as accurate without compensating the errors that are feasible in data accumulation. Most of the commercial GNSS receivers include a licensed version of a post processing software which are believed by the society to grant a higher accuracy of obtained data. Yet these post processing software account for a higher potion of the expense on a GNSS receiver set and hence make the users incapable of buying the instrument. Most GNSS post processing software included with the receivers will only be given the license for a certain period and renewing the license causes more expenditure iteratively. This circumstance is one of the major bounds which draw back the desire of most of the surveyors to use the GNSS receivers for their surveying purposes. Thus, the ultimate motivation of this study is to ascertain the applicability of the available open source GNSS post processing software to yield best possible accuracy in field data collection.

For the consideration of this research two open source software were examined in essence named U centre and RTK Lib

II. METHODOLOGY AND EXPERIMENTAL DESIGN

At present the accuracy of a GNSS receiver is identified to be ranged between centimeters to meters depending upon many homogenous 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). The reliability of the processing software benefits in a larger range for the elimination/ minimizing of the error sources and the escalation of the accuracy. Yet, in having to address the growing issue of the financial incapability of acquiring a licensed software the methodology of this study has been designed in order to find the reliability of the open source software common in the industry.

For the consideration of the above scenario the following software have been taken into examination.

1. U centre
2. RTK Lib
3. Magnet Tool (Licensed software for Topcon)

They can be elaborated specifically as follows;

1. U centre

U centre is an open source software which allows GNSS positional data post processing. The u-center GNSS evaluation software for automotive, mobile terminal and infrastructure applications provides a powerful tool for evaluation, performance analysis and configuration of the u-blox GNSS receiver which is a low cost GNSS receiver which can be used for data accumulation. Yet this includes a limitation that only some formats are supported for this particular software including the u blox log files and Rinex formats. At the same time for the data processing it is always committal to port a U blox controller to the processing computer. Thus, u center cannot be used for applications where a u blox receiver is not supported.

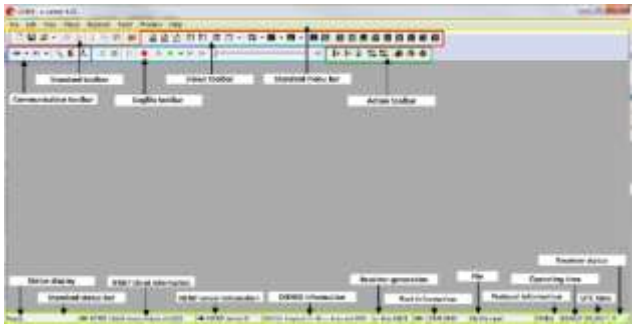


Figure1: U Center GUI

2. RTK Lib

The RTK Lib software is also a freely downloadable open source software which can be very comfortably downloaded from the internet. It contains a simple Graphical User Interface which directly leads the user to its menu which contain five basic processing applications

I. RTKNavi -GNSS Realtime Calculation and NMEA Output,
II. RTKPost -Post-processing Software,
III. RTKPlot -Visualisation,
IV. RTKConv- Convert to RINEX Data and
V. pos2kml -Create a Keyhole Markup Language (KML)-Dataset

Figure2: The RTK LIB GUI

As the basic method of data accumulation, pre-known coordinate locations of a set of points were post processed using the software in under several conditions. In order to adhere to the fact that errors can also be possible during data collection a common data set has been used in every case which were obtained using the Topcon GR5 survey grade GPS receivers which were properly calibrated to reduce the system errors. At the same time rigorous observation techniques were endorsed throughout the data accumulation process to minimize all the potential errors including multipath, ionospheric delays and receiver noise. Thus, this fact should be highlighted that any error potential during data collection will be equally compensated to all the software. Data collection was hence done using the static mode of the receivers where the instrument was placed at each place for three hours with the 1s data logging rate and 15^0elevation mask.

Once the data have been obtained then were separately processed using the magnet tool software which is the licensed version for the Topcone GR5 instrument and were tried to process using the open source software u center and RTK lib. The processing criteria are summarized separately as follows;

Once the raw data file is being obtained the foremost thing was to convert the data for an appropriate format. One of the major advantages of the RTK lib software was that its algorithms allow the conversion of raw data to many useful formats including Rinex and NMEA.

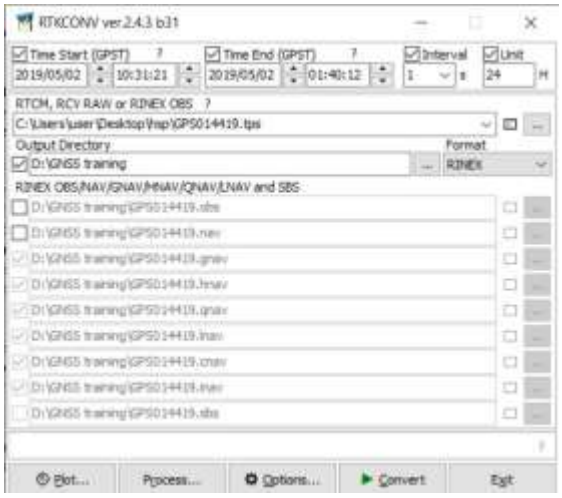


Figure3: RTK Conv Window

The software then can be used for the post-processing using the RTK Post and RTK Navi windows where appropriately and the user manually needs enter the details including the elevation mask, ambiguity resolution and the requirement of GNSS satellite systems for the processing by the user.

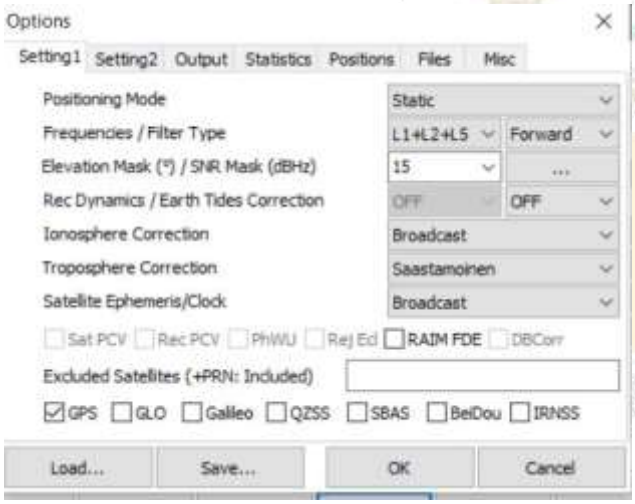


Figure4: RTK lib Processing Window

With the provided necessary information the software provides the coordinates of the point and also if required the software also provides a proper visualization of the points and data gathered.

3. Magnet Tool

Magnet tool is the licensed post processing software provided to the Topcon GR5 Survey Grade GNSS kit by the manufacturers. This software costs around 600,000 Sri Lankan currency and the software only supports when the licensed USB drive is supported to the computer. This software was taken for consideration depending upon the condition of the study to compare and assess the reliability of the open source software used. Thus, in order to gain much cleared understand about the props and cons of the open source the listened version of the instrument was used as a comparison.

The same data file used for RTK lib was now post processed through the magnet tool software.

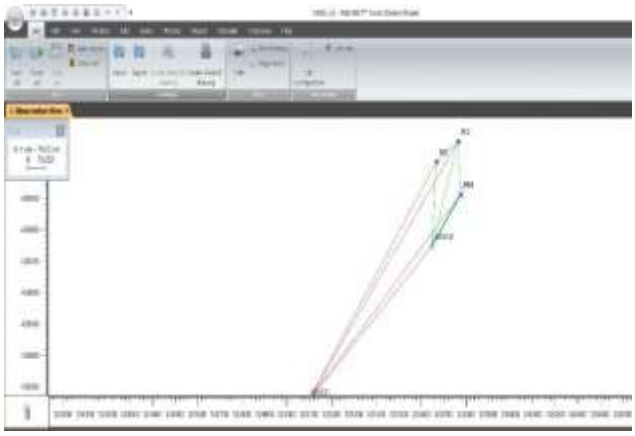
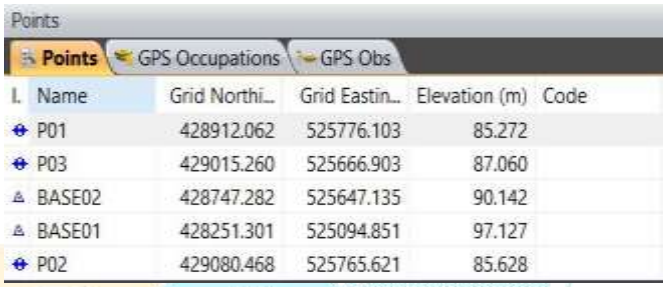


Figure5: Magnet tool Processing Window



I.	Name	Grid Northi...	Grid Eastin...	Elevation (m)	Code
	P01	428912.062	525776.103	85.272	
	P03	429015.260	525666.903	87.060	
	BASE02	428747.282	525647.135	90.142	
	BASE01	428251.301	525094.851	97.127	
	P02	429080.468	525765.621	85.628	

FIGURE6: Magnet tool Processed data

III. RESULTS AND DISCUSSION

With all the preliminary studies, the observed measurements and post processing the results of the positions could be calculated. The results from the two software can forwarded as follows.

Point A (P01)

Magnet Tool	428912.062 N	525776.103 E
RTK Lib	428912.126 N	525776.031 E

Difference between Northings: 0.064 m
Difference between Eastings : 0.072 m

Point B (P02)

Magnet Tool	429080.468 N	525765.621 E
RTK Lib	429080.397 N	525765.686 E

Difference between Northings: 0.071 m
Difference between Eastings : 0.065 m

Point C (P03)

Magnet Tool	429015.260 N	525666.903 E
RTK Lib	429015.312 N	525666.839 E

Difference between Northings: 0.052 m
Difference between Eastings : 0.064 m

Thus, it is clear that with the extreme rigorous observation techniques and fine equipment the magnet tool software and the RTk lib software only showed a difference up to a maximum of 0.1 m. This convince the fact that the open source software can also be used for certain application yet based on the requirement of accuracy. It should undoubtedly be noted that this should not be used for applications like control point establishment where a pin point accuracy of millimetre level is required.

Further more both the systems have their own props and cons which can be discussed up to a greater extent. The Magnet tool software is a more user-friendly software and hence dealing with the software is much convenient. Yet it can only work with its proper version that should be purchased which seems to be the greatest disadvantage of this software. The RTK lib is a multipurpose GNSS software which allows many operations including data conversion, data post processing, kinematic data handling and the data visualization. This also contains many functions that are included in the magnet tool software such as data visualization options, positional data variations satellite visibility, statistical and table views and so on.

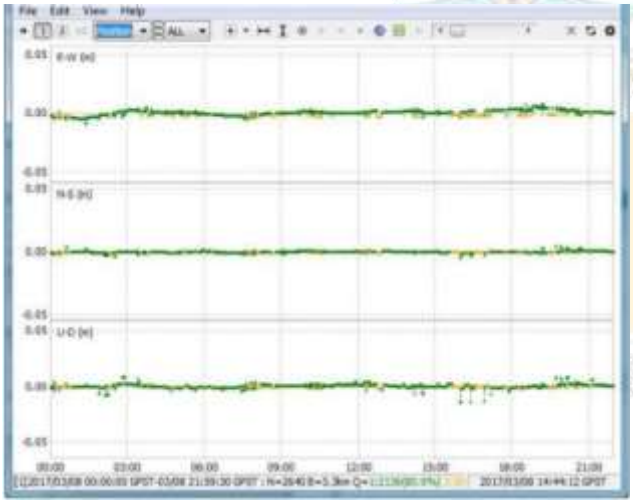


Figure7: Positional Variations as shows by RTK Lib

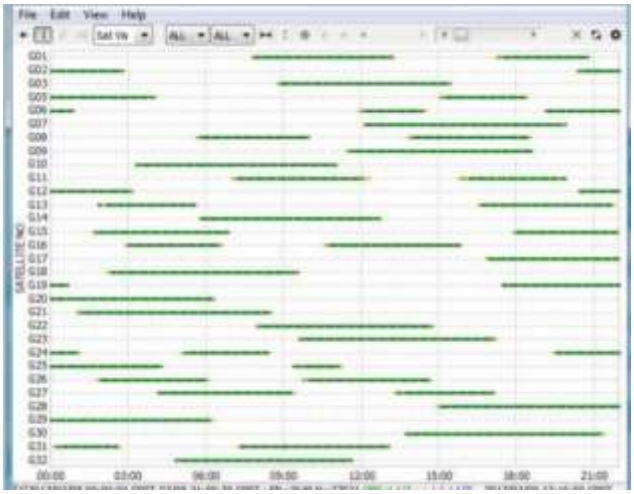


Figure8: satellite visibility

IV. CONCLUSION AND RECOMMENDATION

GNSS is a widely used recipe for many applications in different fields and still its applications in the surveying field are very unique and receives a far better skill involvement, commitment, hardware and software. The software used for post processing is hence a needfully considerable factor within this context. Many manufacturers of GNSS instruments and equipment generate their own versions of post processing softwares which includes Magent tool which was considered in this study and is generated and developed by Topcon. Smillarly Trimble, Leica and other manufacturers contain liscensed post processing software which are hadly able to be purchasedby the surveyors due to the higher expenditure in purchasing and reneiwing the lisence.

Considering this pathetic situation the available open source softwares were experimented through this study with the ultimate objective of assessing their reliablity for use.

Furthermore the two open source softwares U centre and RTK Lib were thoughrougly examined to identify their props and cons seperately. This research thus lead us the path to find out that the u center software is a much effiecient and effective software to deal with the low cost gnss receivers. Thus, is a situation where the highest accuracy is irrelavent the the u blox receiver and the u centre software provides an ample of good results which will undeniably be cost effective and efficent . hence for a surveyor who is dealing with such acivity it would be highly profitable to purchase the kit.

Essentially the RTK Lib software is heavenly propitious for many purposes. It allows most of the fuctions of a liscenced software to be done by this open source software without costing a peny on the softwares. This will allow to gain a desireable accuracy on many applications including the static and kinematic modes. At the same time it allows real time data processing on your computers.Also being an open source software this can be

furthur developed and the errors amd other incompatible functions can be modified by the developers.
For the situations where an average accuracy is bellyfull the software would grant the user a basket of proper yeild to the requirement. This software can be hence used for many Real Time Kinematic operations and static operations excluding the pin point acuracy requirements like new control point establishment. It should be noted that these analysis were based on a properly configured Survey Grade GNSS receiver and these obtained accuracies can be varied epending upon the used instrument and the adopted observation techniques.

Concluisvely, it can be presented that the RTK Lib and the U centre softwares can be used to obatin a considarable output by adhereing to their requirements and appropriate data accumulation and processing techniques which is highly cost effective

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