Report on GNSS Training

Course ID: T151-40

Team No: 04

Team Members:

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Training held at GIC/AIT, Thailand

6 – 10 JAN 2020

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1.1. EXECUTIVE SUMMARY

The course covers an introduction to GNSS, comprised of GPS, GLONASS, GALILEO, BDS, QZSS and NavIC. Discussion on RTKLIB and related software for High-Accuracy GNSS Data Processing with the used of RTKDROID, SW MAPS, GNSS Analysis APP, and GNSS logger were tackled. Field surveying were conducted using Low-Cost receiver for High-Accuracy positioning. Some Real-time and post-processing technique were also introduced for GNSS Data processing. Discussions on PPP using QZSS MADOCA signal form Japan were also done. Lastly, another technique of logging the data in real-time with the GNSS raw data were also done. The activity were introduced for applications such as surveying, Mapping, GIS, Remote sensing, Telecommunications, and many more related applications. The course was able for the participants to understand about how a GNSS receiver works, its application, survey methods and data processing for high-accuracy in real-time or post-processing modes.

We were able to learn about GNSS from the basic through the different lectures delivered by experts coming form NASA/GSFC, UNOOSA/ICG, The University of Tokyo, Tokyo University of Marine Science and Technology, and GIC/AIT. Some of the topics discussed were:

1. Introduction to Navigation Satellite System and GPS
2. Introduction to GNSS (Glonass, Galileo, Beidou, QZSS)
3. GNSS Signals and Signal Processing
4. GNSS application
5. GNSS Data Formats Accuracy, Errors, Coordinate System
6. GNSS Survey Methods for High-Accuracy
7. GNSS Data Logging and Processing in Smart-Phones
8. Introduction to RTKLIB
9. Introduction to RTK
10. MADOCA/CLAS

There were also discussions conducted on what are the activities being done and conducted about GNSS.

1. ICG Presentation
2. GIC Presentation
3. Sponsor's presentation (Septentrio)

Practical works were also experienced during the training and it includes the following:

1. Installation of Software and processing of sample data
2. GNSS Data Logging and Processing in Smart-Phones
3. GNSS Field survey
4. GNSS Data Processing with sample data
5. GNSS Data Processing with sample data by the participants
6. Discussion on GNSS Data Processing Outputs

In summary, the 5-day training became very worthwhile and inspiring. New outlooks on the actual applications of GNSS/GPS were learned and inspired each participants to develop or think of new ideas for practical applications of the technology in their specific field of works. The resource persons shows

high expertise in the topics they discussed and were able to clarify everything that any concerns the participants asked. The venue in AIT is also very conducive for the training and the accommodation is very satisfying with the support of every staff of the organizer and the AITCC.

1.2. TEAM MEMBERS

Write name, affiliation and e-mail ID of all team members here

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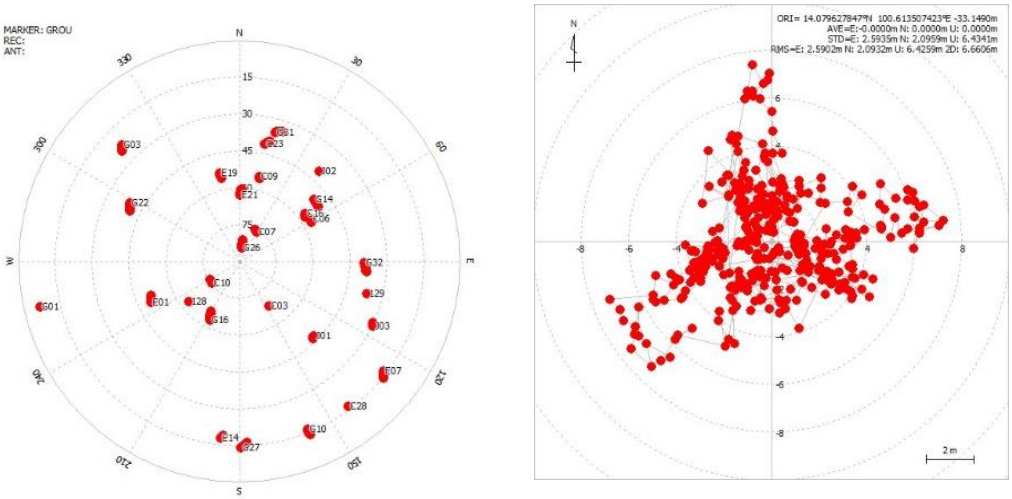
1.3. INTRODUCTION

The training course leads the team to learn how to use the U-center software. The software is used to log the data received by the different receiver through an antenna used during the whole training. Basic lectures serves significant materials for the participant to know the basic and theories of GNSS/GPS. It prepares the participants to appreciate what has being done in the practical training and field surveys. Another software was used to process the data which is called RTKLIB. It is a powerful tool in processing the data. It gives way for us to see the different information that the received signal has and showed it in different ways suitable for analysis and interpretation. Many techniques were also learned during the training on how to enhanced the information by minimizing the errors received by the antenna and receiver. Using software, it was able to filter the data and retain the most significant information. Techniques on using different constellations was also learned to minimize the error of the true locations. This technique is calld the GNSS. Another technique known as RTK or real-time kinematics was also taught during the training. This technique is also powerful to minimize the error of up to cm and sub-cm level. However, base station is needed and there is a limitations on the distance of the base station in reference to the rover station to have a better results. In the figure shown, two data is always compared which are the static and the dynamic data. Data of static and dynamic are sometimes came from the actual data gathered in the field survey. Some static and dynamic data came from the pre-recorded field surveys for the purpose of discussions and practice.

1.4. SUMMARY

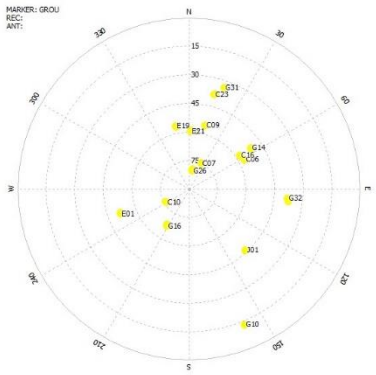
- **Data Logging (Day 2), GNSS Antenna, U-blox M8T Receiver, U-center**

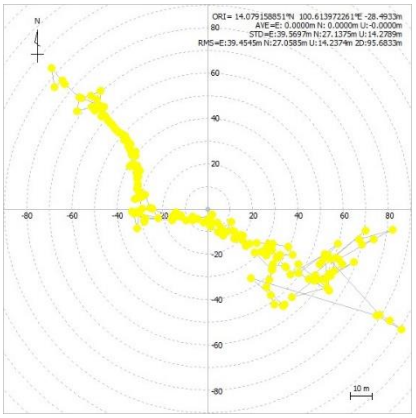
  During the 2nd day of the training, the team was able to learn how to gather data and log it using the U-center software. Conversion of the data from the ubx file into navigation and observation file were learned and observed the information contained in the file. The files can be opened using any text editor software. The team was able to plot the converted data using the RTKLIB engine RTKPOST.



Static

The above figure are the skyplot and the scatter plot of the static data gathered in the pre-recorded field survey using GNSS receiver.

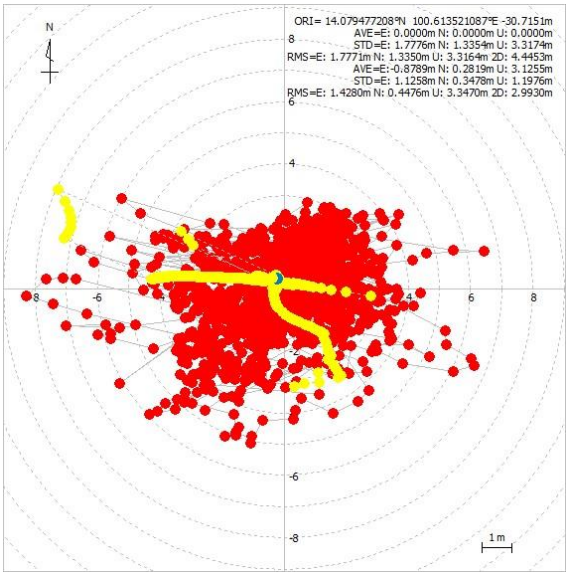


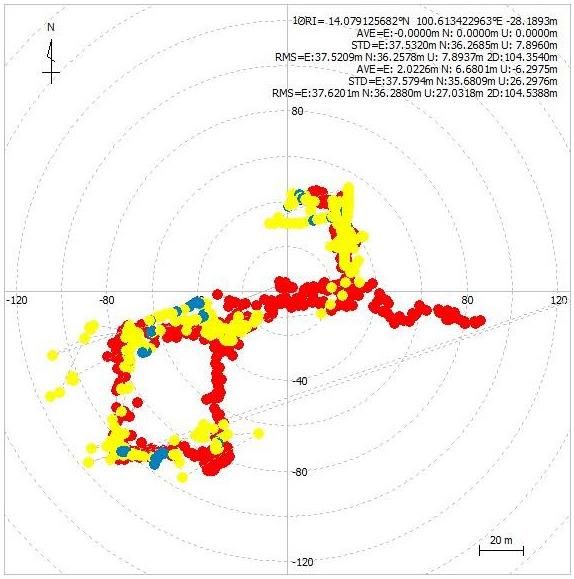


Dynamic

- **<u>Data Logging and Processing (Day 3), GNSS Antenna, U-blox M8T Receiver, RTKLIB</u>**

On the 3rd day, using the same receiver and antenna system, the group gathered its own data in the actual field survey. Below shown are the scatter plot of both the static and the dynamic data with some processing implementation which is the Real-time Kinematics with sub-meter error of Q=1 and Q=2. Fixed solution is also shown as an overlap red points.





Static

Dynamic

Single

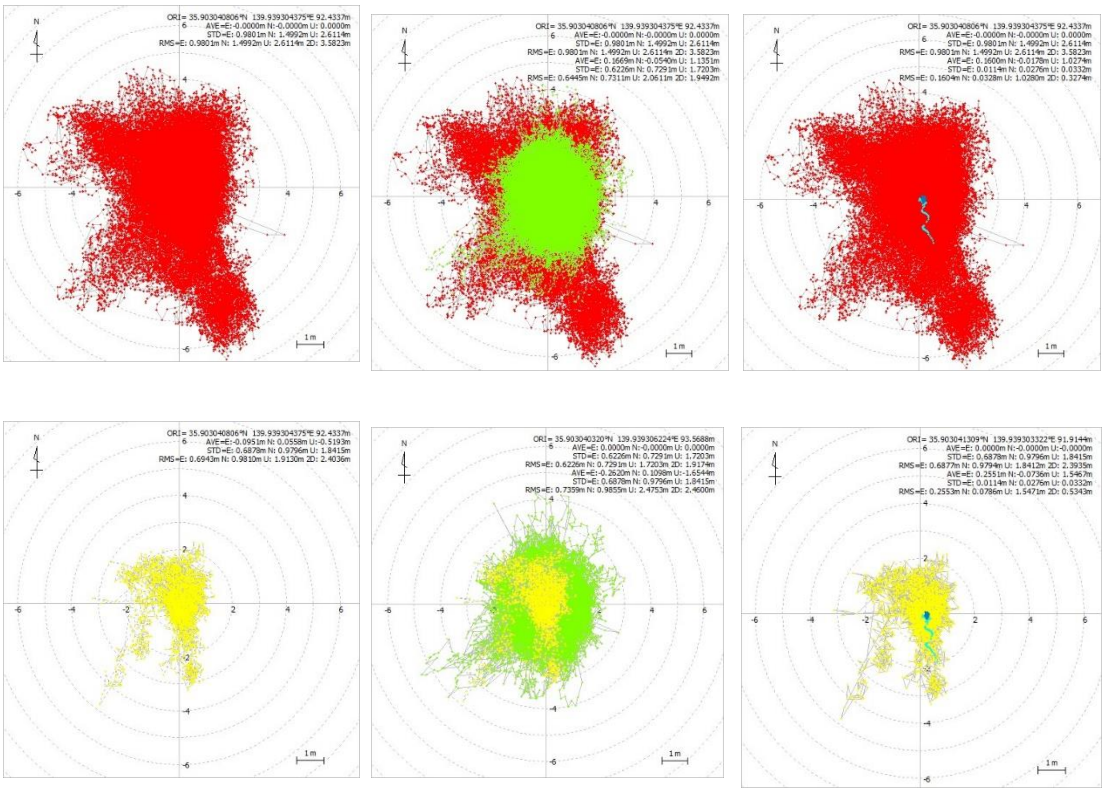
RTK (Q=1)

RTK (Q=2)

- **Data Processing (Day 4)**

In the 4th day of the training, different receivers were compared to check the quality of data gathered. Though here, only the static data was processed, the scatter plot show a versy significant difference between the two types of receiver.

After having been, identified the better receiver, a new techniques was introduced, which is using a base station to become a reference point to better correct the position data. This is the real-time kinematics (RTK). This method is compared to GNSS, and its shows that RTK gives better results than GNSS with some limitations.



M8T

NetR9

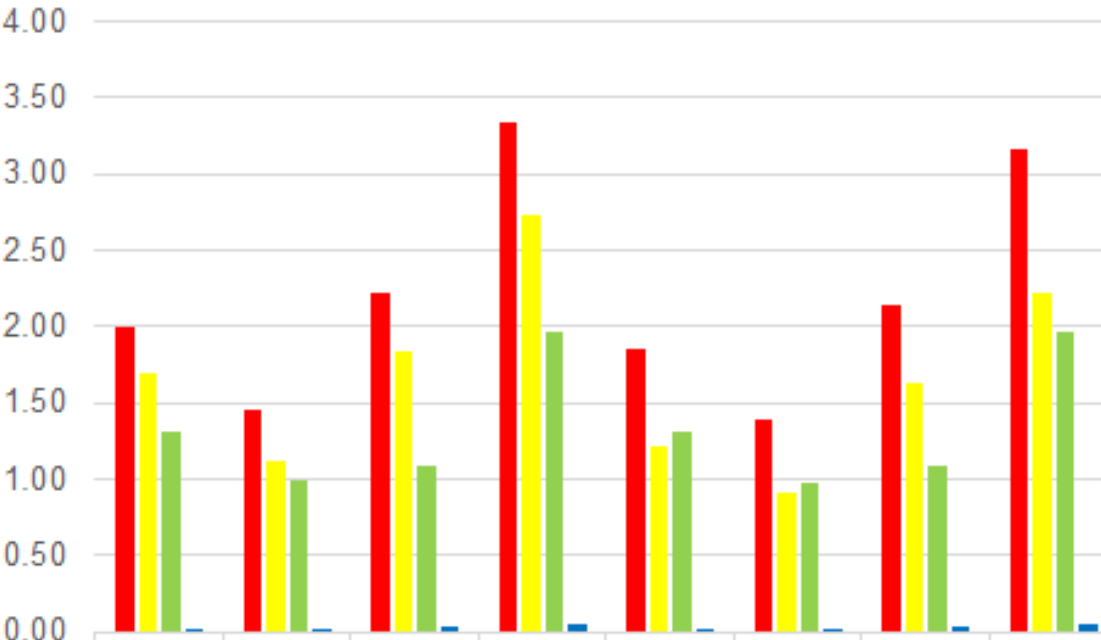
DGPS

RTK (Q=1)

RTK (Q=2)

- **Error Comparison (Day 4)**

The analyses on the data quality gathered by different receivers, was performed using simple statistics to calculate the precision and accuracy. The graph shows that by using the DGPS the precision error and accuracy error were brought down into meter level. Then, suing the RTK, precision error and accuracy error were brought down into sub-meter level

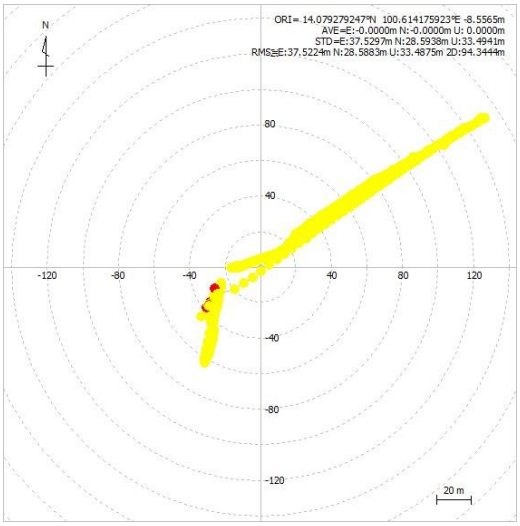


	True Value Based Error				Mean Value Based Error			
	Ex	Ey	Ez	E	Ex	Ey	Ez	E
M8T	2.00	1.46	2.23	3.33	1.86	1.40	2.15	3.17
NetR9	1.69	1.12	1.84	2.74	1.22	0.91	1.63	2.23
DGPS	1.31	0.99	1.10	1.97	1.31	0.98	1.10	1.97
RTK	0.03	0.02	0.03	0.04	0.03	0.02	0.03	0.04

The team had a better understanding on how to identify and differentiate the technical term precision and accuracy and how to mathematically calculate to prove them. The confidence of the participants strengthened in assessing the quality of the receiver that they might be acquiring in the future. This part of the training open-up a very significant knowledge for the participants.

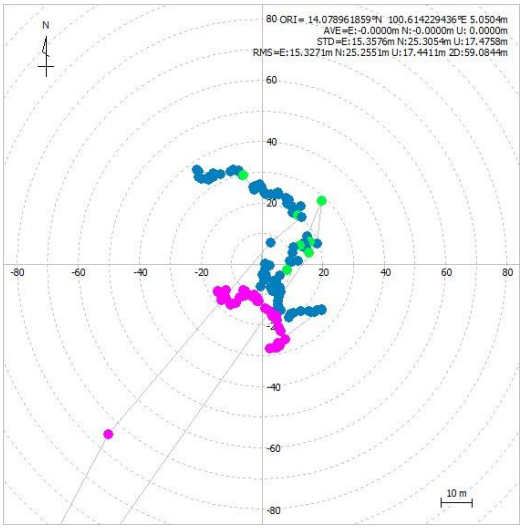
- **Data Logging (Day 5)**

On the last day, another technique was introduced for the participants to explore more on the different processing of the data. The figure shown below is the static and dynamic data gathered from the actual field survey. The data were processed using NMEA, which can be seen the significant improvement of the observed data which were able to show the fixed solution, the meter level error position data, and the above meter level error of position data.



Q = 1
Q = 2
Q = 3

NMEA (Static)



Q = 1
Q = 2
Q = 3

NMEA (Dynamic)

Photo of the members of TEAM 04 working together for the field survey data using the U-center software, the GNSS u-blox receiver and antenna.

1.5 Recommendation

Based form the experienced gathered by the team from the training, we may say that the training is excellent especially for the new participants of GNSS. Though the training span for 5 days, the topics covered seems to squeezed for the time allotted though this may be the case for the new participants. It might be expected that when we will be given another opportunity to participate in related training on GNSS/GPS we may catch up more. There were some minor technical errors happened during the lectures like the projectors, video conferencing, and some pre-recorded data that were used during the practice of data processing, but these things happened but maybe minimized. Maybe in the next coming training, we may suggest to have more practical field survey and practical applications of the data since we already have basic knowledge and experience in GNSS.