A SOLUTION FOR DATA TRANSMISSION VIA INTERNET TO MEASURE RTK

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ABSTRACT

This paper introduces a solution for phase data transmission from the base station and rover station to server via 3G mobile network to measure RTK with the high accuracy and the low cost. The data from the GPS receiver which has RTCM 3.x format is transmitted to the server and is processed by the RTKNAVI module from open source RTKLIB version 2.4.2. This solution is suitable for RTK application to topographic, cadastral mapping with large scale and offshore bathymetric survey

1. INTRODUCTION

Currently, RTK GNSS positioning techniques are widely used in the field of bathymetric, topographic mapping, intelligent transportation systems ... Traditional RTK technique uses telecommunication systems UHF band (frequency of 400 MHz) to transfer phase data from the base station to the rover station to solving baseline vectors using phase-carrier measurement. The restrictions of data transfer by using UHF band is a short range (<10 km), depending on geographical features and manufacturer and especially high cost , so RTK applications are limited.

To increase the operating range of the RTK system, through this paper, we propose solutions using 3G mobile networks to transmit phase data from base station and rover station combined with software RTKLIB (developed by Tomoji Takasu and colleagues). Module RTKNavi.exe supports reading data from the receiver, converting to RTCM2, RTCM3 and processing phase measurement. The receiving data of protocol is quite varied, data can be received via COM connection, Internet, files. This module runs stablilty on Windows, Linux, Mac iOS operation system. Module allows processing phase measurement on single frequency or multi frequency modes with as low accuracy single point positioning (Single), real-time measurement RTK (kinematic, Moving-Base), high precision point positioning (PPP) [3]. The software is updated and more complete in the new version in order to catch up with the development of satellite systems GNSS positioning of the world. Overall, the results of real-time processing using the extended Kalman filter algorithm of the software is matched with other commercial software [1] [2].

2. SETTING UP THE SYSTEM

The solution proposed is to use smartphones as device data transfer phase from the receiver to the computer. This is feasible because the smartphone will receive data from GNSS receiver via Bluetooth and then transmitted to the computer through the Internet 3G.

Smart phones are used to replace the role of the controller (or fieldbook) of the rover station. Diagram of device connecting is shown in Figure 1.

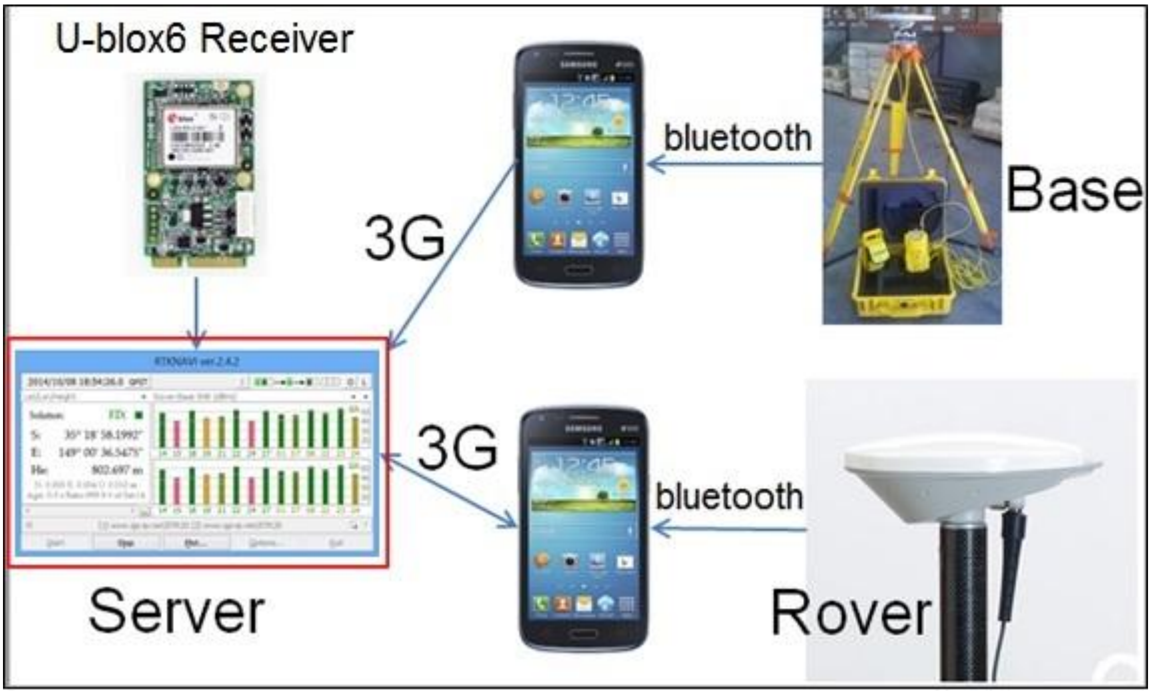

Figure 1. Diagram of device connecting for RTK technique using 3G mobile networks

To realize RTK measurement system according to proposed idea, the authors connect the computer to the Internet via modem. To transfer data from phase GNSS receiver on the computer, the authors programmed BluetoothInternet.apk application (installed for smartphones using the Android operating system), InternetCOM.exe (settings for the server use Windows OS). In particular, BluetoothInternet.apk function receives data from GNSS receivers via bluetooth connectivity and data transfer via 3G Internet server; Software InternetCOM.exe functional GNSS receiver receives data transmitted over the Internet and then push the data to virtual COM (support of Virtual Serial Port Driver software version 6.9). From the virtual COM, RTKNavi module will receive and process data from the GNSS receivers. In addition, the authors programmed application ServerInternet.exe to receive coordinates from RTKNavi processing module via virtual COM station and rover transmission over the Internet and application ClientInternet.apk to display coordinates on smartphone using web-browser.

However, the most difficult when implementing this system is output data from GNSS being suitable data format and function of RTKNavi. This means only this RTK system to take advantage of the receiver base station functionality. Most of the GNSS receiver in Vietnam only allows exporting phase and code measurements, but not for the satellite ephemeris data, so the module RTKNavi can not process data. So we added a OEM receiver U-blox 6 to the system to retrieve satellite ephemeris data. In addition, the connection to the receiver to set the system difficult because publishers often do not allow users to interact with the hardware of the receiver. The advantage of this system is low cost (only used by receivers with a function base station) and can be used simultaneously types of receivers of different manufacturers.

3. EXPERIMENTS AND DATA PROCESS

3.1 Experiments

The system was tested at two stattions in District 2, HCMC including the first station (base station) is located at Mai Chi Tho Street, the second station (rover station) is located in the campus of Southern Natural Resources and Environment Corporation (Figure 2). The distance between two stations is about 2.5 km. The experiment was conducted from 10:00 AM to 11:00AM on 11/19/2014

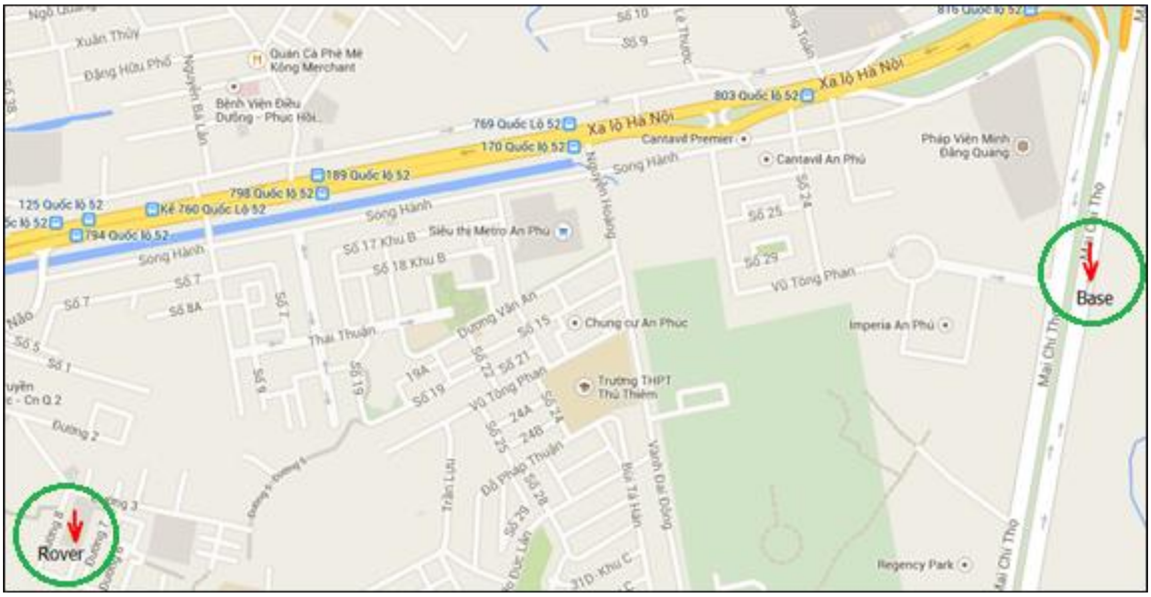

Figure 2. Map of experimental location

Equipment and softwares used for the experiments are listed in Table 1.

Table 1. List of equipment/software are used for experimental

Type of equipment/software	Function
02 dual frequency receivers, Trimble R7	Receive L1, L2 phase and code measurement, export RTCM 3.0 format
01 single frequency OEM receiver, U-blox6	Satellite ephemeris data
01 smartphone Samsung Galaxy Core Duos I8262 (Android)	Collect data from receiver using BluetoothInternet.apk application
02 laptops	Server, data processing by RTKLib, data transfer by COMInternet.exe
01 USB 3G	Connect 3G internet
RTKLIB ver. 2.4.2	Process RTK measurements
COMInternet.exe (Windows)	Transfer data from COM to Internet via USB

	3G
BluetoothInternet.apk (Android)	Transfer data from bluetooth to Internet to SIM 3G
InternetCOM.exe (HĐH Windows)	Receive data from Internet to COM
Virtual Serial Port Driver ver. 6.9	Virtual COM management

Setting up systems: Server installed software RTKLIB version 2.4.2 is connected to the Internet modem to create a virtual server (because IP is used as a dynamic IP). Internet connection is used of fiber optic cable FiberVNN Fm 12Mbps package. According to Figure 3, at the base station, data from Trimble R7 receiver are transfered via bluetooth smart phone and then sent to the server via 3G SIM. At the rover station, data from phase Trimble R7 receiver combining satellite data from the calendar U-blox 6 receiver is transmitted to the server via 3G UBS. At the server, the data is saved (for phase post-processing) and processing each epoch according to default setting of the module RTKNavi.

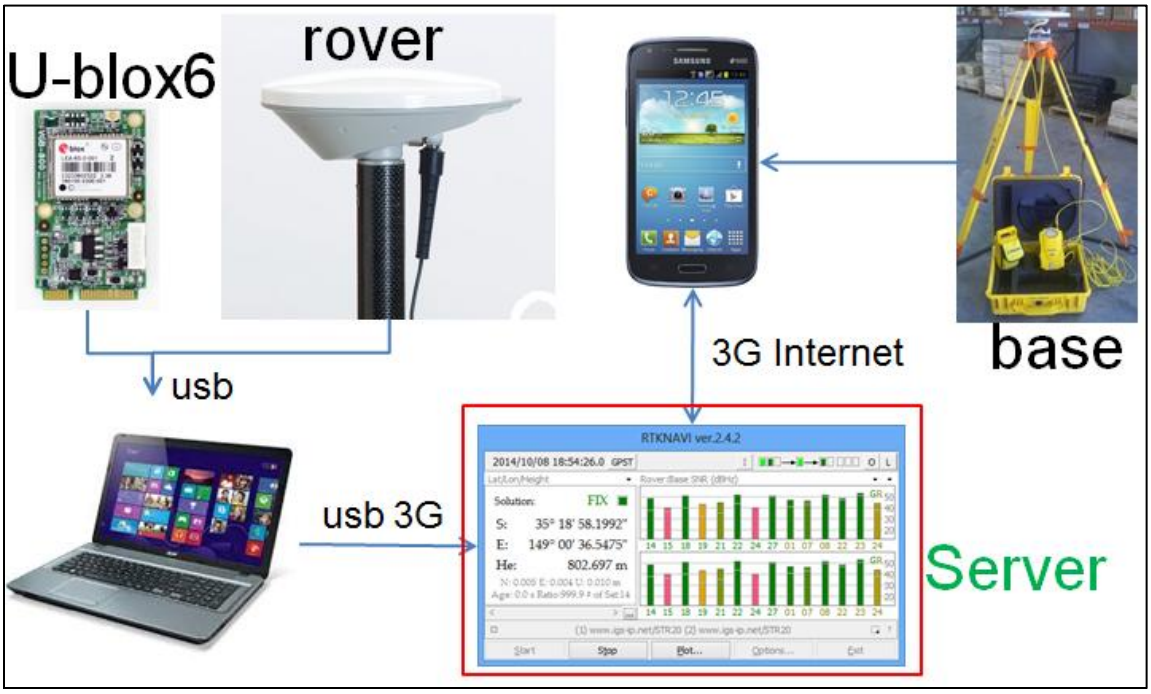

Figure 3. Diagram of device connecting for experiment

The software supports data transfer stability on both Windows and Android operating systems. Because U-blox 6 receiver updates and exports satellite ephemeris per 1 minute, results are not shown on screen in the first minute . After the first minute, results processing and stabilizing the transition from the float to fix solutions (Figure 4).

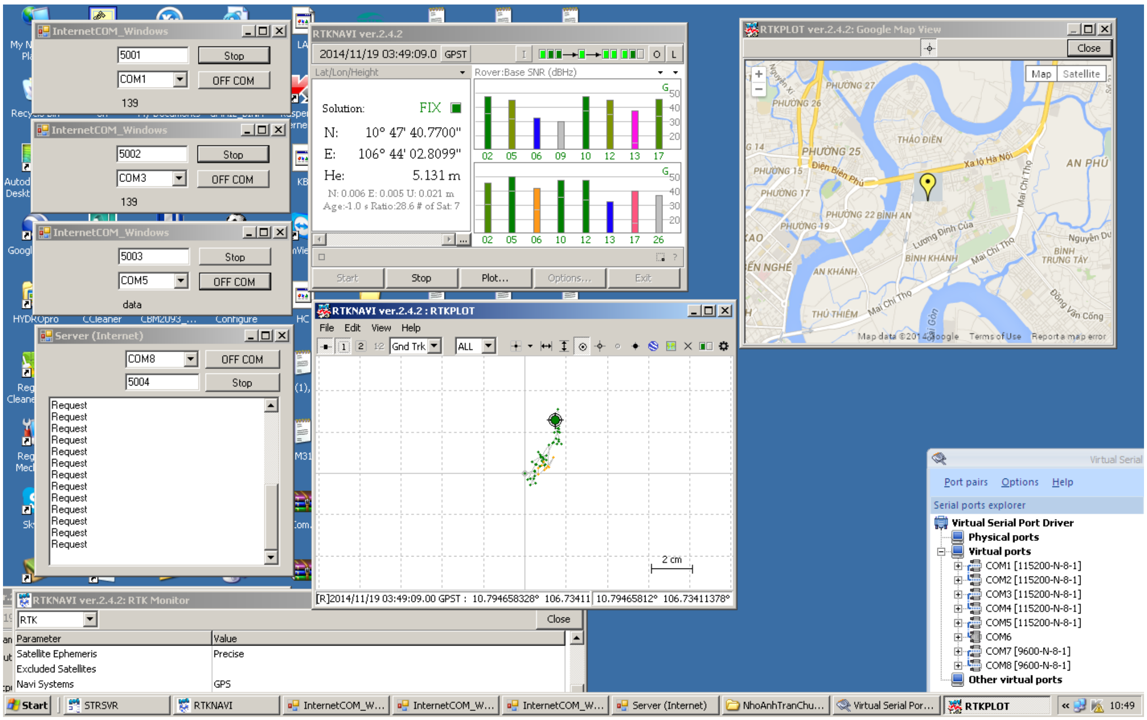

Figure 4. The interface of the software RTKLIB running

The results are temporarily not be good. Although solution is always to reach the fix (Figure 5a), but the convergence of the solution is not high. If ignoring the single and float solution, the convergence of the coordinates of the rover station is located in the radius of nearly 1m, although the base station and rover stations are fixed in place (Figure 5b).

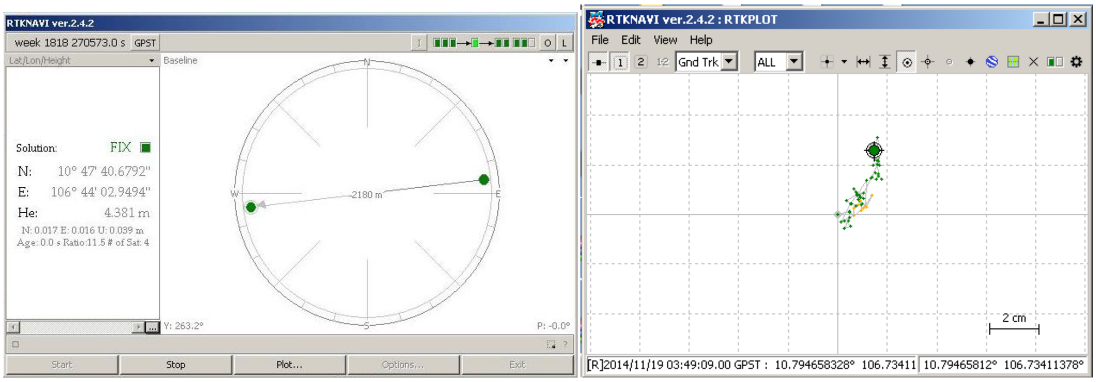

Figure 5. (a) status of the fix and baseline (b) fixconvergence of solution

Topcon Tools and RTKNavi softwares are used to process the phase measurement by two variants (post-processing and RTK mode) and the results are as follows:

+ Post-processing mode: The deviation of the coordinates in the local coordinate system between the average baseline processed by Topcon Tools RTKNavi is approximately 2cm. Accordingly, the North component ΔN is 8mm, the East component ΔE is approximately 13mm and Vertical component component is approximately 3 cm (Table 2). RMS of Topcon Topcon solution is better than RMS of RTKNavi solution 6.5 times (7.6 mm vs 48.9 mm)

Table 2. Result of baseline processing using post-processing mode

	ΔN (m)	**ΔE (m)**	**ΔU (m)**	**RMS Horz (mm)**	**RMS Vert (mm)**
Topcon Tools	-256.938	-2168.714	0.280	3	7
RTKNavi	-256.946	-2168.727	0.309	21	44
Δ	0.008	0.013	-0.030		

+ RTK mode: The deviation of the coordinates in the local coordinate system between the average baseline processed by Topcon Tools RTKNavi is approximately 2 m in horizontal (Table 3). Hower RMS of RTKNavi solution is this case is better than post-processing mode. This shows that the software RTKNavi give a good convergence solutions but the coordinates are shifted by a section about 2 m.

Table 3. Result of baseline processing using RTKmode

	ΔN (m)	**ΔE (m)**	**ΔU (m)**	**RMS Horz (mm)**	**RMS Vert (mm)**
Topcon Tools	-256.938	-2168.714	0.280	3	7
RTKNavi	-255.105	-2168.289	5.611	19	3
Δ	1.833	0.425	5.331		

The shift can be generated by the signal delay when transmitting data over the Internet with dynamic IP. Next time, we will test the system using static IP when transmitting data over the internet, and improved algorithms of phase processing in RTKLib software to enhance accuracy meet the requirements to establish large scale topographic maps

4. CONCLUSION

Thus, the paper solves the problem of data transmission phase from the receiver to the server via 3G Internet connection. The data transmitted over the Internet to solve disadvantages of traditional RTK system (limited radio link and the bottom edge distance). This paper shows the application of near real-time (near RTK) and RTK system consists of a base station and rover station, then just build virtual server systems use dynamic IP cable Internet. This saves costs and increase flexibility build server for the project shortly, small scale. Of course, if the system is equipped with a static IP server configuration and powerful computers, the signal delay will be improved.

The results by using RTKNavi module are not good due to default settings of the software. Next direction of the solution is explore the installation parameters and improve algorithms of phase processing in RTKLib software for applications in practice.

5. REFERENCES

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