The Development of Wireless Network Surveying System

TCHA Dek-Kie, Republic of Korea

Key words: RTK-GPS, Totalstation, mobile surveying, network surveying, Bluetooth.

SUMMARY

The surveying activities in the field of data logging is complicated due to the lot of devices and surveying methods. In the view of surveyor, she/he wants to use the simple processing procedures and an integrated it in one system. Now days, we faced with the digital and mobile circumstance as the PDA, tablet PC, bluetooth, wireless internet, smart phone and surveying tools of the RTP-GPS and TS. In my study, I try to integrate remotely the RTK-GPS and TS surveying equipments by a bluetooth and wireless internet with PDA, smart-pone and HAM for building a topographic and cadastral feature's database by the steps of the data logging, processing, accessing and building of database through a special text and graphic protocol. By the result of the study, the various devices of the RTK-GPS and TS system are seamlessly communicated with each other and access to the remote server and the clients by the PDA and tablet PC in the real time.

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1. INTRODUCTION

In the past, there needed surveying equipments, terminals and data processing in the office and the surveying procedure was done step by step. However, due to the development of modern information technology industry, various mobile telecommunication equipments has been used in a network surveying and made it possible to be surveyed in real time and receiving and sending data regardless of space. Paying attention to this point, the system is created in this paper that by using the telecommunication technologies surveying results acquired in the field can be shared with each other in real time and be encoded to the objects. It is estimated that mobile network surveying system has contributed to enhancement of the productivity and efficiency of surveying affairs. The characteristics of this study lies in unified management of different surveying results of Total Station and GPS by wireless system such as PDA and table PC. Wireless communication is to be connected between GPS and Total Station and this makes it possible to overcome not only the distance between surveying field and the office by abolishing intricate cables of surveying equipments and terminal but also to operate multi-tasking procedures by several persons at the same time within the one project area.

2. THE SCOPE OF STUDY

In this paper, a number of basic principles and details of wireless communication were introduced and a communication protocol was set to apply for the surveying area, connecting various GPS equipments into wireless system. Also in order to integrate surveying affairs of both fields and offices, these are composed of exclusive server program of surveying, wireless internet, making modules by using communication channels and modules to control surveying equipments such as Total station and GPS. These modules can be applied to each other in terms of hard wares and data could be integrated in the same protocol so that a multi-tasking surveying system was established. The general system of it is as follows. An experiment of communication and control measurement according to each module was done to check the confidence of the modules, systematic management of surveying results and to accomplish real time mapping by coordinate conversion and three dimension vector.

Host module	Client module
Client management Project management Data management GPS Reference setting GPS RTCM management Wireless channel setting	Total Rover control RTK-GPS setting RTCM and NMEA TS observation data Using Field Terminals -PDA(Windows CE, Palm OS) -Tablet PC, Smart Phone

3. CONTENTS OF STUDY

Positioning systems such as GPS, Total station and Digital level are remote controlled wirelessly by surveying equipments with using personal mobile terminal or handy notebook like Tablet-PC. The system is integrated and the surveying results are sent in real time to server by wire so that surveyors may share their data and encode them. For this study, the first step was to attach the dongle type bluetooth to main positioning device and it is controlled from the remote terminal by wireless, making it possible to send and receive data. In case of short distance, the function of bluetooth which is settled in mobile terminal was studied. In case of medium distance, developing a server program in which communications among team workers are done by Packet communication using amateur wireless equipment(HAM) enabling to send and receive both voice and data mutually. And finally it is possible to manage data synthetically between team workers in the field and the office.
The coding method according to the process of wireless data sending was studied so as to set up a system which is possible for easy data acquiring, measuring process, data sending and updating the results of control points. In this paper, basic matters about simple wireless system, components and programming development of it will be introduced.

3.1 Development of Wireless Network Surveying System

Various channels are used in wireless communication and the efficiency and the size of the device and the price will be a decisive matters. In general, electronic wave channel of UHF method is used in surveying because it is portable and consumes less electricity. As receiving and sending data is not so much, 9,600, the speed of communication will be enough to carry on. The wireless methods are bluetooth, packet communication, wireless internet, cellular phone and so on.

3.1.1 Packet Radio

Packet radio is one of the types of data communications, combined with a computer and amateur wireless. Compared to general wire data communication sends data in the computer through a telephone line by modem, it transfers data in computer via TNC through transmitter-receiver. In packet radio, AX.25 of protocol is used in order to investigate errors

perfectly, so 100% accuracy of data sending is possible.

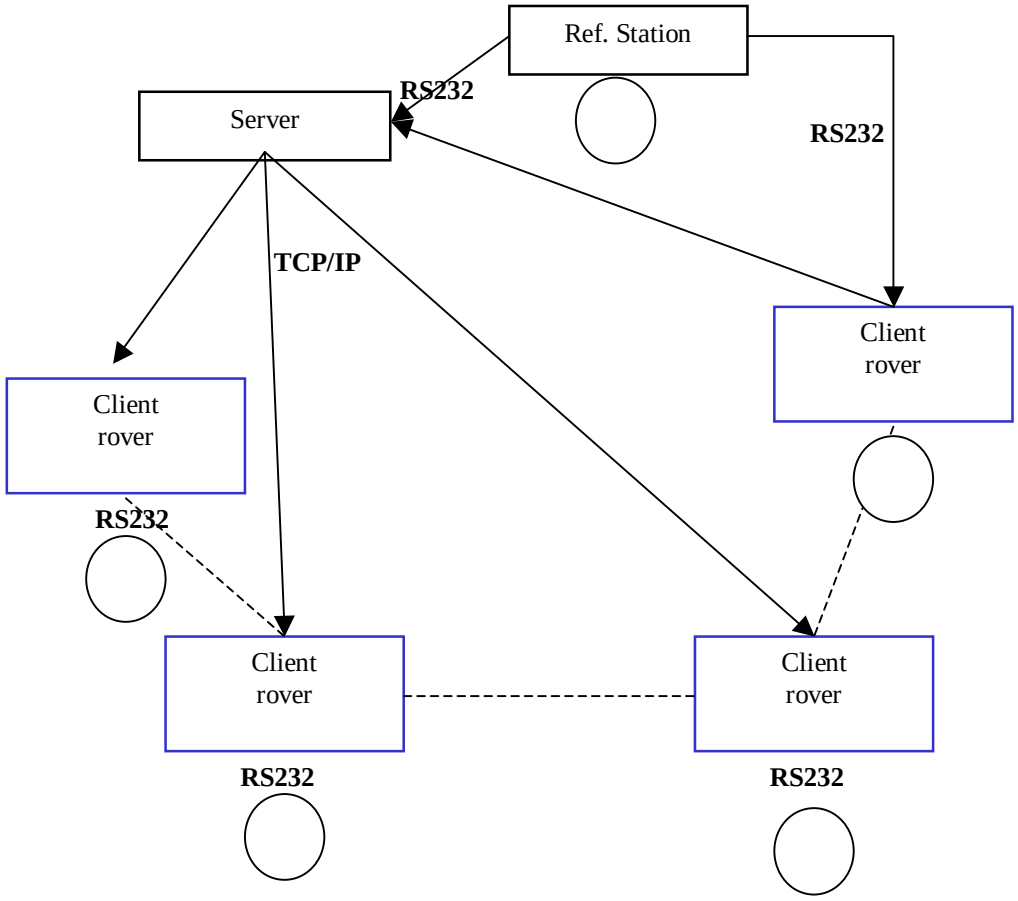


Fig. 3.1 Schema of GPS and TS Network Surveying System

- Also, an error free communication is possible. A number of simultaneous communications in the same frequency are possible. When one packet radio station sends a wave, it is easy to be detected.
- It also can share the frequency with users.
- A number of persons can use it at the same time.
- There is a function of automatic relay. All TNCs have a function of DIGIPEAT which makes it possible to relay other packets.
- It is easy to set up a network.

One of the most beneficiaries of packets is to widen the telecommunication scope enormously by establishing a network. Packets are operated with simple equipments and if network program is used, then wide scope of efficient network will be easily accomplished.

- Man-to-man dialogues by direct communication with colleagues
- Round table communication
- Sending and receiving e-mails by using wireless BBS

- Sending and receiving binary files(using separate protocol)
- Relaying mails world-widely through HF BBS network
- Communicating through HAM OSCAR/sending mails
- Relaying picture information by using NAPLPS code(under pilot stage)

All types of computer resources could be relayed.

3.1.2 Cable Replacement Protocol(RFCOMM) by Bluetooth

As you see RFCOMM is known as cable replacement protocol, it can substitutes serial transmission such as RS-232C connected to the modem and has a bases of ETSI 07.10. It plays a role of controlling RS-232C in upper protocol which needs serial receiving function like OBEX and supporting data signals on baseband. Unlike wireless LAN, a stack of bluetooth protocol defines all the seven levels of OSI. The main protocols used are RFCOMM which can be seen a serial port, PPP, IP, TCP/UDP and so on. There are also TCS BIN protocol for applying for the phone and OBEX used at IrDA in order to transmit large amount of files. L2CAP(Logical Link Control and Adaptation Protocol) is always running for the control of the protocol.

Table 3.1 Bluetooth protocol layers

Protocol Layer	Protocols in the stack
Bluetooth Core Protocols	Basedband, LMP, L2CAP, SDP
Cable Replacement Protocol	RFCOMM
Telephony Control Protocols	TCS Binary, AT-commands
Adopted Protocols	PPP, UDP/TCP/IP, OBEX, WAP, vCard, vCal, IrMC, WAE

Generally,bluetooth connection consists of the following modes.
Standby: devices outside the same Piconet are connected to the standby mode. In this mode, each devices wait for the message at 32 hop frequency every one point twenty eight second(the number of frequency is smaller in Japan, Spain and France).
Page and Inquiry: If one device is connected to another device, page message is sent if perceiving the partner's address, or else there will be seen Inquiry message after page message.

# Bluetooth Setting Select Mode (1:1, 1:N Mode) RS-232 setting(dependent HW) Device Name Device Address Flow control Bounding	# Wireless Internet Cellular phone Smart Phone Card Type : CF Type, PCMCIA Type

Table 3.2 Protocol sample

Commands	Data contents	Sample	Remarks
□Message□	Sending a message string	message	All : all users Host : Server
□Host□	Host name	Office1	
□Person□	Connecting clients	KIM	
□GPSPOS□	Measuring Location of GPS	1234.123,…	
□TOTALOBS□	Surveying results of Total Station	SD,VA,HA	
□TOTALPOS□	Coordinates of position	N,E,H	
□CADPOS□	CAD point of symbol	Tree	
□CADLINE□	Connecting lines	100-101	
□FILENAME□	Creating files	Test.txt	…
…	…	…	
□RTCM□	Broadcasting signal of RTCM		
□FILEDATA□	Storing in the file		
□FILECLOSE□	Remote closing a files		

Control of various GPS equipments

- Control of Total Station

In case of Total Stations, there are slight different models according to equipments and basic order of control will mainly be setting up starting azimuth for treating orientation and measuring order.

- GPS control
- GPS is mainly composed of a static measuring and real time

RTK measuring. A static measuring deals with the filename of the measurement, the height of antenna and fixing a parameter for measuring interval and it is far from real time measuring by wireless communication. In doing real time measuring, there needs to fix coordinates of the main station for RTK-GPS and selecting a hard ware and moving station for the adjustment of RTCM.

3.2 Software Development

To develop the program by wireless communication, PDA or T-PC's role of communication control is used to be in charge of GPS and Total Station and surveying results are acquired by RS-232 or wireless serial communication. The original data acquired by Total Station are composed of angels and distance and in case of GPS they are satellite information, coordinates and accuracy of GPS. While the surveying results by Total Station are vector, those of GPS are geodetic references. So, there should be the integration of different references between GPS and Total Station. Encoding on the features and surveyors' ID have to be created. Measuring equipments on the spot are Windows CE, Palm's mobile system in case of PDA. In order to extend the operation by Window XP, Measuring location, CAD processing, orientation and DB examination are accompanied. The collected by GPS and TS is linked on one surve to manage the CAD function and DB. In this case, the data of control points are stored in the server's database and clients can search in it and use the data. Based on them, new acquired surveying results are inserted in the database by the surveyors in the field, updating the database.

TS Module
Configration setting
Control point management
Control TS
- Orientation
- Network
- CAD
- DB management
- Coordinate transformation
- COGO

RTK-GPS Module

- GPS NMEA
- RTCM
- GRS80-> Grid
- CAD
- COGO
- Network

3.3 Application of RTK

In this study, RTK/DGPS focuses on the connection between the server program development by using a PDA and wireless internet network and service. Creating modules with the help of wireless internet, a mobile phone and smart phone, verification on the qualities of communication when a number of persons are connected to it and real time adjustments happen. In DGPS real time communication, CDMA-1X through cellular phones, communication satellite, AM, FM, VHF and internet network could be used. In internet network, a permanent station becomes a server and moving stations will be clients. If this communication network will be applied, 50 byte/sec by RTCM 2.0 of DGPS and 500 byte/sec by

Fig. 3.2 Net-surveying of PDA

RTCM 2.1 of DGPS could be received(or sent). In this study, on the wireless internet network which is already established, control points are fixed by static measurement and a program for RTCM adjustment is made, allotting TCP/IP ports sending received signals by RS-232.

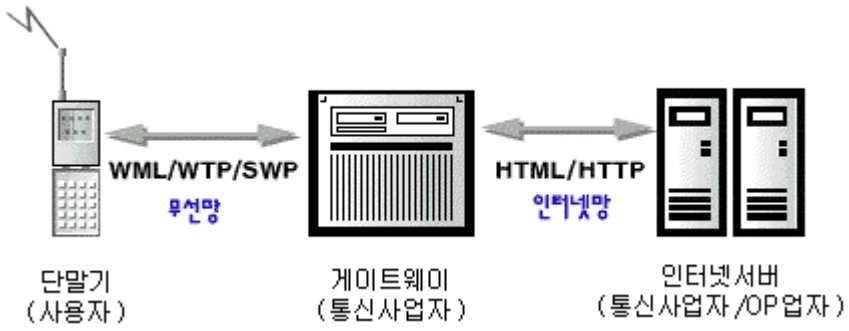
3.4 Wireless Internet and RCTM Real Time Service System

It could be possible that various channels such as Packet communication by RF network, satellite communication like RASANT(Radio Aided Satellite Navigation Technique) are available. In Germany, RTCM 2.0 service are put in operation by utilizing RASANT and the accuracy is within one centimeter with 160Mhz real time service. There is one server in internet and receives RTCM adjustment signals and supply one way service to the several clients. In order to use this service, exclusive transferring modules or hardwares available for connecting internet to do software processing should be used. PDA is suitable for the hardware and the communication packets have to be attached to it for wireless connection. For only RTCM receiving, one way direction service is enough, however in order to achieve VRS or iDGPS, there is needed to be round direction.

3.5 Wireless Internet Service System

Unlike wire internet which is currently used, a wireless internet has to be connected to wireless network. In wireless internet, there exists three internet protocols regarding to used browsers and these are WAP(Wireless Application Protocol), a European style, W3C which is famous for "i-mode" in Japan and ME of Microsoft.

- WAP(Wireless Application Protocol)
It is the standard which is designed for the users to connect the internet easily and provides services, installing the gateway between mobile telecommunication network and internet network.



Client Gateway Internet-Server

Fig.3.3 Basic structure of WAP service

As is shown on the figure 3.3, there is a WAP gateway between them for connecting into the current wire internet network. The communication between the user's terminal and the gateway is done through the protocol defined by WAP, between the gateway and wire internet network, HTTP, an internet communication method is used to communicate. The contents providers have to make their internet sites with WML. Among Korean providers, SK Telecom

offers WAP services based on WML, and Shinsegi Telecom and LG Telecom adopted WAP method from Phone.com based on HDML. These two telecom companies are supposed to adopt WAP method based on WML in the near future. Mutual exchange with HTML and pictures on screen are not offered because they do not use standard internet protocols such as HTTP, and TCP. So gateway is absolutely needed to transfer to HDMl(WML). Microsoft's ME has a browser in the terminal to do the role of WAP gateway. Mutual exchange with HTTP method which is currently used is available and m-HTML, a short form of HTML, could be used.

- W3C(World Wide Web Consortium)
This is an standard organization related in Web languages, which has been active for standardization. It was created in 1994 with the participation of MIT in U.S. and Geio University in Japan. Over three hundred companies and universities in the world take part in it. It provides 'i-MODE' with wireless internet protocols, spreading rapidly in Japan.

3.6 DGPS Correction

The method of GPS measurement is divided into mainly two parts with surveying method and the purpose of navigation. And GPS measurement could be set apart into single measurement and differential measurement. In order to obtain the precise measurements in real time, the principle of GPS measurement is to calculate the distance from the satellite to the GPS by considering the speed of the light and the function of time. The performance of the receiver depends on the calculating correct time and this includes various errors such as interference of ionization wave, multipath, time error of the receiver, orbit error, SA(Selective Availability). In order to do away with these errors, DGPS technology is applied. That is to solve the signal difference acquired between a known location which is fixed and the other relative location. Calculated errors from each satellites will be adjusted with the form of standard of RTCM-SC104. In dealing with the DGPS to enhance the accuracy of GPS, there are several protocols such as RTCM, RTCA, CMR and they have their own characters. DGPS service uses mobile communication channel(800 □ 900 MHz) and is connected by TCP/IP protocol with the form of four unit eight antilogarithm type.

3.7 Procedure of DGPS Surveying

Double differential of RTCM 18, 19 types are needed to operate RTK. It is possible to update every 0.52 second compared to every 10 seconds in case of the code. Adjustment by RTCM SC-104 relays with the forms of packets such as WHF 150□144 and UHF 450□470. Restriction by the distance is that the broadcasting scope widens as the distance between the satellite and the GPS receiver is longer and the radius "k" of the sender affects the error. Though there is no barriers, wave degree of strength will be weaken according to the scope of senders and receivers hinderance. In case of RTK, the cost, size and weight of the equipments, convenience to use, reaching scope, time to initialize, confidence of interpretation and atmosphere will play an important role in DGPS. In order to achieve the accuracy of cm level, it needed to initialize satellite signals.

3.7.1 Establishing a permanent reference station

In order to broadcast RTCM, the results of single and known points against the permanent station could be input directly. It is desirable to use the results connected to national network for the known results as they affect the results of a moving station. Currently, there are types of adjustment signals such as RTCM/RTCA/CMR, users or service agencies should choose one of them. When completed a permanent station, an update rate and original IDs are set up for the broadcasting of adjusted message and then send messages to moving stations. In order to maintain wireless internet connections to RTCM results of the permanent station by a number of users, there should be restrictions of user's connection to it. In other words, original ID and password have to be allowed to users to manage it effectively and automatic or worked connection to the permanent reference station according to the scope of server's location.

3.7.2 Setting rover station

In order to receive the adjusted signals of RTCM from the permanent station, TCP/IP connection of wireless internet should be maintained first of all. Most of wireless internets based on PDA are supplied from telecom companies and there is no need to make a separate program. By using a PDA, it is possible to connect a wireless internet IP. It is all right not to use a fixed ID. Then the moving station is connected to GPS and PDA-RS232C is set up as the same condition of GPS receiver to transmit adjusted signals of permanent station. And checking out whether it is connected to wireless internet and the condition of DGPS over the receiver(1:receiving, 2:DGPS, 4:Fixed, 5:Float, 9:WASS) should be done.

4. EXPERIMENT ANALYSIS

The control of GPS receiver and programming for acquiring data were performed to analyze RTCM adjustments by wireless internet. The control program enabled to recognize the location of the permanent station, to input the results, to operate the host by TCP/IP, and maintain connection to the clients. Clients are restricted to connect it by the user's ID and password and the number of them is within ten persons to use memo. The port of TCP/IP is fixed 600-700. And if the disconnection happens and needs to connect again, another port will be used.

5. CONCLUSION

To sum up the results of the study, it was possible to send and receive the data according to various communications and to integrate modules. As a result of this study, 1) it is possible for a number of persons to survey in real time at the same time against a project area. 2) Securing convenience of the work by wireless communication 3) Solving the data exchange problems of hardware and coordinate data according to the integration of surveying between GPS and Total Station. 4) Shortening working hours to send and receive remote data 5)Enhancement of working circumstances. These are the advantages from the study. This contributed to making modules to control various surveying equipments and enhancement of convenience and productivity of working by application of wireless internet and bluetooth. It

is expected that the progress of surveying industry could be achieved by applying these systems to surveying, making it possible to work conveniently and stably.

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BIOGRAPHICAL NOTES

1978-1982, Student of Jeon-Buk National University(Geodetic Eng.)
1985-1986, Student of ENSG,NGI in France(Cartography)
1986-1996, Engineer of Korea Cadastral Surveying Corps.
1996-1997, Application Engineer of Leica Korea
1997-2002, Doctor degree of Kyung-gi University(Geometics)
2002-2003, General manager of Korea Cadastral Surveying Corps.

CONTACTS

Tcha Dek-Kie
General manager of corporate strategy division of
Korea Cadastral Surveying Corporation
#45,Yoido-dong, Youngdeungpo-Ku
Seoul
REPUBLIC OF KOREA
Tel. + 82 2 3774 1180
Fax + 82 2 3774 1179
E-mail: tcha@kcsc.co.kr