Development of Internet Based GPS Data Processing Service

*Sang-Ho Kim, Kwan-Dong Park, Hye-In Kim

College of Forest Science, Kookmin Univ. (E-mail: gnss@kookmin.ac.kr)

Abstract

As GPS equipments improve, one can acquire GPS data easily in the field. However, to obtain precise and accurate coordinates, post processing is additionally required and the processing needs high degree of skills. Besides, it is very common that we can't operate processing software in the field because required system environment is usually not prepared. The aim of this study is the development of internet-based GPS data processing service. For post processing, we use GIPSY developed by JPL. It has many advantages such as precise point positioning, which enables a rapid determination of receiver positions. The developed service in this study proceeds as following orders by interlocking GIPSY and internet service on a Linux platform: Users upload raw data files on the internet, then GIPSY runs automatically and then the user get the result in the field. We use an Apache Web Server as a hosting program and PHP is used in coding web pages.

Keywords: GPS, GIPSY, Data processing, PHP, Apache

1. Introduction

GPS has been a significant technique in surveying, geodesy and other applications such as ITS (Intelligent Transportation System), LBS (Location Based Service), crustal deformation study and weather forecast. Required positioning accuracy varies depending on the specific application of the user. Especially, scientific studies and precise surveys require highly accurate coordinates. Sometimes, to obtain high-accuracy positions, post processing is additionally required. Bernese, GIPSY-OASIS II (GIPSY) and GAMIT are well known as high-accuracy post processing software. The high-accuracy post processing software is difficult to use because its execution needs high degree of skills and, sometime, UNIX platforms with high speed CPU.

As an alternative way, Automatic GIPSY (AG) service was developed by Jet Propulsion Laboratory (JPL). One can use the AG service via E-mail and FTP (Zumberge, 1999). Its homepage is http://milhouse.jpl.nasa.gov/ag/. Figure 1 shows the status of the worldwide AG usage since October, 1998. After the user uploads a RINEX file to the AG server through E-mail, a reply will be sent back to the user shortly. The solution report will be saved at a FTP site specified in the return E-mail.

Because AG is based on the precise point positioning (PPP) technique, the user does not need to consider a surveying network or bother to set up a base receiver. Therefore, it is very efficient in surveying applications compared to the past surveying solutions (Lee, 1999). But you cannot obtain the solution immediately through FTP and E-mail, thus it is difficult to use in real-time in the field.

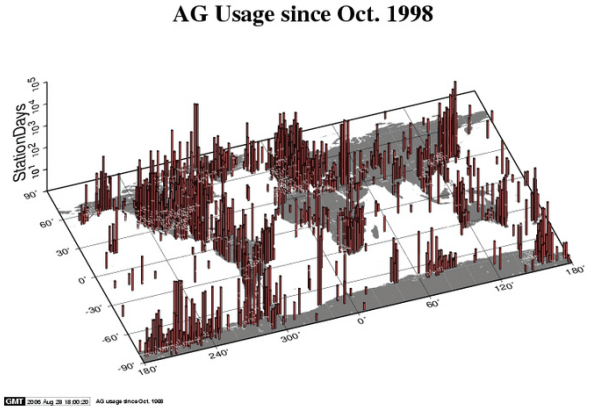

Figure 1. AG usage since October. 1998

OPUS (Online Positioning User Service), serviced by National Geodetic Survey (NGS), is another kind of online GPS data processing service. One can use it at the NGS Homepage http://www.ngs.noaa.gov/OPUS. When the user uploads GPS data on the OPUS homepage, the data will be transmitted to the NGS processing server. Then, the server computes the position using PAGE5 and International GNSS Service (IGS) ephemeris. Finally it sends the solution to the user's E-mail (See Figure 2).

AG and OPUS have an advantage that one can obtain a solution without any GPS data processing software. But in the case of AG, FTP connection is necessary. Both services have a disadvantage that time delays are unavoidable because it takes some time for E-mail exchanges. In the case of OPUS, the service area is restricted, and Asia is not included in the service area as of August, 2006.

Figure 2. OPUS main page

2. Background

The purpose of this study is the development of an online GPS data processing service based on GIPSY and HTML. GIPSY is high-accuracy GPS data processing software developed by JPL. The best advantage of GIPSY is that it is capable of PPP solutions. In the PPP procedures, one estimates site-specific parameters only and, therefore, saves a tremendous time in data processing.

PPP requires GPS satellite orbits, which can be categorized into four kinds: Precise, rapid, ultra-rapid, and broadcast. Out of these four, ultra-rapid orbits are provided four times a day and it contains predicted ephemerides, so real-time or near-real-time applications are possible (Park et al, 2003). By using GIPSY and ultra-rapid orbits, the user can compute the position very accurately and quickly.

To use GIPSY software is executed in Redhat Linux OS (Operating System). Also it requires server type platform because of preventing overload by high possession rate of CPU and memory. Moreover, internet network to get ephemerides from IGS are essentially required. However, in the field the user cannot prepare these environments easily. Also, because most people do not have skills to use UNIX, GIPSY would be difficult to use.

As an alternative, we developed an online GPS data processing service as following orders: The user uploads raw data through the processing server through the web, then data is automatically processed by GIPSY, then the solution displays on the user's screen. In this way, the user obtains his/her solution in real-time in the field. Centimeter-level positioning accuracy can be obtained without a base station. Especially, interlocking multi user environment of Linux, Apache's multi session and PHP can process many inputs from multi users simultaneously. If a user equips a system which contains web browser that is compatible with HTML 4.01, it is possible to access this service in the field.

3. Service Development

3.1. The Developer's Environment

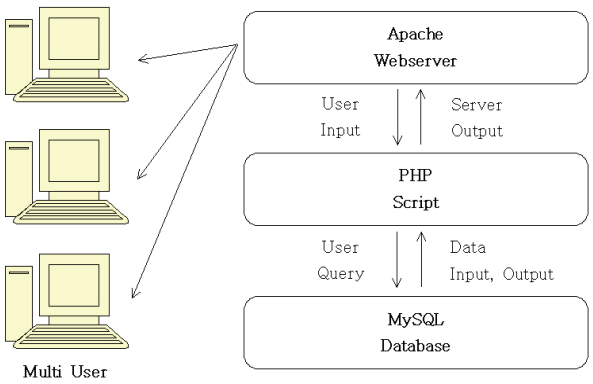

Figure 3. The concept of APM

This service is based on an APM system. APM is an abbreviation of Apache, PHP and MySQL. APM is an interlocked system (see Figure 3).

Apache is a web server solution that possess up to 50% of world market. It can be used on both Linux and Windows platforms. It has lots of advantages; high processing speed, many functions and high security as good as IIS (Internet Information Server) based on Windows. Also it has another advantage that user can get its source code free. When Apache setting completes on server, Apache daemon works continually. So, it can be a hosting server for less than the maximum of 100 clients. At last, the user can approach shared files or web pages in Apache's home directory through server's IP (Internet Protocol) or DNS (Domain Name System) address.

PHP is an abbreviation of Professional HTML Preprocessor. It is a programmable script language which can be interlocked with HTML. Because parsing of PHP code is processed in the server and only computations are forwarded to user, it has the following advantages: The user doesn't need to have the parser, so it is easy to improve execution speed and security. Also maintenance can be done simply by correcting codes without re-compiling.

Especially, as the number of user sessions is increased, a program based on Perl or CGI requires much resource, so system would be overloaded easily. But, PHP is executed a part of web server process, so it requires less resource and can be executed speedy (Thomas et al, 2002).

MySQL is one of relational databases. It is a freeware and has no disadvantages compared with commercial programs. Also, it can be operated stably on a Linux platform interlocked with Apache and PHP. So, it is easy to construct GPS databases in the server.

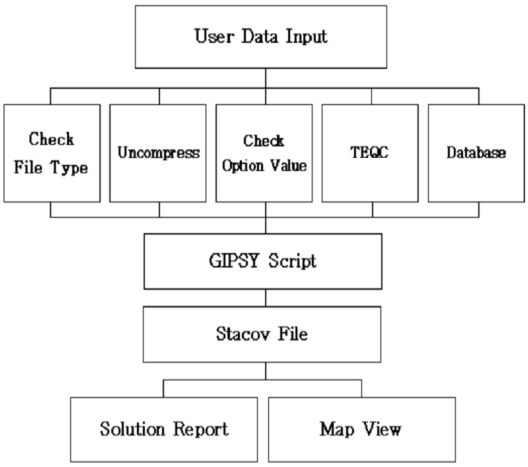

Figure 4. Flow chart of service

This service is processed as depicted in Figure 4. First, when the user uploads the data, PHP scripts run automatically, and TEQC and GIPSY do the required data quality-checking and processing. GIPSY is not a single-command-driven program. It is composed of many scripts like C-shell and Perl. To run the whole process in one simple step, an auto execution script is required. In this study, a script written in C-shell is used and the procedure includes getting satellite orbits and clock solutions from IGS or JPL by FTP. The user can choose an elevation cutoff angle. When it is not possible to get precise ephemerides, the system gets rapid or ultra ephemerides. So, the user can obtain a solution by providing observation files only.

The input data should be in a RINEX format, whose latest version is 2.10. In case when the user provides the data in an earlier RINEX format, the service added a data-conversion process using TEQC. TEQC developed by UNAVCO is a freeware and includes the following functions: translation, editing and quality-checking (Estey et al, 1999). Among these three functions, an editing function was added to the service.

3.2. The User's Environment

Figure 5 is the main page of service. There are two input forms. The first is for uploading and the other is for choosing an elevation cutoff angle. The maximum uploading size is controlled by the Apache server. In this study, the size is limited to 32 Mb. Generally, the size of the data from a dual frequency receiver with 30 second sampling is 2-3 Mb. If the user submits without a data file, a warning message displays and the page goes back to the main page. An elevation cutoff angle value is optional and the default value is 10°. An observation file with an .YYo extension, or its compressed files with .zip, .gz and .Z extensions are allowed. The file naming convention should follow the classical 8.3 RINEX standard: SSSSDDDF.YYT (SSSS: Site ID, DDD: Day of Year, F: File Sequence Number, YY: Year, T: File Type).

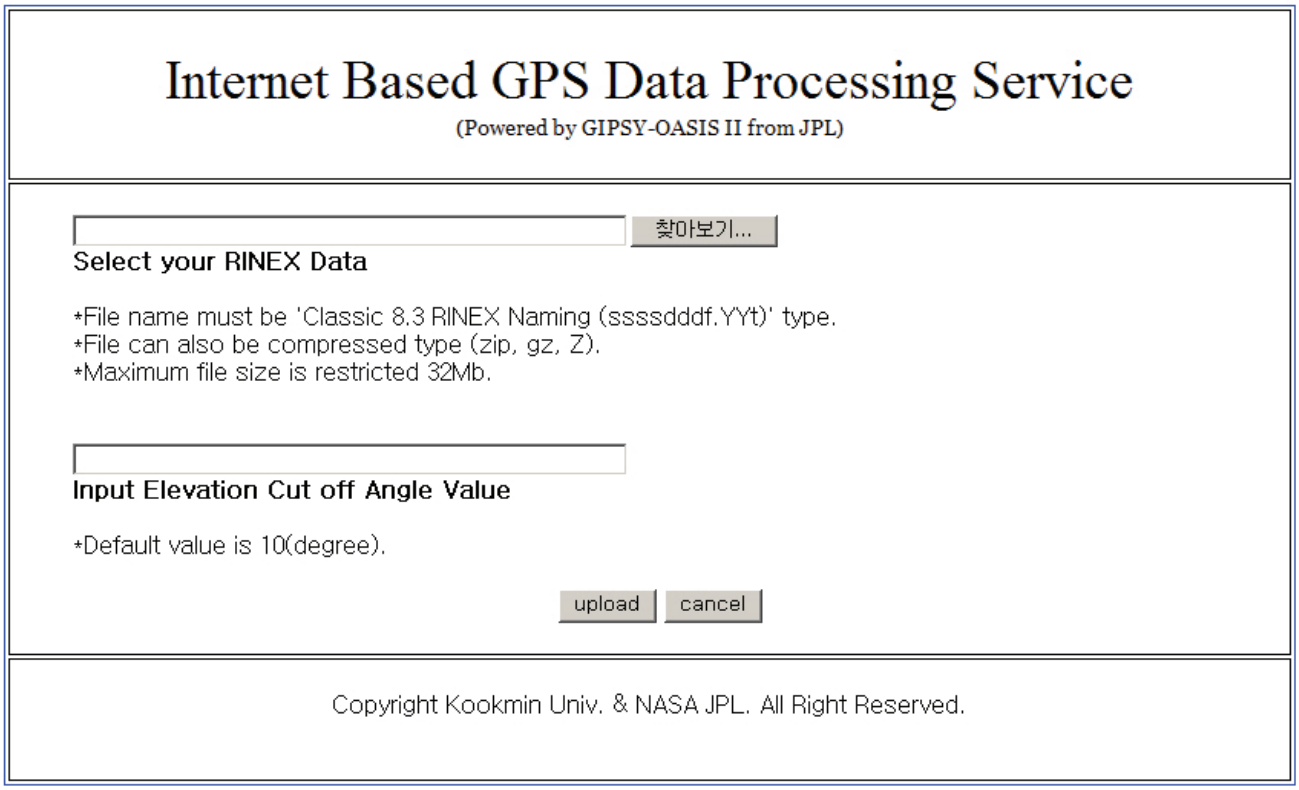

Figure 5. Main page of service

Solution Report

FILE:icnw3100.05o DATE:2006-09-02

ITRF00		
X	Y	Z
-0.302210742167327	0.407043666850111	0.385735704093763
LLH(DEG)		
Longitude:	Latitude:	Height(MSL):
126.592145975	37.4519990979	34.2960396791
LLH(DMS)		
Longitude:	Latitude:	Height(MSL):
126` 35' 31.7255097612"	37` 27' 7.19675260164"	34.2960396791

Elapsed Time: 48sec map_view

Figure 6. Solution report page

When you are done with file uploading, a "*Now Processing*" message displays on the screen. In the server, PHP and GIPSY scripts start their execution at the same time. The data goes into MySQL database and gets copied to a temporary directory. Then, another script checks if it is possible to process the data or not. After that, it checks out the data format and prepares the data for processing. After uncompressing the file in case it is in a compressed format, TEQC checks and edits the header information. Finally, GIPSY scripts run, and they process data automatically. It takes about 30 seconds to process 24-hour data on the Linux server with an Intel Xeon CPU. But if many users request the same service at the same time, it can take more time.

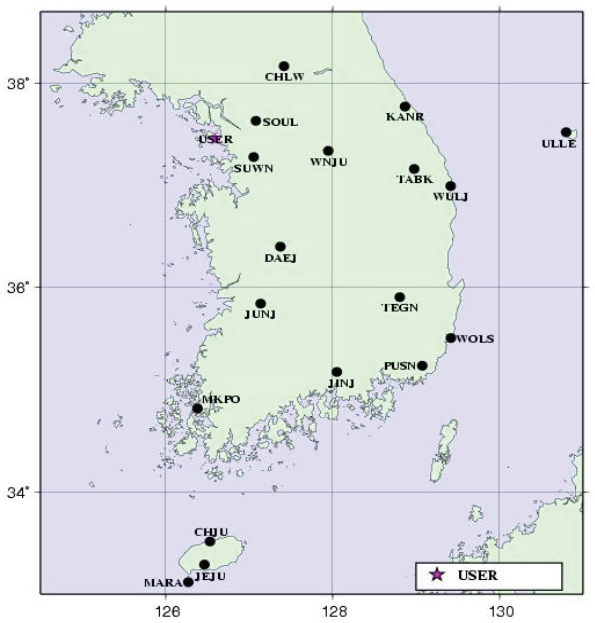

Figure 7. Map screen with user's location

When the processing is completed, the user's screen is reloaded, and the solution report (see Figure 6) displays. The GIPSY output file is in an ASCII type (*.stacov extension), and it contains X, Y and Z coordinates. These parameters are converted to latitude, longitude and MSL (Mean Sea Level) through a converting algorithm. Also, the coordinates are displayed in DEG (Decimal Degree) and DMS (Degree-Minute-Second). There is a button in the bottom of the page to display a map showing the user location. The map (see Figure 7.) is a JPEG (Joint Photographic coding experts group) format file generated by GMT (Generic Mapping Tools, http://gmt.soest.hawaii.edu/). The map displays several permanent stations along with the user's location.

4. Conclusion

The following results are about the development of internet based GPS data processing service.

1. GPS data processing by this service computes cm level precise solution in short time without setting base station and surveying network. The solution can be obtained in a variety of formats. A location map is also displayed on the user's screen.

2. Web interface with APM (Apache, PHP and MySQL) enables that a user, who has only HTML compatible web browser and internet connection, can get coordinate solution in real-time.

3. Maximum of 100 sessions can be established at the same time with the Apache server. PHP makes the system maintenance easily, because it doesn't require compiling.

This study can be applied to the case where the users who do not have GPS data processing capability and need prompt processing in the field as well.

This service will be improved to apply phase center variation, ocean tide loading model and variable antenna options. Additional solution will also be supported for meteorological modeling.

Acknowledgement

This work was funded by the Korea Meteorological Administration Research and Development Program under Grant CATER-2006-3105.

Reference

1. Y. C. Lee, "The Coordinates Computation of the GPS Base Station by Precise Point Positioning" *Journal of the Korean Society of Surveying, Geodesy, Photogrammetry and Cartography,* Vo. 17, No. 2, 1999, pp. 145-152.
2. H. C. Yun, B. G. Choi and Y. W. Lee, "A Study on the Internet GPS Data Processing System" *Journal of the Korean Society of Surveying, Geodesy, Photogrammetry and Cartography,* Vo. 22, No. 2, 2004, pp. 145-150.
3. K. D. Park, J. H. Joh, J. H. Ha and H. C. Lim, "Rapid and Accurate GPS Data Processing with Ultra-rapid Orbits" *Journal of the Korean Society of Surveying, Geodesy, Photogrammetry and Cartography,* Vo. 21, No. 4, 2003, pp. 309-316.
4. Zumberge, J. F. "Automated GPS Data Analysis Service" *GPS Solutions*, Vo. 2, No. 3, 1999, pp. 76-78.
5. Estey, L. H and Meertens, C. M., "TEQC: The Multi-Purpose Toolkit for GPS/GLONASS Data" *GPS Solution*, Vo. 1, No. 1, 1999, pp. 42-49.
6. D. Thomas, W. Choi, J. Coggeshall, K. Egervari, M. Geisler, Z. Greant, A. Hill, C. Hubbard, J. Moore, D. O'Dell, J. Parise, H. Rawat, T. Sani, C. Scollo, "Professional PHP4 Programming", *Wrox*, 2002.