Automated GPS Data Analysis Service

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Summary

Automatic analysis of geodetic-quality GPS data is available using e-mail and ftp (file transfer program) as an interface to a computer at the Jet Propulsion Laboratory (JPL), where precise transmitter parameters -- GPS ephemerides and clock errors -- are computed regularly. The interface is such that e-mail from an external user causes the JPL computer to fetch the user's data. The computer then analyzes the data, and places the results in an area accessible to the user. An e-mail to the user informs him of the location of the analysis results, which the user can subsequently fetch. Operations on the JPL computer are entirely automatic, and require essentially no labor.

Introduction

A method for precision analysis of Global Positioning System (GPS) data is described in Zumberge et al. [1]. Called precise point positioning (ppp), the method relies on precise estimates of GPS transmitter parameters -- satellite positions and clock corrections -- which are produced routinely by JPL and other organizations that participate in the International GPS Service (IGS, e.g., [2]).

Precision analysis of GPS data measured by a receiver at an arbitrary location is possible, and performed regularly, using these transmitter parameters and JPL's Gipsy/Oasis-II (GOA-II) software. A number of researchers have installed Gipsy on their own computers. Such users can download the precise transmitter parameters -- available publicly from JPL through anonymous ftp -- and perform the analysis on their own computer. The labor burden to these users involves their learning the GOA-II software, maintaining it, retrieving transmitter parameters from JPL, and running GOA-II ppp software.

An alternative means to the same end is Auto Gipsy (ag), an e-mail/ftp interface to a JPL computer that allows a user to submit GPS data for analysis, and receive results within minutes. The main advantage to the user is that he need not spend time learning, installing, and maintaining complex GPS analysis software.

Submitting data

Having acquired GPS data with dual-frequency measurements of pseudorange and phase, you should make sure that they are expressed in the RINEX format; the file name should conform to the RINEX standard. (See ftp://igscb.jpl.nasa.gov/igscb/data/format/rinex2.txt for details.) For ag you can optionally compress your file with either Unix compress or gnuzip. The file must be placed in an area accessible by anonymous ftp.

Your data should have at least an hour's worth of measurements, preferably more. The name of the file is used by ag to indicate the day of data -- GPS day -- that are in it. As an example, wxyz1900.98o.gz would identify data from site WXYZ on day 190 (July 9) of year 1998. The transmitter parameters for ag on that day extend from July 8 21:00 to July 10 03:00, that is, within 15 hr of GPS noon. If all your data

do not fall within such a window, you should make up separate files, one for each day.

The recommended measurement frequency for efficient data editing is every 30 sec. In ag's parameter estimation phase, data every 5 minutes will be used. Although the system may be enhanced at some point to allow data from receivers in motion (see below), the current system assumes the data are from a fixed receiver.

With one exception, ag ignores information from the header of the Rinex file. The exception is the entry with the set of nominal coordinates. To obtain estimates with 1-mm precision, your nominals should be accurate to about 100 m. As far as antenna heights, ag's estimates refer to the antenna phase center, without regard to what may or may not be in the header of the Rinex file. If you want the coordinates of a nearby monument, you should do the associated vector arithmetic on your own.

The next step is to send e-mail to ag@cobra.jpl.nasa.gov. Your subject should be "Static", and the body of the e-mail should contain the URL of your Rinex file. An example that can be used to test your use of the service is ftp://sideshow.jpl.nasa.gov/pub/ag/toul1800.97o.gz.

Results

The system automatically detects most abnormal conditions. For example, if your subject isn't "Static", or if there are problems with the ftp fetch of your data, you'll get an e-mail reply to that effect. Note that the system does not buffer requests (another planned enhancement), so if it is currently busy you'll be asked to try again later.

Under most circumstances you can expect a reply within ten minutes, indicating the URL from which your results can be retrieved. You'll get a README file with detailed explanation of all results. These include receiver coordinates, receiver clock estimates, phase bias parameters, zenith troposphere delay, and post-fit phase and pseudorange residuals. Only data above 15-degree elevation are used.

Transmitter Parameters

Precise GPS satellite orbits and clocks, in the format required by current ppp GOA-II software and used by ag, exist from July 1995 to within about two weeks of the present. These are the products of JPL's Flinn analysis, and are one component of our contribution to the IGS. Using these orbits and clocks, you could expect daily repeatabilities of a few mm in horizontal components and about a cm in the vertical for daily data from a stationary site with a geodetic-quality receiver.

Possible Enhancements

Several enhancements to the system have been considered since it went into operation about a year ago. To avoid the two-week wait for the Flinn transmitter parameters, it is possible that JPL's rapid service products could be used when the user's data are less than two weeks old. In this case, data as new as one or two days could be analyzed with only slightly less accurate results. A second enhancement would allow kinematic analysis of GPS data, from moving vehicles, for example. In

this case, data rates more frequent than once every 30 seconds could be analyzed, and the high-rate clock solutions produced at JPL [3] would be used. Finally, the benefits of phase ambiguity resolution could be realized when analyzing data from a local network of GPS receivers. All of these enhancements are feasible and depend only on sufficient resources for their implementation.

Limitations

The ag system was developed to serve science investigators in NASA's Solid Earth Natural Hazards program. There is currently no charge for the service, although this policy may evolve. Of course, we cannot guarantee or provide any sort of warranty for results produced by ag. Caveat emptor!

Acknowledgement

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References

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Biography

James F. Zumberge has been at the Jet Propulsion Laboratory since 1990. As a member of the Satellite Geodesy and Geodynamics Systems group, Dr. Zumberge contributed to JPL's participation as an IGS Analysis Center, and also served as a member of the IGS Central Bureau. His interests include efficient analysis of GPS data and, more recently, time transfer applications of GPS. He was recently appointed Program Element Manager for NASA's global GPS network.

Dr. Zumberge earned his Ph.D. in physics from the California Institute of Technology in 1981. Prior to joining JPL, he worked on industrial applications of nuclear physics at MDH Industries in Monrovia, CA.