Research of opportunities of absolute positioning PPP technologies when dealing with the change of city boundar

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The article focuses on researching the accuracy of the method of absolute positioning PPP (Precise Point Positioning). Application results of the method are described.

Key words – GPS, GNSS, SOPAC, International GNSS Service - IGS, coordinates, USK-2000

I. Introduction

In recent years, while doing geodetic works satellite technologies ensuring centimetre accuracy in positioning of points have become very popular. This level of accuracy can be achieved by using the method of relative satellite positioning. However, this method has some defect. In order to use it you need a set of equipment consisting of at least two single / dual-frequency receivers, one of which is the base station which requires a long process of coupling otherwise it is necessary to work from a network of permanent stations at large distances to them, which constitutes a significant problem for single-frequency receivers.

Under these conditions, precise point positioning method PPP is an alternative. An important feature of the PPP method is that it does not require a base station, and is in fact a kind of absolute GNSS positioning method, thus in order to use it only one receiver is sufficient. To compensate for major errors occuring during the absolute phase GNSS measurements, this method uses exact values of ephemeris and satellite clock corrections, as well as information about the satellite signal delay in the ionosphere and troposphere etc.

II. Basic principles of the precise point positioning method

Nowadays, there are several conditions to be taken into consideration in order to obtain accurate results while processing the data using the PPP:

- A session of absolute satellite observations at a point whose coordinates are to be determined, ought to be not less than 1 hour;
- Data processing of satellite observations using PPP is only for phase measurements, and requires accurate files or fast satellite ephemeris and satellite clock corrections as well as simulated atmospheric corrections of satellite signal.

Such information in the form of separate files is created in international service centers of GNSS observations data processing (GPS and GLONASS) and is provided via specialized Internet resources.

One of them is SOPAC (Scripps Orbit and Permanent Array Centre) - a major international centre for gathering and processing Global Navigation Satellite Systems data. Similar information is provided by the International Service Center GNSS (International GNSS Service - IGS). However, due to a large scope of information received and processed by these centers (more than a thousand permanent reference stations), there is difficulty in obtaining information files on time and in ensuring its precision.

III. The technology of observation, processing and analysis of results

The experiments have been conducted in the city of Putyvl, Sumy region. For our research item landmarks fixed as as second level points of traverse. The total of 3 points has been selected.

In 2009, there was a range of activities carried out aimed to change the boundaries of Putyvl. In general, the coordinates of 101 point landmarks were determined (Fig. 1). The coupling was carried out with the help of GNSS receivers using a static set of single frequency GNSS receivers TRIMBLE R3, and all subsequent angular and linear measurements were carried out by means of tachometry, using tachometer Pentax V227 N.

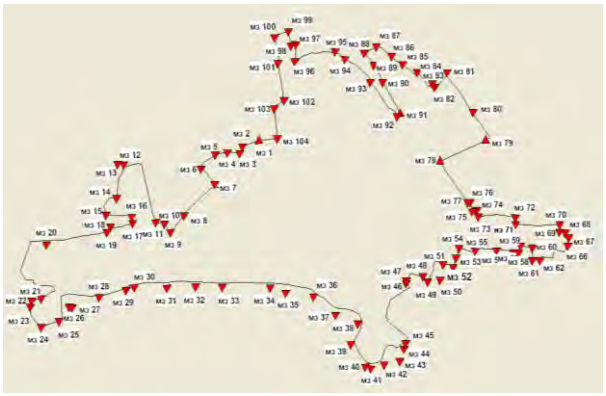

Fig. 1. The scheme of location of boundary points of Putivl

Since in Sumy region there is no permanent or active reference station, the user has to work with a set of GNSS receivers, one of which serves as the base, and another – as a mobile receiver. Working with a set of single frequency receivers, users spend much more time organizing and conducting observations themselves. Actually, this may be alternatively substituted by the PPP. This method, as it has been stated, does not require an additional base station, and works as an independent receiver in static mode.

The aim of our further research was GNSS observations at landmarks by means of PPP, as well as processing, analysing and comparing the obtained data with known coordinates with the help of a dual-frequency GNSS receiver.

Satellite observations were conducted with a dual-frequency receiver Trimble 5800 L1/L2. Experimental GNSS observations were carried out in November 2012 at three previously-selected points. Observation sessions lasted 1 hour each in static mode. At a distance of about 80 km from the area of work there was the base station located (Figure 2.). Precise coordinates of the base station were determined on account of three files of daily observations and were calculated in the software package Trimble Total Control in relation to the nearest permanent station POLV (Poltava).

Fig. 2. The scheme of location of the base station POLV

Thereafter we calculated the coordinates of the selected three points in relation to the base station, taking into account the precise satellite ephemerides. The location of GNSS observation points is shown in Fig. 3.

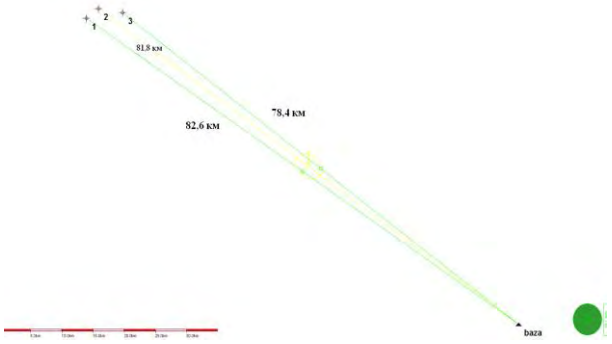

Fig. 3. The scheme of location of GNSS observation points

Precise coordinates of points were calculated by software packages Trimble Total Control and Trimble RTX-PP. The accuracy of the obtained results produced by the software applied was subsequently compared with the data provided by GNSS observations. Differences between the coordinates are shown in Table 4.

TABLE. 1

The accuracy of the coordinates of points GNSS observations

The name of the observation point	Differences coordinates					
	Trimble Total Control			Trimble RTX-PP		
	ΔX	ΔY	ΔZ	ΔX	ΔY	ΔZ
1	0,041	0,034	0,052	0,026	-0,094	0,083
2	0,022	0,048	0,039	0,040	0,015	-0,093
3	0,013	0,029	0,04	0,023	-0,003	0,043
baza	0,037	0,018	0,041	0,009	-0,016	-0,080

Thus, by comparing the values of coordinates it can be concluded that PPP method can be used for geodesy tasks in particular in such type of work as the border separation of settlements.

Conclusion

The research of the positioning by means of the PPP method conducted in the city of Putyvl in Sumy region has testified to the high accuracy (1-9 cm) of this method without an additional base station.

Thus, Precise Point Positioning method can serve as an alternative to determine the coordinates of points by means of dual-frequency receivers without installing an additional base station or in an area where there is no active reference station which could provide corrections in real time.

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