base station; rover receiver; antenna;
pseudorange; local correction; data link

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DEVELOPMENT AND RESEARCH OF DIFFERENTIAL MODE GNSS MODEL FOR INTELLIGENT TRANSPORT FUNCTIONING PROVIDING

Summary. Description of the modeling system of differential GNSS mode for the operation ITS is considered. Differential method of navigation allows to precise determination of the coordinates and is not very complicated for technical realization. The coordinates of the consumer are calculated with high accuracy because the base station and the user are located in a short distance from each other. Determination of the origin location is on the same satellite and method of local correction is implemented.

МОДЕЛИРОВАНИЕ И ИССЛЕДОВАНИЕ МОДЕЛИ ДИФФЕРЕНЦИАЛЬНОГО РЕЖИМА РАБОТЫ GNSS ДЛЯ ОБЕСПЕЧЕНИЯ ФУНКЦИОНИРОВАНИЯ ИНТЕЛЛЕКТУАЛЬНЫХ ТРАНСПОРТНЫХ СИСТЕМ

Аннотация. Рассматривается описание проведенного моделирования системы дифференциального режима работы GNSS для обеспечения функционирования ITS. Метод дифференциальной навигации обеспечивает точное определение координат и имеет не очень сложную техническую реализацию. В работе координаты потребителя вычислены с высокой точностью, что обеспечено относительно близким размещением навигационных приборов. Определение координат местоположения производится по одним и тем же спутникам с использованием метода локальной коррекции.

1. INTRODUCTION

It is necessary to regulate traffic flow due to the growing congestion of highways, increasing the intensity of road transport in modern cities. It is also a very acute issue of road safety. Therefore there is a need to create an intellectual transport system.

The accuracy of determining coordinates of the consumer, which provide GPS and GLONASS, is about 10 meters, however, for intellectual transport systems such accuracy is not sufficient. For example, to identify a drunk driver it is necessary to monitor the trajectory with an accuracy of a few tens of centimeters. Such precision can provide a differential GNSS mode.

In this work the model of DGPS is realized. As the equipment for the implementation of this mode selected GNSS receivers NovAtel M6XV1G, antenna for receiving GNSS signals, a personal computer. Configuration receivers (both basic and rover) performed in the mode of the interface program CDU. The data link between the receivers is provided via Wi-Fi.

2. GENERAL DESCRIPTION OF PROBLEMS AND METHODS OF THEIR SOLVING

The base station is the GNSS receiver which is acting as the stationary reference. It has a known position and transmits correction messages to the rover station. The rover station is the GNSS receiver which does not know its exact position and can accept correction messages from a base station to calculate differential GNSS positions. It is a data link between the base station and rover station (two receivers) in order to receive corrections.

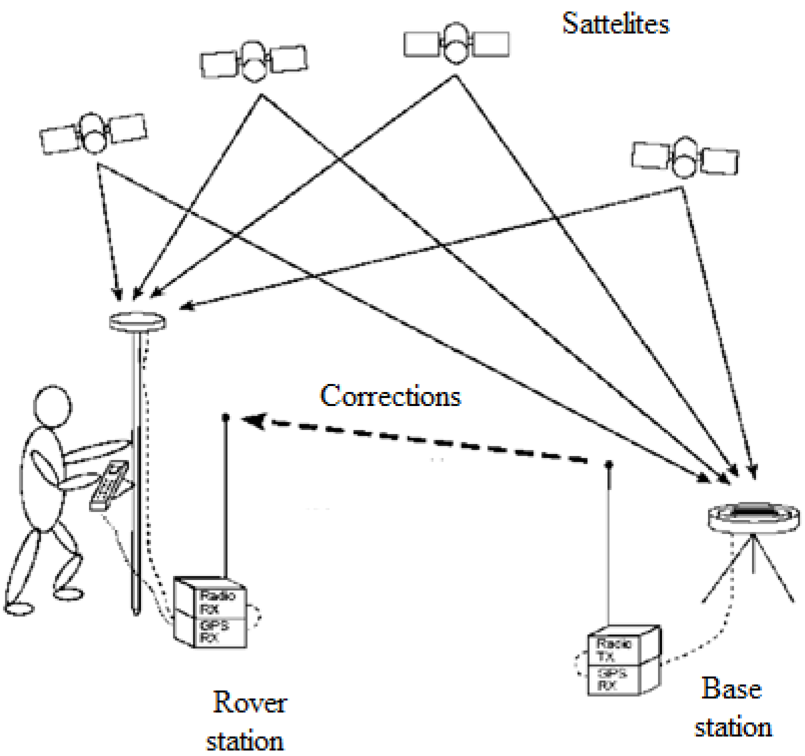

Fig. 1. The essence of differential methods of satellite navigation
Рис. 1. Пояснение сути реализации дифференциальных методов спутниковой навигации

There are many methods of differential navigation, however, in the most general terms they can be classified as follows:

- the differential correction method of navigation parameters;
- method of the wide differential navigation [1,6].

3. AIMS, TASKS, STRUCTURE AND SELECTING WAYS OF PROBLEM SOLUTION

The aim of this work is to create a model of differential mode of GNSS. The main task is to improve the accuracy of coordinate determination of the object. Having considered the various ways to create control station it will form structure of the final model of DGPS and develop the block diagram.

The structure of the system is defined by its functions and includes:

- Antenna GNSS to provide reception, selection and amplification of signals from navigation satellites;
- Basic and rover navigation receivers for the primary and secondary processing of navigation options;
- Data link between the base and rover receivers to provide the transfer of the corrections;

- Computer (block data processing) to perform the processing of measurements and their output to the monitor.

Concept of differential mode according to the diagram shown in Fig. 2 has the following principal features.

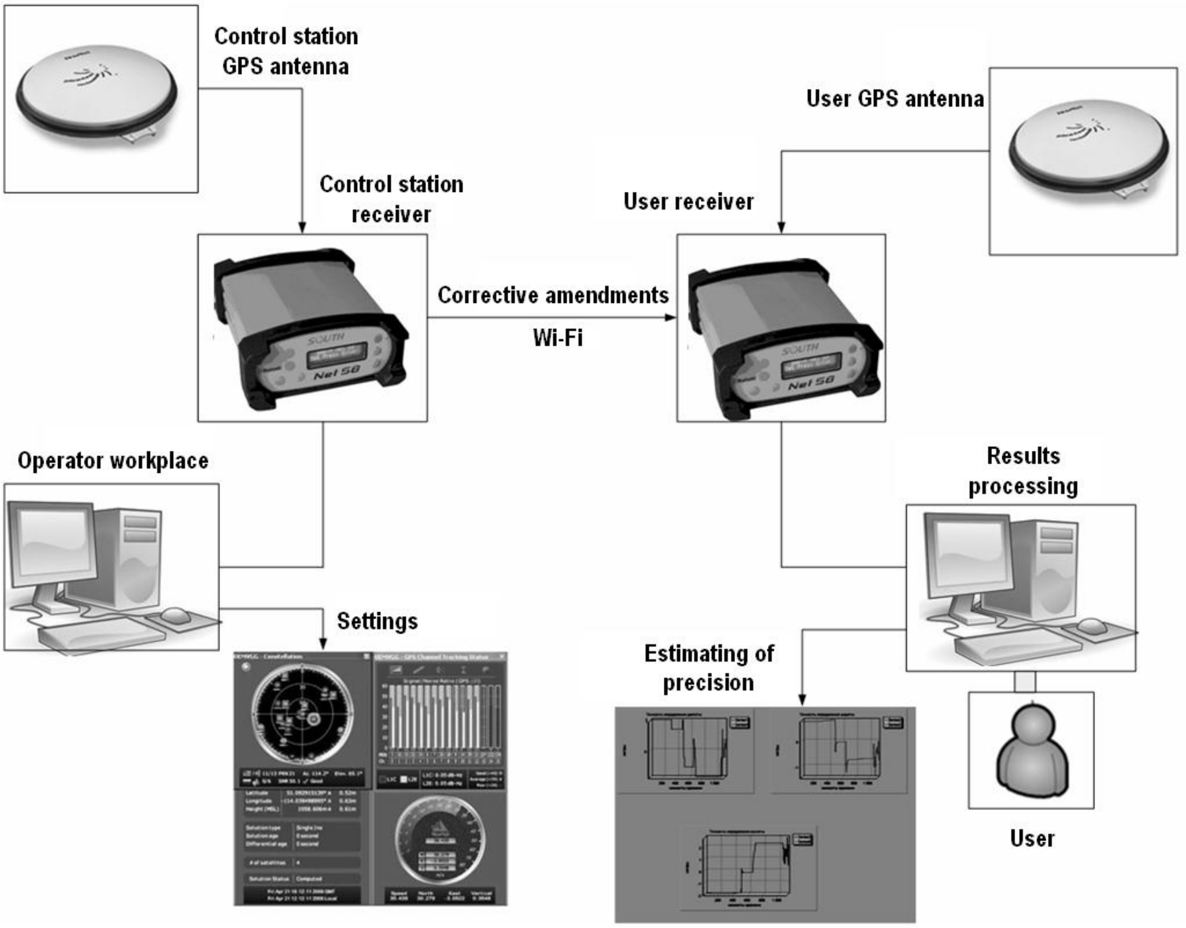

Fig. 2. Diagram of realization of model DGPS
Рис. 2. Схема реализации модели DGPS

The main component of the system is the base station, which is a GPS-receiver, which provides solution of the problem of development and formation of correction information. Rover receiver takes into account these corrections to determine its location. Software unit solves the tasks on development and the provision of standard protocols, and also gives information about the changes of coordinates user for a set time.

3.1. Selecting the means of implementation: GPS-receivers, software

To perform the functions of the base station and the consumer receivers shall meet the following requirements:

- The receiver must receive and process the signals of elements GNSS, with whom he interacts, namely GRS satellite signals, the signals via GNSS antenna-feeder device;
- Receiver must have 19-23 channels for simultaneous measurement;
- The receiver must provide continuous support for at least four satellites, and navigation solution based on the measurement and processing of their signals;

- receiver GPS must compensate for dynamic doppler shift measurements of the C/A code and the phase of the carrier nominal SPS signal doppler shift, which is unique at the time of application;
- GPS receiver to the solution of any navigational task is to certify the correct of ephemeris and time, and continuously monitors the value of identifier parameter set time (IODC), set identifier of ephemeris (IODE)[6], update the ephemeris and time parameters at detecting changes in the values of one or both of these parameters, using time parameters and ephemeris with the corresponding values of IODC and IODE for this satellite [2,4].

NovAtel GNSS receiver M6V1G corresponds to all these requirements.

Active GNSS antenna which includes a low noise amplifier antenna signal and a band pass filter is required to work with the receiver. The antenna must have good characteristics for a hundred stability of the phase center and be provided maximum protection from the effect of re-scattered signals. All antennas models of NovAtel are protected from influence of an environment and compliant with the European Union (EU) Restriction of Hazardous Substances (RoHS) .We will use the antenna GPS-702L.

Antenna cable is required to connect the antenna to the receiver. An appropriate coaxial cable is one that matches the impedance of the antenna and receiver being used (50 ohms), and whose line loss does not exceed 10.0 dB. If the limit is exceeded, excessive signal degradation occurs and the receiver may not be able to meet its performance specifications. [3,7] We use Belden cable-H100 with a low coefficient of attenuation.

Data transmission from the base station to the receiver is transferred by using Wi-Fi.

Setting the receiver is carried out by means of a personal computer using the interface of the software NovAtel of the CDU. By means of USB connection connect the receiver to the computer.

Valid system model is shown in Fig. 3.

Fig. 3. Hardware realization of the system
Рис. 3. Аппаратная реализация системы

Software for visualization of the receivers have been developed. It can be used to track the position of satellites, to assess the quality of signals which are received from satellites, to see the coordinates and their errors also values of the corrections are displayed to the operator. The interface user is presented in Fig. 4.

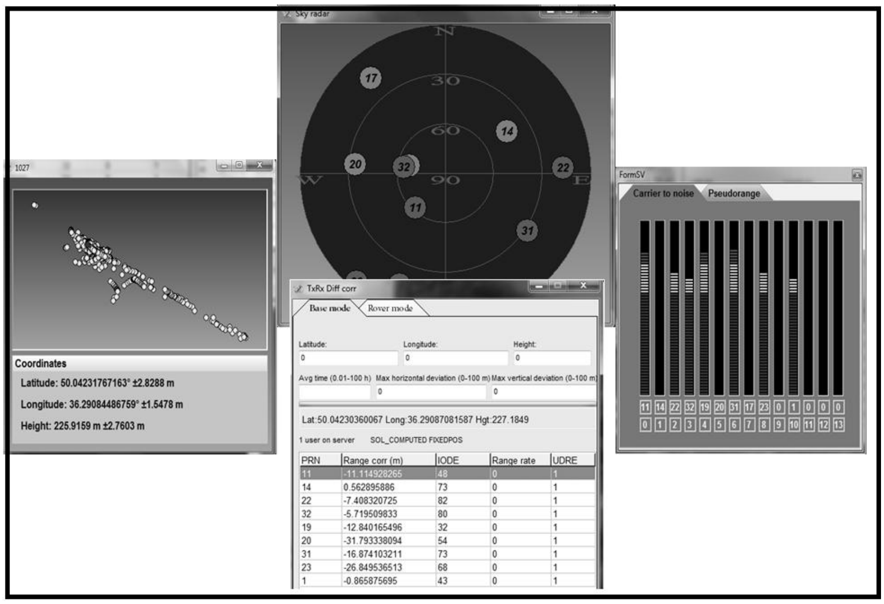

Fig. 4. The interface of user
Рис. 4. Интерфейс пользователя

4. EXPERIMENTAL PART

The results of these experiments:

- Study the local differential mode at the time of corrections 5 seconds. The results of comparison in longitude, latitude, altitude are shown in Fig. 5;

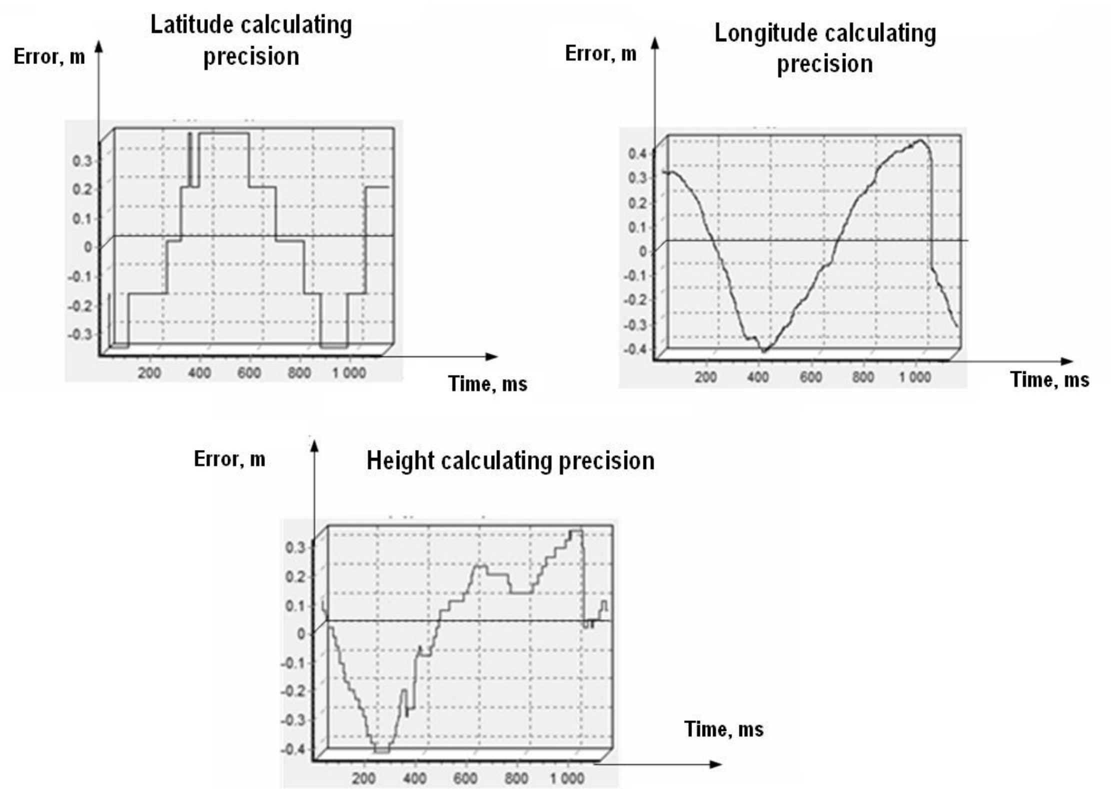

Fig. 5. The accuracy of location time of corrections is 5 seconds)
Рис. 5. Точность определения местоположения (возраст поправок 5с)

- Study the local differential mode on a time correction of 50 seconds. The results of comparison in longitude, latitude, altitude are shown in Fig. 6;

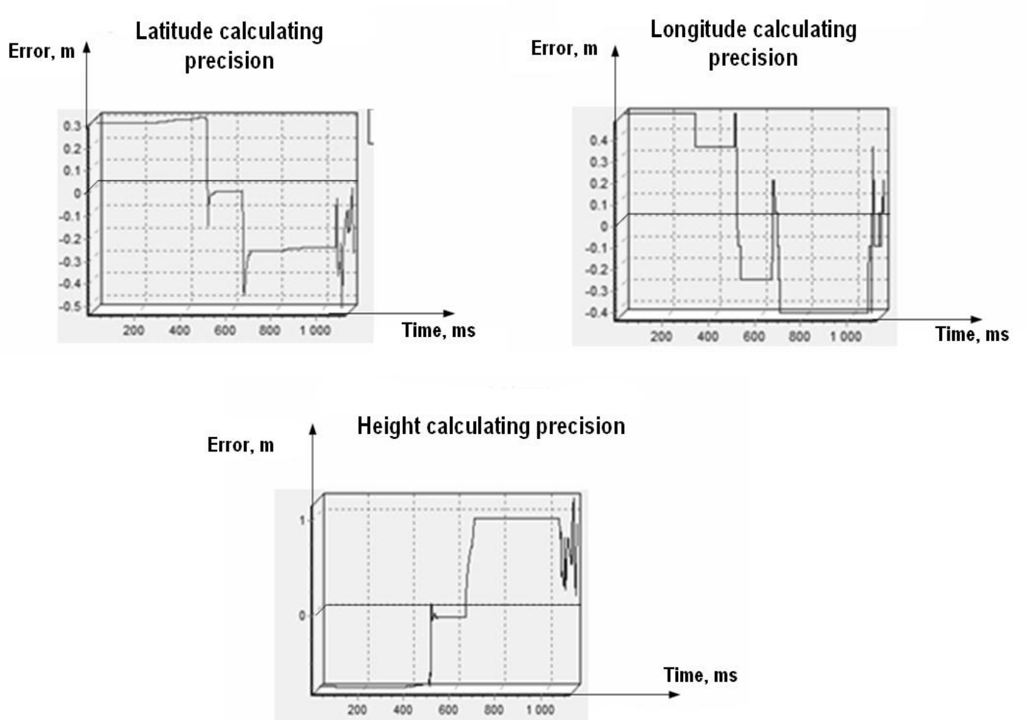

Fig. 6. The accuracy of location (time corrections of 50 seconds)
Рис. 6. Точность определения местоположения (возраст поправок 50с)

- Study the local differential mode at a larger distance to the base station. The results of comparison in longitude, latitude, altitude are shown in Fig. 7.

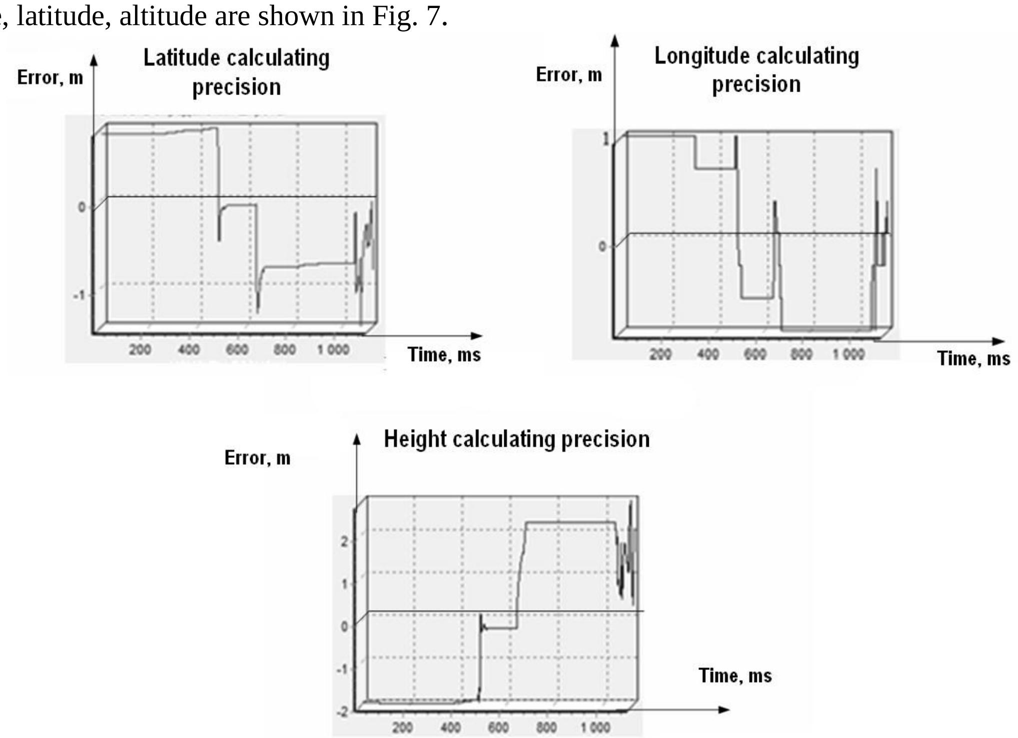

Fig. 7. The accuracy of location (base station is Kharkov DGPS)
Рис. 7. Точность определения местоположения (базовая станция – Харьковская DGPS)

We can draw the following conclusions on the results of research on the local DGPS:

- Differential mode has been implemented in a static point;
- The accuracy was obtained up to 30 cm in latitude and longitude, and 40 cm in altitude at the time of corrections 5 seconds;
- Accuracy has worsened to 50 cm in latitude and longitude, and 90 cm in altitude when the time of correction was 50 seconds;
- Accuracy has worsened to 1 m in latitude and longitude, and to 2 m in altitude at a greater distance to the base station.

The experimental results showed that the most effective DGPS is when the distance to base station is small and the time of corrections is minimum.

5. CONCLUSION

Model of the system operating in differential mode has been designed in this work.

The usage of differential navigation in the transport will increase traffic safety.

The method of differential navigation is widely used because of a very precise measurement and not very complex technical implementation. But the main disadvantage of this mode is that the base station and receiver must be position at short distances.

It may be noted that in the work coordinates of the user are calculated with high accuracy because the base station and the user is located in short distance from each other (in the same audience). Accordingly the determination of the location is on the same satellite and implements the method of local correction.

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Received 05.08.2011; accepted in revised form 02.11.2012