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INFORMATION ON GNSS RECEIVERS AND THEIR ADVANTAGE

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ABSTRACT

The article is devoted to the use of GNSS (Global Navigation Satellite System) receivers in the construction industry. GNSS technology plays an important role in various geodetic surveying tasks, such as land surveying and moving a point easily. The importance of GNSS receivers is growing in popularity due to their accuracy, reliability and ability to work in different conditions. This article covers general information about GNSS receivers and how to use them.

KEYWORDS

GNSS (Global Navigation Satellite System), GLONASS, NAVSTAR GPS (Global Positioning System), GALILEO, NaviC, BeiDou, CORS, RTK (Real-Time Kinematic), UHF (Ultra-Frequency Streams), cellular modem (GSM, GPRS or CDMA), Geoinformation Systems (GIS).

Introduction

Nowadays, innovative news and new methods of solving problems are being considered in many fields all over the world. Including in the field of geodesy, such a change is a lot. One of the main tasks performed in the field of geodesy is the measurement of the place with the help of special tools and the processing of the measurement results. Until recent years, geodetic instruments such as theodolite and scale were used in the measurement works. It is difficult to work with these tools, and the accuracy of the obtained results is low. One of the similar devices is a total station. It is easy to use and the results are clear. But the tacheometer is very heavy, and carrying it was a nuisance for the surveyor. As the number of satellites increases over the years, Earth surveying is becoming easier. Systems such as GNSS (Global Navigation Satellite System) have been developed. This brought relief not only to surveyors, but to all specialists working in this sphere. Production of GNSS receivers using this GNSS system began. Their advantage over other instruments is that they are easy to use, lightweight, and the results obtained are accurate and easy to process.

Main Body

The Global Navigation Satellite System (GNSS) is a set of satellite systems (the most common being GPS and GLONASS) that are used to locate any location on Earth using special navigation or special receivers. GNSS technology is widely used in geodesy, urban and land cadastre, land inventory, construction of engineering structures, geology, etc. NAVSTAR GPS is a system of satellites launched by the United States of America. This system can work together with the Russian "GLONASS" satellite system. In addition, there are satellite systems such as "BeiDou" of China, "GALILEO" launched by the European Union and "NavIC" of India. These satellite systems move in different orbits of the earth and are used for various purposes, i.e. military, agricultural, land surveying.

A GNSS receiver, also called a Global Navigation Satellite System receiver, can receive signals from multiple satellite systems such as NAVSTAR GPS (Global Positioning System), GLONASS, Galileo or BeiDou is a device used for These satellite systems provide positioning and timing information that allows the receiver to determine its exact location on the Earth's surface.

A GNSS receiver works by receiving signals from multiple satellites at the same time. It uses the time delay between the transmission and reception of the satellite signal to calculate the distance from each satellite. By combining range information from multiple satellites, the receiver can determine its 3D position (latitude, longitude, and altitude) with high accuracy.

A modern geodetic GNSS receiver consists of three main elements:

– receiving and transmitting a signal (Base);

– receiving the signal from the base (Rover);

– a special controller (control panel) for monitoring and processing the obtained results.

Even without a base, the Rover can be measured by itself. In this case, a specially installed remote Base system called "CORS" is used instead of the Base.

GNSS receiver greatly facilitates the work of surveyors, cartographers, geologists and other specialists. The device allows you to quickly and accurately determine the location of the object, its speed and direction.

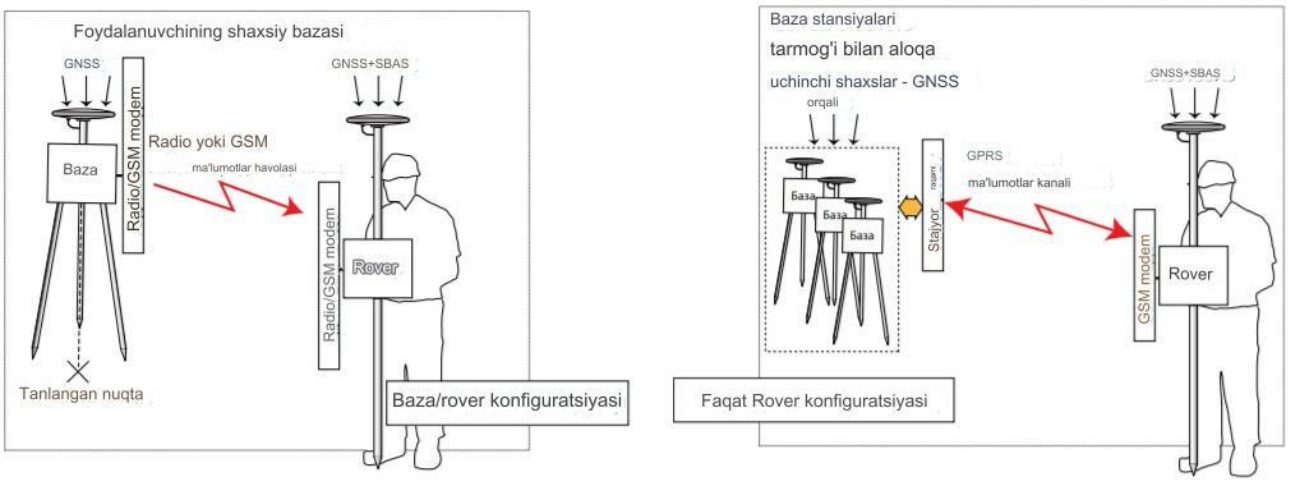


Figure №1. Operation of the GNSS receiver in Base/Rover and Rover Only configurations

Two receivers are used: one (base) is installed at the selected location, and the other (rover) is used for measurement.
The base will consist of: UHF (Ultra-Frequency Streams) radio modem or GSM modem.
The connection that controls the base or network of base stations is implemented using the NTRIP (Network Transport of RTCM over Internet Protocol) protocol and provides data to the rover via a GSM/GPRS modem. A data link must be established to transmit RTK corrections from the base receiver (base) to the rover.
Data transfer can be done in several ways:
– UHF radio
– cellular modem (GSM, GPRS or CDMA)
– other external devices (for example, Wi-Fi, etc.).
Multiple rovers can operate simultaneously using one Base, each receiving RTK correction data from the same Base. Determining and recording the coordinates of points is carried out in the selected coordinate system.
The main advantages of a GNSS receiver:
1. Line of sight between points is not required.
2. By automating measurements, observer errors are minimized.
3. Allows you to determine the coordinates of objects in any part of the world throughout the day in any weather conditions.
4. The accuracy of GNSS detection does not depend on weather conditions (rain, snow, high or low temperature and humidity).
5. GNSS significantly reduces the time required to complete the work compared to traditional methods.
6. GNSS results are presented digitally and can be easily exported to cartographic or geographic information systems (GIS), geology, etc.
Depending on the complexity of technical solutions and the amount of hardware costs, satellite receivers are divided into:
1. Single channel - allows receiving and processing the radio signal of only one satellite at any time;
2. Multi-channel – allows simultaneous reception and processing of signals from several satellites.
Currently, multi-channel receivers are mainly produced. In addition, receivers can be divided into two types:
1. A single system is a receiver of GPS signals.
2. Dual system – receiver of GLONASS and GPS signals.
Depending on the type of received and processed signals, receivers are divided into:
1. Single frequency, code;
2. Two-frequency, code;
3. One-frequency code-phase;
4. Two-frequency code phase.
According to the accuracy, satellite receivers are divided into three classes:
1. Navigation class - the accuracy of determining coordinates is 150-200 m,
2. Cartography and GIS class - 1-5 m,
3. Geodetic class - up to 1 cm (1-3 cm in kinematic mode, up to 1 cm in static measurements).

Materials and Methods

GNSS receivers are designed to be very easy to use. It has a special box (Futler) in which all the devices needed for work are placed. This will save time. For positioning with GNSS receivers, the Base should be mounted in an open area using a tripod and tripod. After that, after mounting the Rover on a specially made long carbon fiber frame, the Base and Rovers must be connected to the remote control in series (using Bluetooth or WiFi). After that, you can easily start painting.

Figure №2. GNSS receiver overview

In construction, there are often ready-made projects. In this case, the Geodesist is required to determine the location of the points in this project on the construction site. When performing this work with a tacheometer, the surveyor faces several difficulties, and another assistant is needed to perform this work. This can be done with some ease if done with a GNSS receiver. It will be possible to move the points without the help of any partner. There are two modes of GNSS receiver.

1. The position of the point visible on the controller in the normal state is determined. In this process, special navigation arrows will guide you and it will be possible to easily find the location of the point.
2. In the second case, it will be possible to determine the location of the point through the camera installed on the GNSS receiver. In this case, the navigation arrows will show the way. The advantage is that measurements will be more accurate.

GNSS (Global Navigation Satellite System) receivers can operate in different modes depending on user requirements and available satellite signals. Some common operating modes for GNSS receivers include:

–Independent mode: In this mode, the receiver relies only on signals from satellites of one GNSS system (eg GPS, GLONASS, Galileo, BeiDou) to determine the user's position. It does not rely on any external support or additional information.

–Differential mode: In this mode, the receiver receives correction information from a station or base station that has a known precise position. This correction information helps reduce errors caused by atmospheric conditions, satellite clock errors, and other causes. Differential mode significantly increases the positioning accuracy of the receiver.

–Auxiliary mode: Auxiliary GNSS mode involves obtaining additional information from external sources such as network infrastructure or a server. This support helps in faster acquisition of satellite signals, initial positioning and improves overall performance in challenging environments.

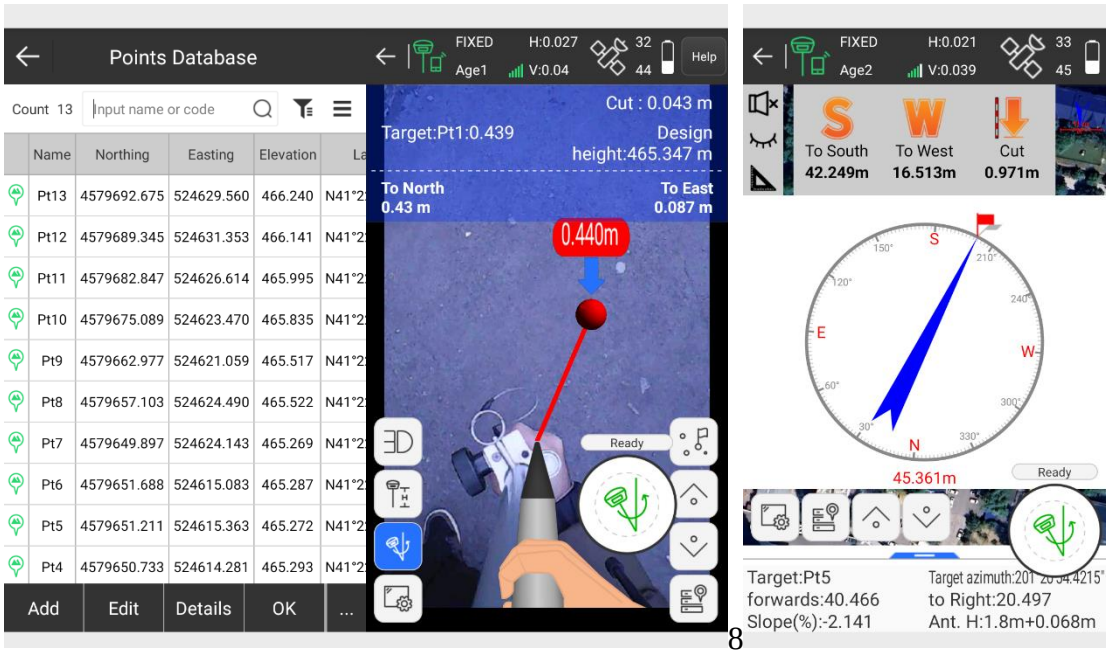
–Real-time kinematics (RTK) mode: A high-precision positioning technique that relies on an RTK base station and rover receiver. The base station provides real-time correction data to the rover's

receiver, providing centimeter-level accuracy. This mode is commonly used in surveying, agriculture, and other applications that require highly accurate positioning.

–Post processing mode: In post processing mode, the receiver records measurements and sketch data for further analysis. This data is combined with base station correction data during data processing to increase accuracy. Post processing mode is usually used in measurement work that requires high accuracy.

Different operating modes of GNSS receivers offer different levels of accuracy, speed and convenience. The choice of mode depends on the specific application and the requirements of the Surveyor.

Results:



a) b) c)

Figure №3. Move finished points in the drawing process

a) Point markers obtained using a GNSS receiver

b) move the point with the camera

c) moving a point with a known position in advance

Table 1. Results obtained using the receiver

№	North, m	East, m	Altitude, m	X	Y	Z
Mark1	4466600.418	649623.073	279.722	2075990.125	4404017.132	4106698.667
Mark2	4466600.809	649622.655	279.812	2075990.416	4404016.785	4106699.029
Mark3	4466598.682	649626.691	279.673	2075987.367	4404019.684	4106697.256
Mark4	4466612.871	649606.063	279.502	2076001.685	4404002.344	4106708.274
Mark5	4466588.239	649639.220	280.148	2075979.328	4404031.525	4106689.413
Mark6	4466620.993	649632.139	280.140	2075976.062	4404009.520	4106714.483
Mark7	4466630.870	649613.837	279.411	2075989.375	4403995.301	4106721.817
Mark8	4466611.311	649649.127	280.696	2075963.816	4404022.931	4106707.204
Mark9	4466616.573	649635.884	280.157	2075974.000	4404013.722	4106711.067
Mark10	4466618.214	649632.031	280.092	2075976.961	4404011.042	4106712.335

Mark11	4466640.439	649639.957	279.901	2075963.239	4404001.560	4106729.031
Mark12	4466649.199	649621.476	279.692	2075977.211	4403988.266	4106735.854
Mark13	4466632.747	649658.926	280.557	2075948.660	4404014.758	4106723.305
Mark14	4466637.423	649647.865	280.095	2075957.080	4404006.897	4106726.738
Mark15	4466640.419	649640.569	279.887	2075962.690	4404001.830	4106728.998
Mark16	4466662.716	649649.852	280.533	2075947.999	4403993.476	4106746.270
Mark17	4466668.441	649630.129	280.394	2075964.001	4403981.448	4106750.832
Mark18	4466653.391	649667.384	280.596	2075935.000	4404006.579	4106738.938
Mark19	4466664.987	649654.646	280.608	2075943.046	4403994.317	4106747.977
Mark20	4466666.341	649651.195	280.680	2075945.774	4403992.074	4106749.108

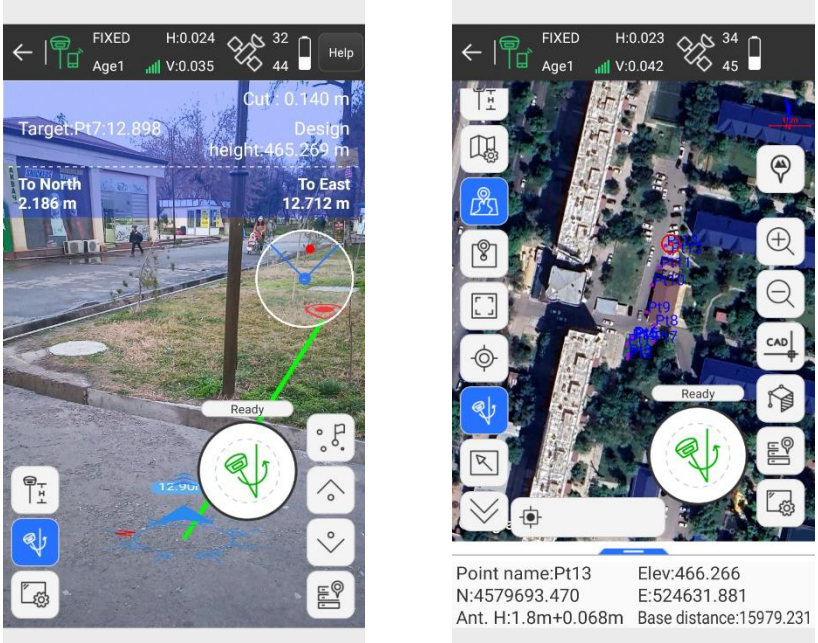


Figure №4. Representing the location of a point on the screen with colored lines

When the GNSS receiver is in camera mode, the controller screen displays the above images, which show the current location of the point.

Conclusion\Recommendations:

New technologies are introduced every day in all fields and directions. Although it has not been long since the introduction of devices such as the GNSS receiver, it has been facilitating the work of many professionals working in the field of Geodesy. The reason for this is the ease and speed of working with the GNSS receiver, which allows the geodesist to measure even very large areas in a short time. The GNSS receiver is much lighter and more compact than other devices. This is very useful in work. In addition, the GNSS receiver provides the actual location coordinates of the point we are measuring.

In the process of using GNSS receivers, it is necessary to follow the following recommendations in order to increase the accuracy of the result and reduce errors. In the process of using receivers, it is necessary to make sure that communication wires, electrical wires, and trees do not pass from above. Because there are obstacles listed above in the work area, it will affect the measurement accuracy.

Another way to reduce error is to work with the tool's vertical and horizontal errors displayed on the controller screen. The geodesist should also take these errors into account when obtaining the values of the measurement results.

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