POSITIONING NAVIGATION FROM SATELLITES TARGETING WITH TOOLS

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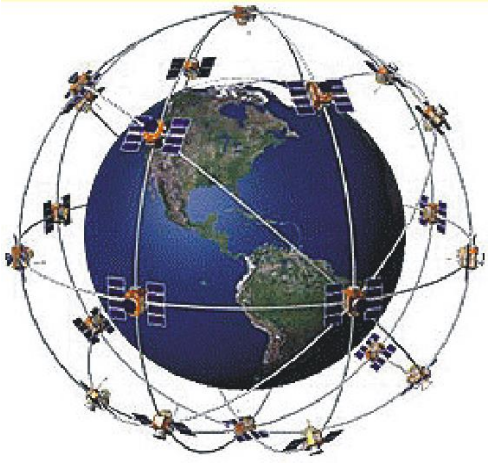
Satellite positioning refers to the use of an instrument by an observer to determine their position using satellites. The tool determines the distance to the satellite to find the coordinates of its location , then solves the inverse intersection problem to determine the user's location and other navigation parameters.

Navigation device - (other names are navigation receiver, navigator and satellite station) is an electronic device designed to receive radio signals from navigation satellites and, as a result, determine the coordinates of the location, altitude and other navigation data. .

Global navigation satellite systems , i.e. GNSS, are systems that can operate at any time of the year, in any part of the day and in any weather conditions. are systems that allow you to continuously determine the coordinates of stationary or moving objects, the speed of movement, as well as many other navigational data. GPS, GLONASS and Galileo are Global Navigation Satellite Systems (GNSS).

Global navigation satellite systems consist of three segments (links) .

1. **Space segment - this segment consists** of satellites that form an orbit around the earth, and the average distance of their orbit from the surface of the earth is 20,000 km. The space segment (Fig. 55) is designed in such a way that the instrument can at any time capture at least 4 satellites located at an angle greater than 15° above the horizon . Satellites constantly emit waves in two bands. It is thanks to the reception of these waves that the device perfor all the measurement work.



55-rasm. Yo‘ldoshlar turkumi.

2. **Control segment -** this segment consists of the main control station located on the earth, control stations and radio antennas that receive and transmit data from satellites located near them. The control segment tracks the satellites, updates their orbital positions, and adjusts their clocks. Its main task is to determine the orbit of satellites and determine their flight trajectory for the next day. Antennas receive waves from satellites and then transmit them to nearby stations. And they, in turn,

transmit this information to the main control station for processing and updating. The processed information is transmitted to the satellites in the same way.

3. **User segment.** Any navigation device can participate as this segment.

basis of coordinate determination using satellites is the problem of determining the distance to the satellite with the instrument. The tool does this as follows:

The satellites broadcast signals continuously, and the instrument solves the problem of backcrossing based on the signals received from at least four satellites and derives the position coordinates (the instrument uses the first three satellites to determine the position, until and with the help of the fourth satellite determines the height).

Reverse intersection means determining the coordinates of three (or more) points whose coordinates are known by crossing a straight line to the point whose coordinates are being determined. In our example, the coordinates of the satellites are the exact point, and the instrument is the point whose coordinates are being determined . This is why it is necessary to receive signals from at least three satellites. This can be explained as follows: if we know the distance to three points, we will be able to determine our position in relation to these points. That is, we know that by determining the distance to one satellite , the instrument is located in some circle, and the center of the circle is that satellite. By finding the point of intersection of three such circles, the location of the tool is determined.

There are several ways to determine coordinates using satellites. Which one to use depends on the accuracy required by the user and the capability of the tool. In general, these methods can be divided into two large groups:

1. **Single (absolute) navigation.** This is the most common and simplest way to use the instrument, and it allows you to determine the location in one second. Accuracy in measurement is greater than 50 m .

2. **Differential (relative) measurement methods** - their differences from single navigation are as follows:

only one instrument is involved in single navigation, and two or more instruments are used in differential measurement;

in single navigation, it is not possible to correct the coordinates on the computer, and the differential measurement work is logically completed only after processing on the computer.

Differential methods are used only in precise geodetic measurements, so they are not considered in our example .

following factors prevent the error in determining the coordinates with the tool to be theoretically zero :

1. **Eclipses in the atmosphere.** We know that electromagnetic waves are refracted when they pass from one medium to another. This phenomenon is called refraction in science. Similarly, waves emitted by satellites are refracted as they pass

from the vacuum environment of space into the ionosphere and then into the troposphere. Cloudiness of the weather in the troposphere also affects it .

As the waves pass through the atmosphere, they are intercepted (or absorbed), slowed down, and refracted. Although the atmosphere does not permanently block the passage of waves, the following exceptions occur :

horizon travels a greater distance in the atmosphere, naturally, it is absorbed more, that is, the power of the signal decreases and is broken;

at night , the negative impact of the ionosphere is very low, and during the day (especially during periods of solar activity) the ionosphere has a greater negative impact;

water vapor in the atmosphere also has a negative effect on the passage of waves.

2. Error in **satellites and instrument clocks** . Although satellite clocks are highly accurate atomic clocks , they also tend to fall behind or go ahead. However, this shortcoming is being overcome every day. Even if the clock of the instrument is set incorrectly , a serious error in determining the coordinates can occur.

3. **Mechanical barriers** . Such objects include buildings, structures, dense forest (tree groves) , and large objects (trucks, power lines are not examples of such objects). They prevent the wave from the satellites from traveling in a straight line to the instrument. As a result of this, a phenomenon called wave interference (waves passing around obstacles) occurs. In order for the instrument to work perfectly accurately, it must receive a wave coming along a straight line , not a round wave .

4. **Wave-reflecting objects** . Objects that reflect waves include buildings, bodies of water, and large objects (in particular, objects with metal surfaces, power line poles, cisterns).

In addition to the waves spreading around the obstacles, they hit them and part of them is absorbed, and the other part changes its direction and turns to the other side, this phenomenon is called the return of waves. If the device is placed at a distance of up to 50 m from such objects, the phenomenon of reproduction of satellites will occur. That is, the device receives both a direct and a return wave coming from the same satellite , which does not affect the accuracy of its coordinate measurement. This phenomenon occurs as a result of the device receiving the wave not directly from the satellite, but after hitting some object on the earth and returning . This shortcoming is eliminated by using special antennas.

The negative impact of the first four factors can not be eliminated in single navigation . Therefore, it is necessary to limit them.

5. **Strong radio wave sources** . Examples of them are radio stations, as well as high-voltage power lines . Radio waves emitted by such objects can create radio interference. If the device is located at a distance of up to 1 km from radio stations and up to 50 m from high-voltage power lines , radio interference can interfere with its operation.

6. **Factors arising from the mutual location of the satellites and the tool (pryomnik)** . These factors are generally called DOP (decrease factor) and are divided into the following types:

GDOP - in which the unfavorable position of the satellites affects the determination of coordinates, altitude and time;

PDOP - in which the unfavorable location of satellites affects the determination of coordinates and altitude;

HDOP - in which the unfavorable location of satellites affects the determination of coordinates;

VDOP - where satellites' unfavorable position affects altitude determination.

Inconvenient location of satellites - the instrument must receive a signal from a satellite that is always at the same zenith, from several satellites that are evenly distributed around it and whose height is at an angle greater than 20° above the horizon line. If the main part of the satellites is located on one side of the sky , the accuracy of the coordinate measurement decreases.

Any navigation device consists of the following working parts:

1. Antenna
2. Wave receiving unit (sensor, sensor)
3. Microprocessor
4. Control unit (keyboard)
5. Display
6. Memory
7. Do not connect with external electronic equipment
8. Power source (battery, accumulator)

Radio waves hit the antenna, which converts the waves into electromagnetic vibrations and transmits them to the receiver . The microprocessor does all the measuring and calculating. The keyboard and display are the controls.

In most devices, some of these parts are combined and equipped with one common part (for example, a controller).

In addition, the instrument also has a number of auxiliary equipment, including:

racks , rails, tripods, brackets (installers) and vehicle brackets;

additional and auxiliary power sources, charging devices, various adapters connecting to the power source, electric current generating equipment intended for operation in non-residential areas;

roulettes ;

external antennas;

computer connecting ports, cables (USB, PC);

sheaths , belts, field bags;

flash cards, discs and similar electronic media;

radio stations (radio modems), modems, etc

Depending on which satellite system the instruments can receive a signal from:

single -frequency (GPS devices, GLONASS devices);

multi- frequency (receives signals from several or all satellite systems).

According to the installation object:

portable (mobile (compact), designed to be carried in the hand, side or pocket);

vehicles ;

stationary (installed on buildings and they perform the function of constant monitoring of signals received from satellites).

By type of installation:

separately ;

attached (to a cell phone, car, missile, bomb, etc.).

According to the work to be done :

simple navigator;

who performs work related to the field .

According to the target area:

popular _

professional (for the Armed Forces, tourists, hunters, fishermen, etc.);

professional (for high-precision measurement work).

According to the type of planning :

topographic (to create a site plan);

geodetic ;

cartographic (gathering information about the geographic information system and for mapping location changes).

Today, navigation devices have become a mass consumer product.

Their use has penetrated into many areas of human activity. To date, three generations of tools and hundreds of varieties have been created. Many types of navigation devices , of which we will consider only the general aspects of the purpose of the "Montana-600" and "Meridian Platinum" devices.

All tools require initialization before running.

Initialization means prelude, beginning, beginning of work, beginning of words. It is a set of data that needs to be entered by the user in order for any electronic device to function as intended . Such information includes time, date , and approximate or exact location coordinates and altitude. After entering these data, the device will know at what time, in which part of the world it is located and which satellites are in the sky of its location at the same time.

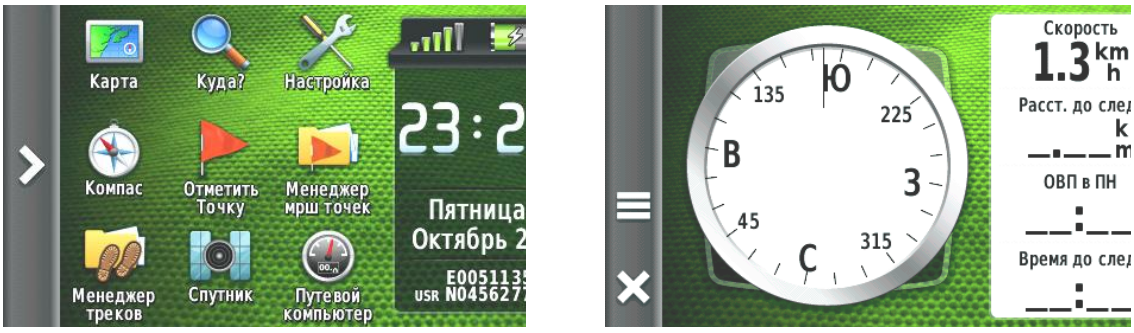
The tasks performed during targeting using Montana-600 tools are performed in the following order (Fig. 56):

the device is turned on;

tool starts (finds the location);

main menu (Fig. 56a);

compass shaft (Fig. 56b);



a) **b)**

Figure 56. Procedure for targeting using the Montana-600 tool.

to select the main direction (true azimuth, magnetic azimuth or direction angle) before aiming in this tool . Because the instrument compass displays navigation information in that unit, whichever unit is selected as the main direction .

When targeting with the Meridian platinum device, the following tasks are performed:

the device is turned on;

the tool waits for a while until it starts;

By pressing the "NAV" button, it goes to the "Compass" screen;

horizon sides are found.

It is advisable to select the main direction (true azimuth or magnetic azimuth) before aiming in this device . Because the instrument compass displays navigation information in that unit, whichever unit is selected as the main direction .

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