REVIEW OF ANALYSIS OF GEOINFORMATION AND GPS NAVIGATION SYSTEMS IN THE MODERN WORLD

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Annotation. This article is devoted to the general concepts of modern analysis of geographic information and GPS navigation systems in the world.

Keywords: GPS, USA, Wide Area Augmentation System (WAAS), GLONASS satellite, GPS limitations, cell phones, watches, computers, weather forecast, energy, precise location, speed and time, solar satellite navigation functions and others.

The Global Positioning System (GPS) is a technological marvel created by a group of satellites orbiting the Earth. Transmits precise signals to GPS receivers which allow them to calculate and display accurate location, speed and time information. GPS belongs to the USA. By receiving signals from satellites, GPS receivers can use the mathematical principle of trilateration to determine your location. By adding processing power and in-memory data such as road maps, points of interest, topography and more, GPS receivers can convert location, speed and time data into a useful format.

The invention and evolution of GPS. GPS was originally created by the US Department of Defense (DOD) as a military program. The system has been in place since the early 1980s, but began helping civilians only in the late 1990s. Home GPS has grown into a multi-billion dollar industry with many products, services and internet utilities. Along with many technologies, its development continues; It is truly a modern miracle when engineers recognize their limitations and continually work to overcome them.

GPS capabilities: GPS works correctly in all weather conditions, around the world and around the world; There is no subscription fee for using GPS signals; GPS receivers are typically detectable within 15 meters, and newer models using Wide Area Assurance System (WAAS) signals are accurate to within three meters.

GPS Limitations: GPS signals may be blocked by dense forests, canyon walls, skyscrapers, bridges, walls, etc., making accurate GPS navigation difficult or impossible; similarly, GPS does not work well indoors and underground; satellite equipment, radio interference and solar storms can cause gaps in shelter.

International movements. GPS, based and operated in the United States, is the world's most widely used satellite navigation system, but the Russian GLONASS satellite system provides global services. Some consumer GPS devices improve the accuracy and likelihood of receiving sufficient location data from both systems.

Interesting facts about GPS. How GPS works remains a mystery to many people who use it every day. These facts may surprise you:

1. Military GPS uses two frequencies, civilian GPS only one. This increases accuracy. Dual-frequency GPS devices are available to civilians, but their cost and size make them ineffective.

2. The US Government has an ongoing multi-billion dollar program of improvement and modernization.

3. US taxpayers fund the world's GPS services, primarily through the Department of Defense. The 2017 budget is approximately $900 million.

4. America's joint civil-military agency, the National Spatial Positioning, Navigation and Timing Executive Committee, manages GPS. It is maintained and operated by the United States Air Force.

5. By 2017, there will be 24 GPS satellites in Earth orbit.

6. GPS is essential for everyday devices, amenities and services such as cell phones, watches, computers, weather forecasts, power supply, navigation and emergency or disaster response.

7. Banking, construction, aviation and financial markets, agriculture and many other industries rely on GPS accuracy.

8. GPS is critical to national security. All new military equipment is equipped with GPS equipment.

9. GPS informs air, sea and road transport systems around the world.

How does GPS technology work? The GLONASS system is the largest navigation system that allows you to track the location of various objects. The project, which started in 1982, is actively developing and improving to this day. In addition, work is underway on technical support for GLONASS, as well as on infrastructure that will allow more and more people to use the system. Thus, if in the first years of the complex's existence, navigation using satellites was mainly used to solve military problems, today GLONASS is a technological positioning tool that has become mandatory in the lives of millions of civilian users (see Figure 1).

Figure 1. GLONASS - global navigation satellite systems. What is GLONASS and how does it differ from GPS?

Global satellite navigation systems. Due to the technological complexity of implementing global satellite positioning projects, today only two systems can fully correspond to this name - GLONASS and GPS (see Fig. 2). The first is Russian, and the second is the fruit of American developers. From a technical point of view, GLONASS is a complex of specialized instruments located both in orbit and on the ground. To communicate with satellites, special sensors and receivers are used to read the signals. Special atomic clocks are used to create location data and calculate time parameters from it. They serve to determine the location of an object, taking into account the transmission and processing of radio waves. Reduced errors allow for more reliable calculation of positioning paameters.

Figure 2. Glonass is considered

Satellite navigation functions. Among the tasks of global satellite navigation systems is determining the exact location of objects on the ground. In addition to geographic location, global navigation satellite systems allow you to take into account time, route, speed and other parameters. These tasks are solved by satellites located at various points on the Earth's surface (see Figure 3).

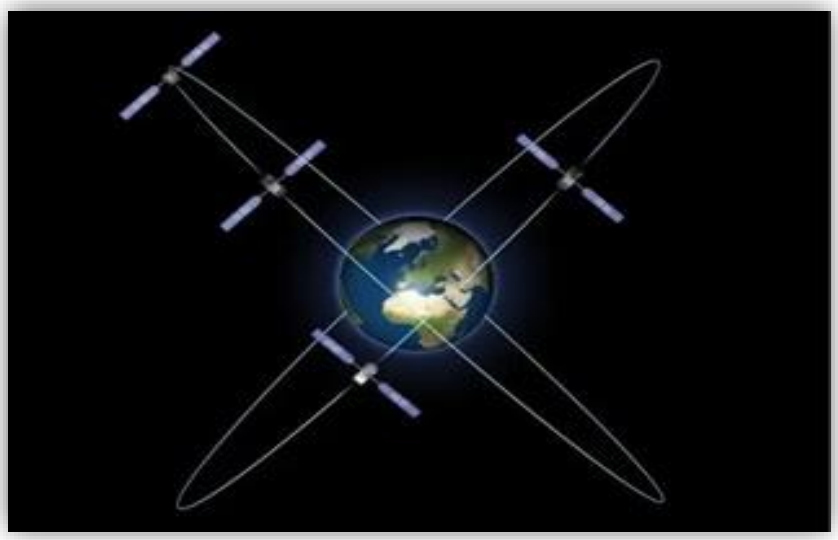

Figure 3. Glonass GPS

Global navigation software isn't just used in the transportation industry. The satellites help with search and rescue, surveying and construction, and the coordination and maintenance of other space stations and vehicles. The military industry was not left without the support of the GPS system. For such purposes, the GLONASS navigator sends a specially designed safe signal to authorized equipment of the Ministry of Defense.

GLONASS system. The system became operational at full capacity only in 2010, although attempts to actively operate the complex have been made since 1995.

Currently, GLONASS consists of 24 satellites operating at different points in orbit. In general, the navigation infrastructure can consist of three components: a spacecraft, a control complex (providing control of the constellation in orbit), and a user navigation device (see Fig. 4).

24 satellites, each of which has its own constant altitude, are divided into several categories. There are 12 satellites in each hemisphere. With the help of satellite orbits, a grid is formed on the surface of the earth, the exact coordinates of which are determined thanks to its signals. In addition, the GLONASS satellite has several backup devices. Each of them is in its own orbit and is not empty. Their tasks include expanding coverage in a given area and repling failed satellites.

Figure 4. GPS Glonass navigator

GPS system. The American analogue of GLONASS is the GPS system, which also began its work in the 1980s, but since 2000, the accuracy of determining coordinates has allowed it to be widely used among consumers. Today, GPS satellites guarantee an accuracy of 2-3 m. Delays in the development of navigation capabilities have long been associated with the limitations of artificial positioning. Nevertheless, their removal made it possible to determine the coordinates with maximum accuracy. GLONASS-compatible results are achieved even when synchronized with miniature

receivers.

Differences between GLONASS and GPS. There are several differences between navigation systems. In particular, the difference is the placement and movement of satellites in orbit. In the GLONASS complex they move in three planes (eight satellites in each), and the GPS system provides operation in six planes (four in each). Thus, the Russian system provides wider surface area coverage, which is also reflected in high resolution. However, in practice, the short “life” of local satellites does not allow using all the capabilities of the GLONASS system. GPS, in turn, maintains high accuracy due to the excessive number of satellites. However, the Russian complex regularly introduces new satellites both for intended use and as backup ones (see Figure 5).

Figure 5. Glonass program

Different signal encoding methods are also used - Americans use CDMA code, and GLONASS uses FDMA. The Russian satellite system provides a more complex model for calculating data for positioning by receivers. As a result, the use of GLONASS requires high power consumption, which is reflected in the size of the devices.

What do GLONASS capabilities provide? The main tasks of the system include determining the coordinates of an object capable of interacting with GLONASS satellites. In this sense, GPS performs similar tasks. In particular, the parameters of the movement of ground, sea and air objects are considered. A car equipped with a suitable navigator can calculate its driving characteristics in a few seconds (see Figure6)

Figure 6. Global navigation satellite systems

In use, global navigation has already become mandatory for some categories of transport. If in the 2000s the spread of satellite positioning was associated with the management of certain strategic objects, today ships and aircraft, public transport, etc. are equipped with receivers. In the near future, it will be mandatory to equip all private cars with GLONASS navigators, except others.

What devices work with GLONASS. The system is capable of providing uninterrupted global service to all categories of consumers without exception, regardless of climatic, territorial and time conditions. Like GPS services, GLONASS navigator is provided free of charge anywhere in the world. Devices capable of receiving satellite signals include not only on-board navigation devices and GPS receivers, but also mobile phones. Data on location, direction and speed are transmitted to a special server via GSM networks. Special GLONASS software and various map processing applications help you use the capabilities of satellite navigation.

Combi receivers. The territorial expansion of satellite navigation has led to a merging of the two systems from the consumer's point of view. In practice, GLONASS devices are often complemented by GPS and vice versa, which increases the accuracy of determining positioning and timing parameters. Technically, this is done using two sensors integrated into one navigator. Based on this idea, combined receivers are produced that work simultaneously with GLONASS, GPS systems and related equipment. In addition to increasing the accuracy of determining geographic coordinates, such a symbiosis makes it possible to track location when the satellites of one of the systems are not photographed. The minimum number of orbital objects that must be “visible” for the navigator to work is three units. For example, if the GLONASS program fails, GPS satellites will come to the rescue.

Other satellite navigation systems. The European Union, as well as India and China, are developing projects similar to GLONASS and GPS. The European Space Agency plans to launch a 30-satellite Galileo system that will provide unprecedented

precision. India plans to launch the IRNSS system, which will operate through seven satellites. The navigation complex is intended for domestic use. The Compass system of Chinese manufacturers should consist of two segments. The first one includes 5 satellites, and the second one includes 30 satellites. Accordingly, the authors of the project accept two service formats (see Figure 7).

Figure 7-rasm. Glonass GPS systems

Mobile object tracking system. Global Navigation Satellite System (GLONASS). GPS monitoring systems. The car is equipped with a tracker capable of receiving signals from the navigation system. In addition, satellite signals and global wireless networks can be used. To do this, the GLONASS system, GPS or LBS module must be installed. Search satellite systems: overview, description, characteristics and reviews. Satellite car security system. Today, humanity even uses space for security. For this purpose, satellite search systems were created. It is believed that such navigation began on October 4, 1957. It was then that the first artificial Earth satellite was launched for the first time (see Figure 8).

Figure 8. Search satellite system

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