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ABOUT A PROBLEM OF GNSS SURVEYING IN BIG CITIES

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Formulation of the problem

Using GNSS technologies in surveying in last years with combination of modern communications facilities provides a high precision measurement for different tasks. Today, measuring of spatial data and coordinates on earth surface in Real Time Cinematic (RTC) mode, become the most demand technology, which will help surveyors to get a coordinates with few-centimeters precision in the field.

GNSS surveying is based on reception of signals from satellites. In cause of physical obstacles existence in satellite signal way, GNSS results may lose them accuracy. Big trees, building area and other high objects of natural or artificial origin may block satellite signals from receivers, GNSS surveying can`t be provide in underground objects and anywhere in cause of a limited review of the celestial surface.

That's why, we can notice that GNSS surveying in big cities may can be problematic in reason of presence physical obstacles which affect on satellite signal.

There are many tasks which accomplishment time is really demand from results of GNSS surveying, such as: development of basic geodetic networks of all levels, conducting leveling work, the study of seismic activity, etc. But one of most topical task in urban development is still become cartography and geoinformatics so, as result, development of geographic-information systems (GIS) which need high precocious data for successfully management.

The main material problems

Considering fast process of GIS development and applying it in different ways, so as in urban development, it's a time question when it will be a standard for data collection and managing. Successfully data managing will need information, which include attributive information for better representation.

There are few ways to get such information. They are:

- vectorization and coordinating of existence cartographical materials;
- decoding of remote sensing data;
- obtaining new data.

Analyzing total relevance situation of cartographic materials, cost of activities aimed at obtaining and decrypting of remote sensing data, the most reliable and informative seems to be new data collection and actualizing of spatial data.

In cause when actually exist a problem of collecting spatial data with GNSS surveying, one of the most easiest ways of it resolve become a combinations with types of surveying, for example – combination GNSS + total station. But that's combination demand the relatively high cost of human and time resources, and high total price of all equipment.

That's why today really exist necessity to solve the problem of GNSS surveying or, at least, define the way to around it.

Analysis of recent research and publications relating to resolve problem

The creation and improvement of GIS technology in the field of urban development in the works discussed a wide range of researchers: AI Baydatskoho, AA Lyaschenko, D.O. Timchenko, O.O.Kostyshyna, V.I. Tovbycha and others. Direct to strengthening power GPS signal devoted a separate publication [2]

Remaining parts of the general problem

Usually, work for creations reconstruction projects of municipal property, based on traditional cartographic materials. In cause, that those materials are old and got no actualizing for a long time, estimation process of needed resources can't be reliable, so it will bring additional resource costs. Considering start and evolution reform of local government, actualizing or creation of new cartographical information, become one of the urgent task for local government.

Remains an unsolved problem and to inform a wide range of individuals and inspection services in connection with the evident inability to visualize the mapping information for a wide representation.

Formulation of the problem

Based on the above, the purpose of the article is to find the optimal hardware for driving GNSS-surveying in the possibility of using the information gathered to conduct a full GIS - project.

The main material problems

Corinne Iozzio in article «NASA and the U.S. Air Force Test a New Ground-Based GPS» in "Scientific American" journal write about process of testing by NASA and the U.S. Air Force new ground-based system is the first to produce a signal that merges seamlessly with the GPS network. Conventional GPS determines location by measuring the time it takes for a signal to travel from a transmitting satellite in medium Earth orbit to a receiver. Three such readings from three separate satellites triangulate a location in 2-D space (longitude and latitude); a fourth signal lets the system assess 3-D space (altitude). Each satellite carries four atomic clocks that are synchronized twice daily with a master clock in Colorado Springs, Colo. The blind-spot problem presents itself

simply: if a user moves out of the satellites' sight lines, the signal is lost.

Scientist says, that system resolves issue by layering in an independent network of transceivers that communicate over ground. A test last year in Washington, D.C., by the U.S. Naval Observatory, the division responsible for maintaining the GPS master clock, found that Locata's web of signals synced up within 200 trillionths of a second, more than 50 times faster than GPS. And unlike GPS, the signals are strong enough to pass through walls.

Analyze that article, we can get a conclusion that one of the GNSS problem decision is increasing the power level of satellite signal, whatever there are no permanent and recommend system or procedure for increase signal power level, so leading manufacturers are developing searching for different solution for realize whole options of GNSS receivers in big cities.

For starting of our local GIS project, first step was determined with the hardware.

Analyze modern solutions in sphere of GNSS receiver's, special attention attracted new products 2015 year from one of the world leader in manufacturing of surveying technologies – Leica Geosystems, and especially on GNSS receiver Leica Zeno 20, which was introduce in summer 2015 in Las Vegas, USA. Device pays attention on declared configuration of accuracy.

Table1

Technical Specifications Leica Zeno 20

Options	GPS: L2, L2C GLONASS: L1, L2 BeiDou: B1 Galileo: E1
Output data protocols	NMEA-0183 (GGA, VTG, GLL, GSA, GSV, RMC, GST, GGQ, LLQ)
Real-time protocols	RTCM 2.x, RTCM 3.0, RTCM 3.1, Leica, CMR, CMR+
Update rate	1 Hz (1 sec), Optional: 5 Hz (0.2 sec)
Horizontal real-time accuracy	1 cm + 1 ppm <5cm + 1 ppm with L1/L2 handheld <40cm L1 handheld <0.9 m with SBAS L1 handheld
Vertical real-time accuracy	RTK (with AS10, L1/L2): 2 cm + 1 ppm, RTK (with internal, L1/L2): <10 cm + 1 ppm
Post processing accuracy static mode	Horizontal: 3 mm + 0.5 ppm (rms) Vertical: 6 mm + 0.5 ppm (rms))
Time to first fix	Typically 40 sec

All GNSS-receivers can totally divide in two groups by their accuracy: navigation and geodetic. As different subgroup must be devices which have an options of GNSS- receivers and integrated GIS software, so called, GIS-receivers.

For resolve named problem of managing local GIS-projects may be use devises such as navigation so as geodetic accuracy (it demand from result accuracy of research data). Accuracy is not only one decisive factor in management profile, in cause of capturing original spatial data in cities very important still stay gather speed and convenience of saving data in GIS format. Exactly from these requirements was searching of optimal ways and technique for data capture [4].

Devise pays attention not only for that it got dual-frequency option, one of the most interesting options was possibility of remote surveying in combination with rangefinder.

With combined solution, which include GIS receiver and rangefinder Disto S910 (Fig. 1), was realized project of GNSS surveying of underground crossing in city Kharkiv, with the aim of latest transformation in GIS-project.

Fig. 1. Zeno 20 and Disto S910 (GamTec pack)

Since a measurement in underground areas is impossible, we used a combination of high accuracy of GNSS measurements and take account by the additional feature of remote measurements. Underground crossing is a rectangular underground room with 5 outcrops (Fig. 2).

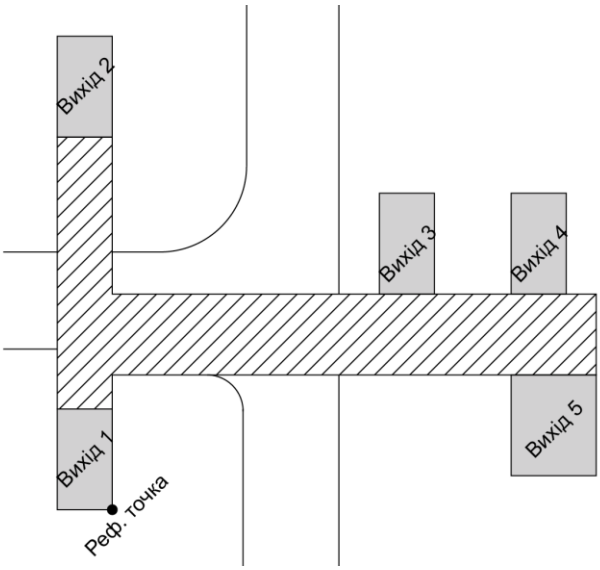

Fig. 2. Underground crossing scheme (Underground and above-ground parts)

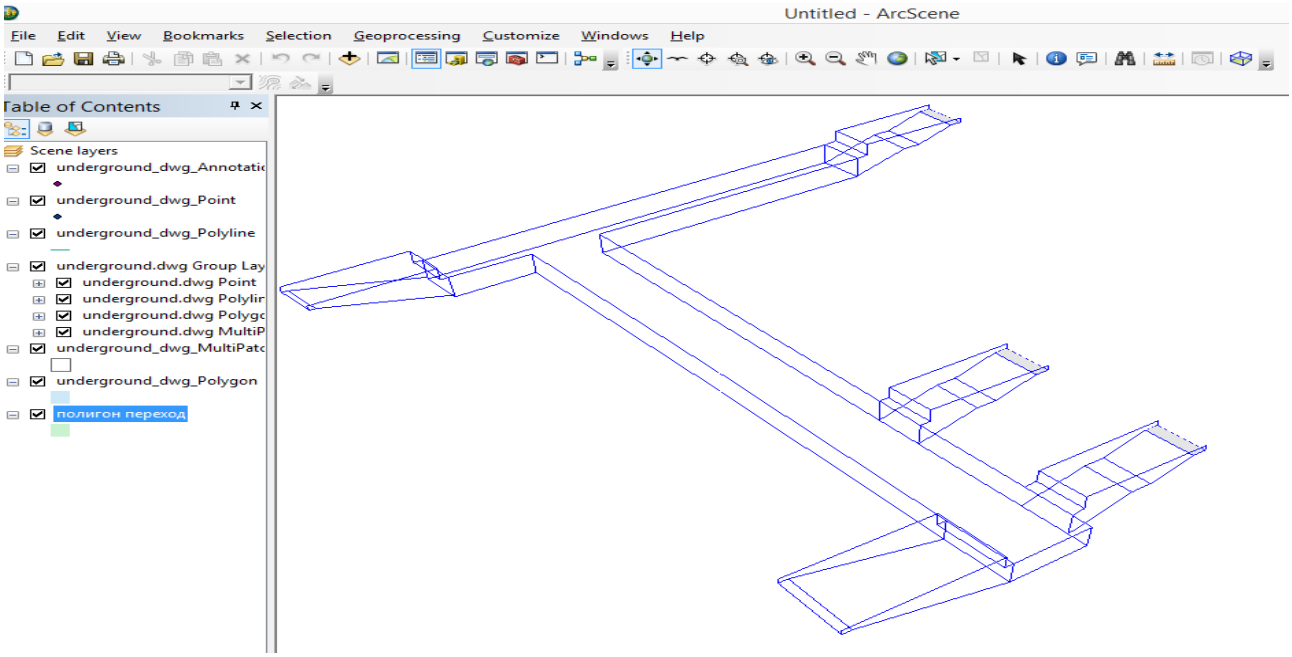

Fig. 3. The project in ArcGIS software

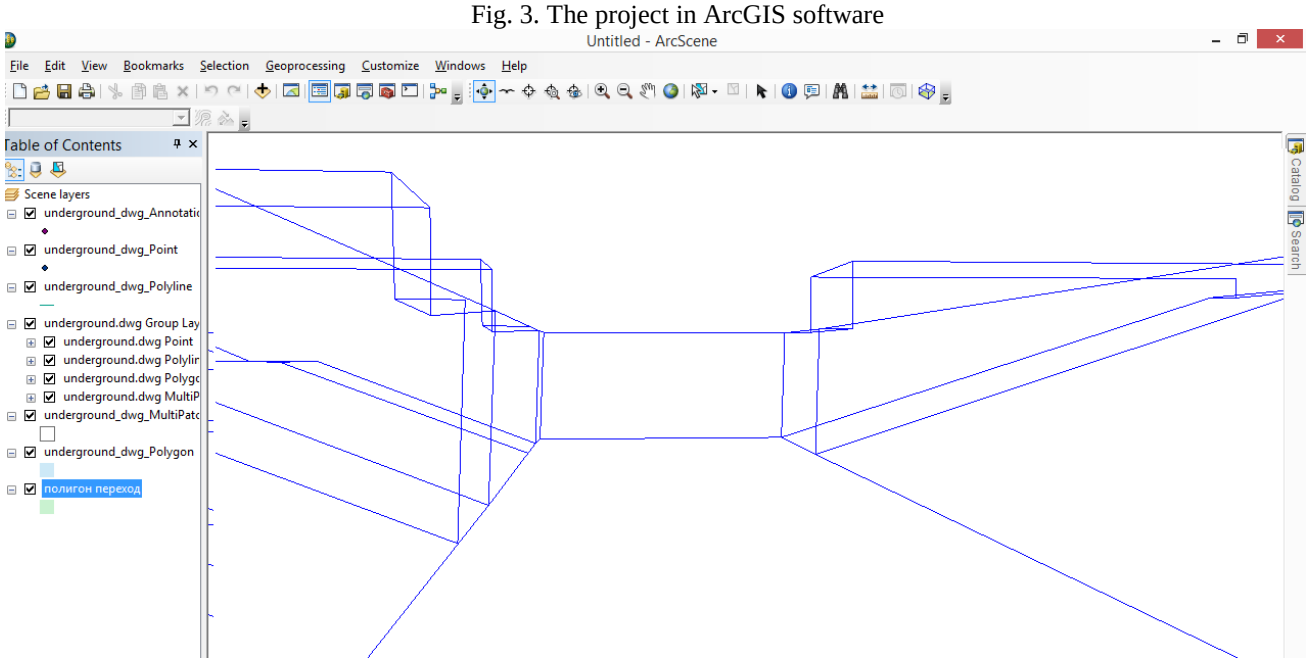

Fig. 4. Transverse image of the object

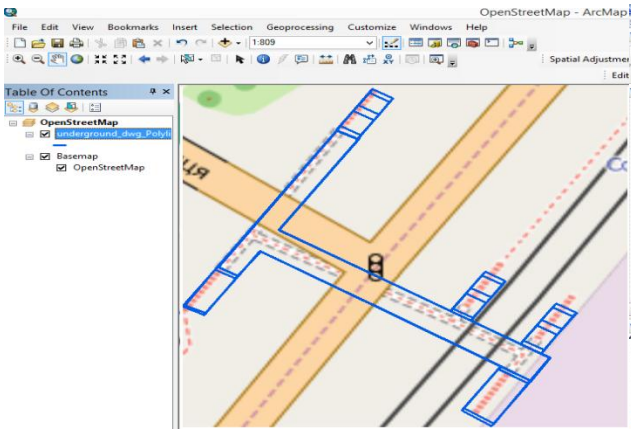

Fig. 5. Adding attribute information

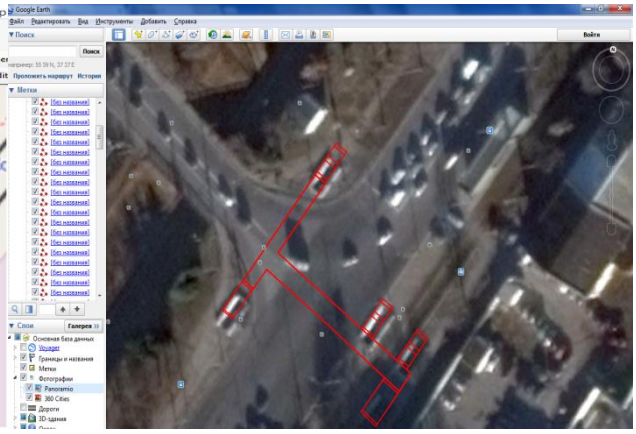

Fig. 6. Export project to Google Earth

Before we start surveying, was selected the reference point (stationary boundary fence) for further orientation of device, which was in sight at all dimensions of exits and underground locations.

Measurements were carried out in sequence: the sight of rangefinders, without descent into the underground room, focusing on the reference point and combining to capture the type of point and polygon received the finished project that has been exported to the ArcGIS software. The feature of combining two devices is that once the project is saved as in the GNSS receivers and recording such as GIS-project by SHP-files so as in the rangefinder, which saves a project in DXF format and can be played in the AutoCAD software to the needs of engineering calculations.

After processing project in the ArcGIS software, the object was assigned in a rectangular coordinate system (Fig. 3) and added as a layer of OpenStreetMap (Figure 5).

For needles of a simple results demonstration, the project was saved and exported in the form of KML, which made it possible to overlay layer in the free software Google Earth (Fig. 6).

In this way, the total recording process took about 25 minutes, as a result was received complete GIS project, and, in parallel, the project for engineering research. Set of receiver and rangefinder created mapping analogue of total station, easy to use and created for managing specific mapping tasks, as was the ability to record attribute data such as images, text notes, intermediate sizes and made it possible, at this stage, to solve the problem GNSS surveys in cities..

Findings

1. Today existing a real problem of GNSS surveys in cities and managing of big GIS projects caused by a number of objective factors and the level of technology development.

2. Updating of map information must be as quickly as possible, and should be based on reliable and verified data. One of the most reliable ways to capture that data are actualizing cartographic materials or creates new.

3. World scientists developed methods of strengthening or remote transmission of satellite signals, which means that problem is topical for today science and development.

4. One of solution to the problem of signal quality is to use GNSS/GIS receivers with remote measurement function, such as, Leica Zeno 20.

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A problem of GNSS surveying in big cities

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Consider the problem conducting a survey using satellite technology in the cities, and the ability to bypass this problem by using modern high-precision GIS devices, analyzed the test project for taking underground space surveying.