УДК 528.5

ANALYSIS OF THE MAIN ASPECTS OF MODERN TOOLS FOR SOLVING GEODETIC PROBLEMS
АНАЛІЗ ОСНОВНИХ АСПЕКТІВ СУЧАСНИХ ІНСТРУМЕНТІВ ДЛЯ ВИРІШЕННІ ГЕОДЕЗИЧНИХ ЗАДАЧ

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Анотація. У статті проведено аналіз можливостей інструментів сучасного зразку для вирішення геодезичних задач.

У дослідженні використовуються методи: спостереження, порівняння, аналізу, вибірки.

Зараз геодезичне обладнання виходить на новий рівень розвитку: і плані механічного удосконалення геодезичних приладів, програмного забезпечення самого обладнання, програмного забезпечення для інтерпретації даних завантажених з приладу, що призводить до пошуку нових шляхів оптимізації геодезичних робіт та обробки геопросторових даних. А найбільш економічним та обґрунтованим є вибір по збільшенню уваги до розробок спеціалізованого програмного забезпечення.

Зараз геодезичні прилади забезпечують достатню точність при виконанні більшості геодезичних робіт. Але все ж велика частина геодезистів ще користуються відносно застарілим обладнанням. Тому зростає потреба в сучасних геодезичних інструментах, які використовують сучасні технології та сучасне програмне забезпечення.

Водночас сучасне програмне забезпечення надає більше можливостей для реалізації сучасних завдань геодезії по збору більшої кількості достовірних даних. Це, в свою чергу, надає більше можливостей для аналізу цих даних.

Ключові слова: геодезія, просторові дані, геодезичне обладнання, програмне забезпечення.

Abstract. The article analyzes the capabilities of modern tools for solving geodetic problems.

The research uses the following methods: observation, comparison, analysis, sampling.

Currently, geodetic equipment is entering a new level of development: in terms of mechanical improvement of geodetic devices, software of the equipment itself, software for interpreting data downloaded from the device, which leads to the search for new ways to optimize geodetic work and geospatial data processing. And the most economical and well-founded choice is to increase attention to the development of specialized software.

Currently, geodetic instruments provide sufficient accuracy when performing most geodetic works. However, a large part of surveyors still uses relatively outdated equipment. Therefore, there is a growing need for modern surveying tools that use modern technologies and modern software.

At the same time, modern software provides more opportunities for the implementation of

modern tasks of geodesy to collect more reliable data. This, in turn, provides more opportunities for analyzing this data.
　　Key words: *geodesy, spatial data, geodetic equipment, software.*

Introduction.

The modern speed of technological development affects all spheres of human activity. One of these fields is geodesy. The impact lies in the development of modern geodetic equipment, improvements in instrument control software, and spatial data processing software. But in the methodology of geodetic works, this influence is insignificant. The use of technological equipment allows you to change the quality and time of work, but the method of carrying out work remains unchanged.

Geodetic equipment is now reaching a new level of development. Previously, devices tried to ensure the highest accuracy. Modern geodetic devices already provide high accuracy. Therefore, there are other directions of equipment development.

There is a need to optimize the methods of performing geodetic works: increasing the efficiency of information collection, the volume of information, increasing the efficiency of typical tasks in geodesy. This need characterizes a new stage in the development of geodetic instruments. It is based on the creation of modern software, which is the optimization of technological processes under new conditions. For example, the use of geoinformation systems, the use of modern equipment, the creation of new geodetic programs.

The new level of development consists in the plan of mechanical improvement of geodetic devices, software of the equipment itself, software for interpreting data downloaded from the device, which leads to the search for new ways of optimizing geodetic works and processing geospatial data. And the most economical and well-founded choice is to increase attention to the development of specialized software.

The purpose and tasks of the work.

The purpose of the article is to study the possibilities of modern tools for solving geodetic problems and prospects for the development of this topic.

To achieve the goal, the following tasks are set:

1. Analysis of modern geodetic equipment and its possibilities for solving modern geodetic problems

2. Analysis of the main aspects of modern geodetic software to support the operation of geodetic equipment and camera processing of spatial data.

Modern geodetic equipment and its influence on the solution of modern geodetic problems.

Previously, the development of geodetic instruments consisted in increasing accuracy. Now there are other criteria: increasing the efficiency of information collection, increasing the volume of collected information, increasing the efficiency of geodetic works. Because of this, there is a need for modern technologies.

Most of the modern geodetic devices are tacheometers, GNSS receivers, and geodetic scanners.

For example, the Leica Nova MS60 1". This is the world's first MultiStation. It allows you to perform all surveying tasks with one instrument (Figure 1).

It combines:
- the possibility of performing the highest class tacheometry;
- 3D laser scanning, which allows you to scan up to 30,000 points per second;
- the possibility of connecting to GNSS;
- digital image by point coordinates.

For example, the Leica GS18 I GNSS receiver (Figure 1). It allows you to determine inaccessible points on the field. The coordinates of these points are determined by images. It uses visual positioning technology, GNSS, IMU (inertial measurement device) and camera technology.

It allows you to solve problems:
- removal of construction objects in nature;
- measuring the area of plots;
- high u-accuracy of measurements during the construction of roads and bridges;
- engineering research;
- topographic survey of the territory [1-2].

Figure 1 – Illustration of Leica Nova MS60 total station and Leica GS18 I Leica Nova MS60 GNSS receiver
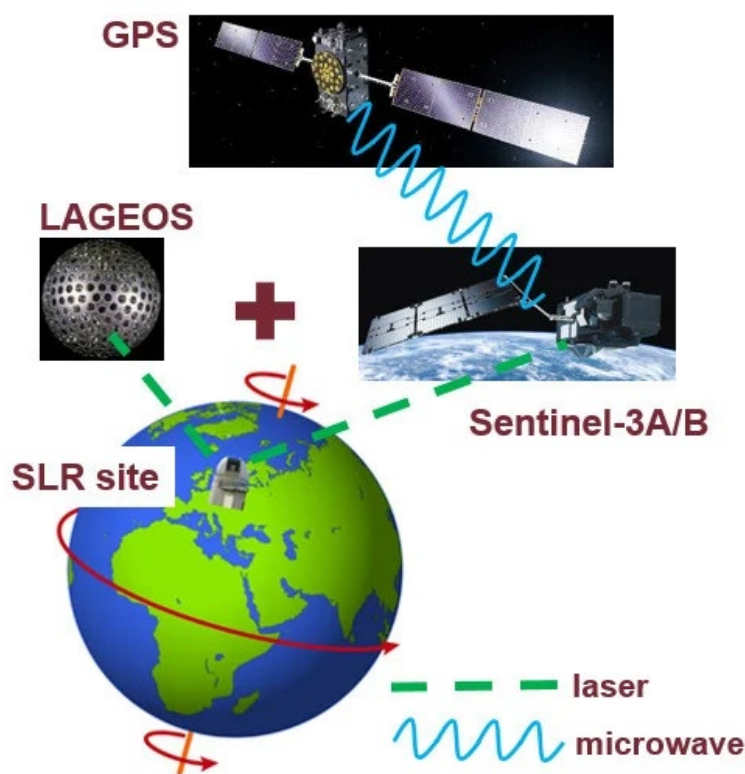
Джерело: [1-2]

At the same time, the two companies FARO and Z+F developed a device for simultaneous scanning and image capture with subsequent joint processing of the results (Figure 2) [3].

Satellite laser locator is an optical space geodetic method that typically uses measurements from active satellites, such as Global Navigation Satellite System satellites or low-earth orbiters , and passive geodetic satellites, such as the LAGEOS - 1/2 cannonball in medium Earth orbits or Starlette , Stella , Ajisai , LARES in low Earth orbits. Geodetic satellites are used to determine the motion of the geocenter, the global scale, the parameters of the Earth's rotation, the standard parameter of gravity GM , the coefficients of the Earth's gravity field of a small degree and to check relativistic effects (Figure 3) [4].

Drawing 2 – Integrated camera from ground laser scanner
Джерело: [3]

Drawing 3 – Satellite remote scanning
Джерело: [4]

Thus, the development trend of geodetic devices is: increasing the amount of information collected; improvement of software support for devices; improvement of spatial data processing software.

Analysis of the main aspects of modern software in geodesy

Modern geodetic means have peculiarities. This affects the collection and processing of geodata. Manufacturers develop special software for these tools . For example, for the Leica Nova MS60 MultiStation to meet your needs with:

- Leica Infinity: a convenient office suite of geospatial programs for professional surveyors; an ideal tool for managing, processing, analyzing and

quality control of field research data;
- Leica GeoMoS: software for automatic strain monitoring;
- Leica Cyclone: point cloud processing software;
- Leica Cloudworx: plug-ins of the automated design system that allow you to efficiently work with large point clouds directly in the selected system;
- Various Hexagon software packages and selected partner software.

For example, for the Leica GS18 I specialized the software – Leica Captivate. Leica Captivate is user-friendly surveying software designed to solve any surveying challenge. Measure, view or share data all in one software with easy-to-use programs and accurate 2D views and 3D models. Leica Captivate covers industry and project use cases with just a simple tap or swipe, whether you're working with total stations, GNSS or both. As a convenient, versatile and customizable field software, Leica Captivate is designed to solve any measurement problem [1-2].

Another example is the ArcGIS PRO software package , which is used to analyze spatial data. For example, one of the interesting projects in this direction at the moment is the use of "Pre-Trained Models in ArcGIS" presented in the work [5].

Similar equipment and related software cover a wide range of needs for geodetic tasks. But in cases when such software is not available, or it has limited capabilities when performing specialized geodetic tasks for a narrow range of specializations , other solutions are needed. Therefore, it is possible to solve non-standard geodetic problems with the help of handwritten programs or tools that allow you to expand the capabilities of already existing software tools.

Conclusions .

1. Disclosed features of modern geodetic devices. It was determined that modern geodetic works require optimization of geodetic problem solving methods.

2. Analyzed modern software. It was determined that modern geodetic software is created based on the capabilities of modern collection devices geodata and optimizes this process, but it is insufficient when performing specialized tasks.

In general, a study of the possibilities of modern tools was carried out: geodetic equipment and specialized software. Based on the results of the analysis, the obtained data can be concluded that the topic is relevant for further consideration.

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The article was sent: 05.02.2023.