American Journal Of Agriculture And Horticulture Innovations
(ISSN – 2771-2559)
VOLUME 02 ISSUE 10 Pages: 32-40
SJIF IMPACT FACTOR (2021: 5. 705) (2022: 5. 705)
OCLC – 1290679216 METADATA IF – 5.625
Publisher: Oscar Publishing Services

Journal Website: https://theusajournals.com/index.php/ajahi

Research Article

IMPROVING THE USE OF MODERN SURVEYING INSTRUMENTS

Submission Date: October 01, 2022, Accepted Date: October 05, 2022,
Published Date: October 13, 2022
Crossref doi: https://doi.org/10.37547/ajahi/Volume02Issue10-07

I.L. Akramov
Head of the department "Geodesy and topography" SSDI "Uzdaverloyiha", Uzbekistan

N. M. Khozhimurodov
Specialist of the department "Geodesy and topography" SSDI "Uzdaverloyiha", Uzbekistan

ABSTRACT

At present, the influence modern surveying instruments has increased significantly. Modern surveying tools make the process easier and saves time. The development of territorial production complexes, exploration and development of mineral deposits, design, construction, reconstruction of industrial, agricultural and energy facilities, land reclamation, land management, modern geodetic equipment must be used for urban and agricultural and other tasks.

KEYWORDS

Geodesy, GPS (GNSS)-technologies, Field controller, UAVs, Electronic tacheometer, Electronic theodolite, Electronic levels, Laser scanner.

INTRODUCTION

In our time, a large number of geodetic instruments and new technologies in geodesy have been created that are fundamentally different from traditional ones.

In previous years, each type of measurement had its own type of instrument: a theodolite for angular measurements, a level for height measurements, and a

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tape measure and range finder for linear measurements. Each device, depending on the intended use, had its own accuracy characteristics. The presence of professional equipment allows you to make the most accurate calculations in the shortest possible time. In the last decade, the pace of modernization of instruments used in geodetic calculations has increased significantly, completely new technologies have been developed, Modern geodetic instruments can be divided into several particularly significant groups:

1. GPS (GNSS) technologies
2. Field controller
3. Drones
4. Electronic total station
5. Electronic theodolite
6. Electronic levels
7. laser scanner

GPS (Global Position System) is a satellite radio navigation system or, as it is also called, a global positioning system. Geodetic GPS receivers are specially designed to accurately determine the coordinates of point objects. GPS receivers can be of the following modifications: single-frequency, dual-frequency and multi-frequency. Currently there are several GNSS:

- GPS (global position system) a system administered by the US government:
- GLONASS (global navigation satellite system), Russian satellite system:
- Galileo , Europe's satellite system:
- Compass. Chinese satellite navigation system.

The advantage of GNSS is the ability to determine the coordinates of points in the desired coordinate system at large distances, and as a result, labor costs are significantly reduced. New geodetic technologies include methods for determining the coordinates of points (positioning) from signals from special Earth satellites . moving in certain orbits.

Figure - 1 GPS technology

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The main advantage of such equipment is the mobility of transportation, since the GPS (Global Position System) has a relatively small weight and dimensions.

Field controller - application in geodesy received relatively recently. Although in the field of electronics and computing devices, this is a fairly common device with which various equipment is controlled.

Combining many functions and modules (sound recording, voice communication, camera, wi-fi , Bluetooth, touch screen, etc.), this tool facilitates the implementation of geodetic surveys and increases its accuracy and efficiency, in essence being a portable computer with rich range of possibilities.

The most important argument in favor of using controllers was the elimination of errors and errors that appeared due to the human factor, and the acceleration of calculations. Although the use of this equipment violates the principle that is mandatory for geodetic justification of topographic surveys: rechecking the data obtained by a second specialist - with repeated measurements if necessary. The ability to connect the controller to various measuring instruments (GNSS receivers, laser scanners, tacheometers, etc.) and the accuracy of calculations allow you to get the most reliable research results in the shortest possible time.

- Convenient, intuitive interface.
- The ability to connect input and output devices without changing their software.
- Large amount of memory for data storage and the possibility of increasing it.
- A large number of modules.
- multimedia options.
- Durability and protection against possible damage when working in the field: resistance to temperature changes, moisture ingress to the case.

When surveying terrain with a field controller, two types of instruments can be used:

1. removable control panel connected to total station type devices
2. autonomous control unit working in geodesy with GPS equipment.

Figure -2 Field Controller

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Unmanned Aerial Vehicle – One of the most common tasks performed in geodesy is surveying and drawing up a detailed plan of the area. With the help of unmanned aerial vehicles, which appeared in service with specialists only at the beginning of the 21st century, this has become much easier. Most field surveys today are carried out by teams of surveyor engineers. In small areas, they provide high measurement accuracy and low cost of maps and plans. In vast areas with difficult terrain, work with "legs" becomes unprofitable due to significant labor, time and financial costs. If, however, such a modern tool as an unmanned aerial vehicle (quadcopter) is used for geodetic surveying of the terrain , then the work can be done much faster, cheaper and more conveniently. This statement is also true regarding the use of drones for dozens of other, very different tasks that require high-quality visual information from the air for their solution.

Figure -3 quadrocopter

This is the widest area of civil application of quadrocopters, which includes many areas:

- design and survey work for the construction and reconstruction of roads, buildings and structures;
- land surveying, inventory and cadastral valuation of land plots;
- monitoring the state of engineering communications, power lines, pipelines;
- assessment of the efficiency of land use;
- designing the development of urban and rural areas with the definition of zones for the placement of various objects;
- preparation of orthophotomaps for the needs of farmers and agricultural enterprises;

Due to relative affordability and quick payback, today, almost everywhere, drones are used for geodetic survey of vast and hard-to-reach areas of the earth's surface in order to create maps and plans for various purposes.

Electronic total station - The emergence of electronic total stations can be considered a natural development

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of geodetic technology, a general development of related instrumentation and electronics. An electronic total station made it possible to obtain coordinates at any point of an object within a short period of time without any additional or preliminary construction of the territory. The accuracy of catch measurement in a modern electronic tacheometer reaches half a second of arc a professional digital surveyor's instrument designed for accurate measurements in the field, elevations, horizontal distances and increments of rectangular coordinates. It combines a light range finder and a theodolite. The device is capable of performing engineering calculations and storing the information received.

Total stations perform a wide range of geodetic tasks:

1. Conducting cadastral and land management works;
2. Building maps and plans;
3. Conducting observations of the deformation of structures;
4. Maintenance of reconstruction and construction.

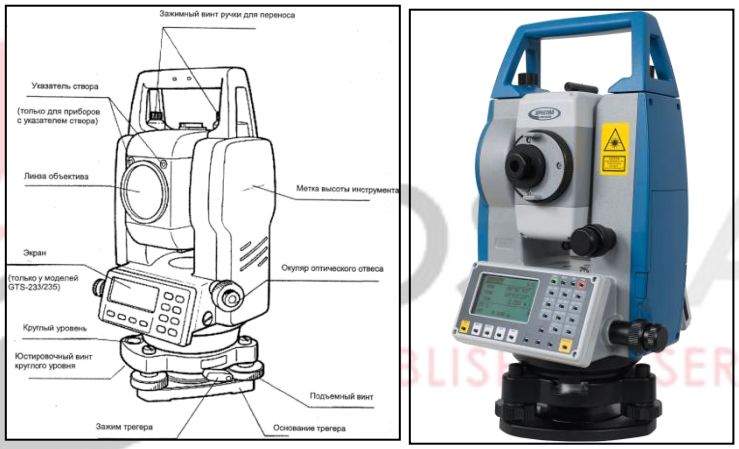

Figure -3 Total Station

The most functional type of geodetic equipment, which includes a huge number of technological options, is an electronic total station, and the price of the total station depends on the number of these options and additional functions. Such a geodetic instrument is capable of not only measuring distances and angles, but also processing data directly in the process of field work. In addition, it can be used to solve many applied geodetic problems. The electronic total station, which is known as the most "intelligent" geodetic equipment, has an internal memory where all the data obtained as a result of measurements can be stored. Distances are measured by the device based on the time it takes for a light beam from a geodetic instrument to reach the reflector and back. The possible measured range depends on the technical features of the device. So, devices with a reflective rangefinder with one installed prism can measure distances up to 5 km, with a few further. Reflectorless rangefinders operate in a range of up to 1.5 km. In addition, this characteristic of a geodetic instrument is affected by the influence of external environmental factors: humidity, temperature, pressure, etc. The highest measurement accuracy will be achieved in calm cloudy weather, in a place protected from vibration of operating mechanisms.

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The instrument's processor has a memory that can store a catalog of coordinates. The presence of the necessary coordinates allows you to get a resection or position yourself on any of the known points in the area, simply by selecting the desired point from the catalog. In addition, such geodetic instruments make it possible to carry out stakeout, shoot in coordinates and solve many geodetic problems.

Electronic Theodolite - Being highly accurate and very easy to use devices, electronic geodetic theodolites are gaining more and more popularity. These instruments are equipped with electronic sensors for taking measurement readings and then displaying their results on a display for the user. Easy-to-use electronic theodolites have become indispensable at the construction site during the construction of infrastructure facilities of any degree of complexity and in the performance of various works:

- fully automate the process of goniometric measurements;
- geodetic and engineering surveys for the construction of topographic plans and maps;
- construction of a network of geodetic points on the ground during general construction works;
- successfully used in military affairs.

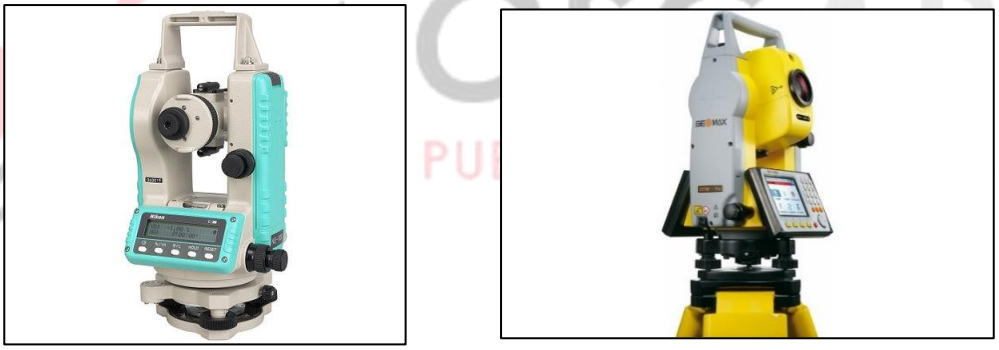

Figure -4 Electronic theodolite

The main working measure within the framework of the theodolite design is horizontal and vertical limbs equipped with minute and degree divisions. When participating in measurement work, theodolite aiming can be used at points with known static coordinates; in geodetic measurements, the device can be used in combination with a grid of threads. So, the electronic theodolite and its more advanced version of the total station represent the evolution of the device mechanics towards changing the used calculation system, providing increased accuracy and stabilizing the operating conditions of the device with modern technological additions. In this case, the electronic theodolite is created on the principle of ensuring ease of operation. The most important difference between electronic theodolites and optical devices is the use of a binary digital measuring system with full rotary angle sensors. Its essence lies in the marking of a

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photoelectric disk with an algorithm of black and white code marks, when illuminated , it turns out 1 or 0. This value is subsequently analyzed and processed in the processor. The captured information is recorded in an integrated storage element or transferred to external media or a PC.

The main components of electrotheodolites are:

1. laser or optical plummet;
2. stand with tribrach ;
3. graphical LCD screen with control panel for the most important actions;
4. visual optical tube with a network of threads for high-quality positioning on the object;
5. screws for fixing, adjusting and aiming;
6. high-strength case with a reference system placed in it.

Modern models, as a rule, are equipped with vertical compensators, which greatly simplifies the work with the device.

Electronic levels are modern multifunctional geodetic instruments that combine the functions of a high-precision optical level, an electronic storage device and built-in software for processing the measurements. The main distinguishing feature of electronic levels is a built-in electronic device for taking readings on a special rail with high accuracy. The use of electronic levels allows you to eliminate the personal errors of the performer and speed up the measurement process. It is enough to point the device at the rail, focus the image and press the button. The device will take a measurement, display the obtained value and the distance to the staff on the screen. Digital technologies make it possible to significantly expand the capabilities of levels and their areas of application. Experience shows that with a digital level, a 50% time saving is achieved compared to a conventional level. The main reasons are the fast data acquisition and the saving of measurements in the instrument's internal memory.

Figure -5 Electronic Levels

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Electronic levels have the following main positive features:

- Full automation, thanks to which the measurement results are immediately displayed on the instrument screen.
- Shock and moisture protection. Thanks to this feature, the device can be used in any conditions.
- Built-in memory. The ability to write information to the device.
- Transferring data to a computer. With a slot for a memory card, you can transfer information from the device to a computer in order to analyze the results in more comfortable conditions.
- Ease of use. Working with the device does not require special skills, everything is clear on an intuitive level.

All these features of the equipment allow you to perform many tasks much faster and more conveniently. Over time, these tools become even more advanced as they add new features that allow you to perform measurements even faster and more accurately. Such devices are indispensable in many areas.

The laser scanner is a completely new geodetic equipment. If we consider the technical side of laser scanners, we can say that a laser scanner is a device equipped with a high-speed non- reflective laser rangefinder and a system for changing the direction of the laser beam - a special rotary mirror. By setting the scanning area - the sector of rotation of the mirror, in which the laser beam of the range finder will propagate at a high speed up to 50,000 points per minute, you can get a continuous survey of the object of interest.

Figure - 6 Laser Scanner

Advantages of terrestrial laser scanning:

- a three-dimensional model of the object is obtained instantly;
- measurement accuracy is very high, section drawings and other drawings; data collection is very

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fast - a significant time saving when working in the field;

- defects and shortcomings are easily detected - it is enough just to compare the resulting design with the design 3-dimensional model;
- safety of shooting dangerous and hard-to-reach objects;
- topographic plans are obtained using virtual survey;
- calculation of the magnitude of deformations by comparison with previously obtained survey results.

Thus, one can see how much the technologies used in the geodetic support of construction have been improved. Modern geodetic equipment and tools allow us to complete the most complex projects in the shortest possible time, ensuring the accuracy of all calculations and increasing labor productivity.

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