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Topographic and Geodetic Supply Applied Devices and State Real Estate Cadastre

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Annotation: This article examines the generalization and analysis of information materials on the areas of application, principles of construction and operation of air laser systems used for topographic and geodetic support for maintaining the state cadastre of real estate. An analysis was made of the principles of construction, operation and main characteristics of air laser systems, their main advantages and disadvantages.

Keywords: land acquisition, aerial survey system, laser scanner, ALTM 3100, air laser scanner, RIEGL LMS-Q680.

Introduction. The contemporary city is a system that is always evolving. On its land, new residences, industries, and other facilities are continually being constructed, while aging structures are being torn down and new green areas are being added. Updating the master plan, keeping an eye on developments, and maintaining green areas stand out among the various duties involved in territory management. It is vital to employ techniques and algorithms that enable you to rapidly and accurately recognize changes taking place on the ground in order to solve them.

It is important to complete the following group of tasks in order to reach this goal:

• be transparent about the geodetic support used for cadastral work, including its primary functions, land surveying concerns, and the precision of establishing the borders of land plots and the real estate items situated on them;

• take into account the two primary techniques for gathering topographic data for the cadastre: ground surveys and remote sensing of the planet;

• to examine the fundamental elements of design, functionality, and primary attributes of airborne laser facilities;

• list the primary benefits and drawbacks of airborne laser systems.

The study's focus is on airborne laser scanning technologies.

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The utilization of laser devices for scanning built-up regions is the study's focus.

Main tasks of geodesy in cadastral works. Based on cartographic materials, land inventory materials, land surveying, and cadastral surveys, which are used in the preparation of plans for land plots attached to documents certifying the rights to these plots, the State Real Estate Cadastre (GKN) and the Town Planning Cadastre, land management, and land monitoring are provided [4].

Since all information about land parcels and real estate must be spatially referenced, geodetic activities are crucial for the establishment of cadastres. Land surveying is one of these tasks since it entails establishing, repairing, and fixing a land plot's physical borders as well as locating and measuring them. There are several types of topographic and geodetic works:

• Creation of a fund of cartographic and geodetic materials, including topographic maps (plans);

• catalogs of coordinates of points of the state geodetic network (GGS) of survey networks;

• catalogs of reference boundary network coordinates (BMS) and boundary marks;

• cadastral maps (plans);

• cadastral surveys.

Cadastral surveys are conducted on the same scale, in the same manners, and with the same precision as topographic surveys, depending on the purpose of the cadastre. The most common scale is 1:2000, the base scale is 1:500, and survey and reference scales are 1:100,000 and smaller. [1].

Cassational maps and plans show:

• the limits of property parcels, belongings, and other land uses;

• land plot cadastral numbers and names;

• provide an explication (description) of the various land use categories and other cadastral data. There's a chance that cadastral maps and plans don't show the terrain;

• a list of the land.

The process of inventorying land and real estate, as well as complex cadastral work, involves the gathering and analysis of available cartographic, cadastral, land management, legal, and other materials, the examination of land plot boundaries, the determination of the type of land use, and the determination of land areas. According to the coordinates of boundary markers, analytical methods are mostly used to compute the acreage of land plots. There are times when allocation of land and cartographic materials are employed.

Land acquisition - this is the procedure for drawing territorial lines in accordance with an administrative decision that has been accepted to allow for the use (ownership) of a certain plot of land. The primary purpose of a

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land plot's border, which is a fixed spatial entity, is to physically and legally divide the land on the plot from the neighbouring areas [2].

The construction of a single data bank and the ability to store object information as digital data are two reasons why cadastral plans of cities should be created in a single state coordinate system[1].

Currently, GLONASS / GPS satellite technologies are utilized in conjunction with digital photogrammetric systems, such as PHOTOMOD (Russia), etc., to gather and analyze information on the territories with intensive urban growth and extensive amounts of nearby land. [3].

Main characteristics of airborne laser systems. ALTM 3100, an airborne laser mapping device.

A device that uses laser radiation to conduct measurements is called a laser scanner. Currently, the ALTM class of airborne laser mapping technologies is employed most often. These scanners come in a wide range of variations. [6].

The key characteristics of this type of scanners are:

• fixing the strength of the reflected signal (allowing for nighttime work);

• the fixation of up to four reflections of a single impulse (possibility of separating plant tops from the ground surface);

• the best efficiency of the already marketed laser mapping systems (for instance, the efficiency of the ALTM 3100 aircraft laser radar, which can cover up to 1000 sq km in a single working day);

• compatibility with hyperspectral sensors, digital cameras, and pulse waveform recorders to provide new, complicated data kinds.;

• the capacity to work with GPS and GPS/GLONASS receivers made by several companies;

• the existence of a planned installation strategy for domestic aircraft;

• adjusting to Russian circumstances;

• high economic efficacy of application in settings when alternative approaches are exceedingly challenging, impractical, or constrained by seasonal variables (seasonal limitations, continuous foliage, lack of reference topography, etc.);

• DASHMap, a high-performance laser data pre-processing program with an integrated 3D viewer for displaying and exporting XYZI data, etc.

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Table 1 - Specifications for the ALTM 3100 Airborne Laser Scanner

Parameters	Meaning
Probing pulse frequency	33 kHz 50 kHz 70 kHz 100 kHz
Shooting altitude	from 80 to 3500 m
Height Scan Accuracy	no worse than 15 cm at a height of 1200 m no worse than 25 cm at a height of 2000 m no worse than 35 cm at a height of 3000 m
Accuracy of determining the planned position of points	better than 1/2000 of shooting height
Shooting swath width	0 to 93% of shooting height
Range Resolution	1 cm
The number of recorded reflections of the laser pulse	4 including the last
Intensity registration	12 bit dynamic range for each measurement
Scan Angle	from 0 to +250
Roll compensation	Nominally ±50, depending on the current field of view
swath width	0 to 0.93×Nm
Scanning frequency	0-70 Hz, depending on scan angle
Distribution of reflections on the surface of the earth	Evenly over 96% of the scan line
Used on-board navigation system	Applanix POSAV, modified
Onboard GPS receiver	Trimble 750
Divergence of the laser beam	0.3 mrad or 0.8 mrad
Laser category	Class 4
Height of safe vision	200m at 0.7mrad 400m at 0.2mrad
Humidity	0-95% non-condensing
Consumption	28 VAC, 24 A average, 35 A peak
Operating temperature range: -scanning unit -control rack -with thermal stabilization	from -100C to +350C from +100C to +350C from -300C to +550C

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Dimensions/Weight: -scanning unit -control rack	26×19×57cm/23.4kg 65×59×49cm/53.2kg

The ALTM 3100 Airborne Laser Mapping System is the most precise, effective, and economical laser mapping system currently on the market (in its class).

Fig.1 - Airborne laser scanner ALTM 3100

The RIEGL LMS-operational Q680's settings may be set up to work with a variety of applications. The instrument is simple to incorporate into an entire (full) aerial scanning system because to the variety of interface possibilities. The Appendix B depicts the RIEGL LMS-Q680 Airborne Laser Scanner.

Table 2 lists the technical specifications of the RIEGL LMS-Q680 airborne laser scanner.

The scanner is a very dependable and sturdy gadget that is perfect for mounting on an airplane. Additionally, it is lightweight and compact enough to be installed on single-engine aircraft, helicopters, and unmanned aerial vehicles.

The equipment just needs a power supply and GPS synchronization signals to run, giving it operational control in the capture of precisely timed and digitized echoes.

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Fig.2 - Airborne laser scanner RIEGL LMS-Q680

The RIEGL Data Recorder provides reliable data recording and storage during the measurement process.

Table 2 - Specifications of the airborne laser scanner RIEGL LMS-Q680

Parameter	Meaning
Probing pulse frequency	80 kHz 120 kHz 180 kHz 240 kHz
Shooting altitude	from 1000 to 1600 m
Error	20 mm
Reflectivity	20%
Laser wavelength	Near IR range
Intensity registration	16 bit dynamic range for each measurement
Scan Angle	from 0 to +600
Roll compensation	Nominally ±50, depending on the current field of view
Scan Engine	Rotating polyhedral mirror
Scanning frequency	up to 160 Hz, depending on scan angle
Raster	Parallel scan lines

Scan speed	10-200 sweeps per second
Angular Reading Resolution	0,0010
Divergence of the laser beam	≤0,5 mrad.
Consumption	7A at 24VDC
Nutrition	18-32V DC
Dimensions/Weight:	480×212×230mm/17.5kg

Figure 1 depicts the basic workings of airborne laser systems. The emitter is a semiconductor laser that operates in a pulsed mode and is typically near infrared in wavelength. The slant range to the reflection point and the angle value that determines the probing beam's direction of propagation in the locator's coordinate system are both noted for each act of scanning. For each line of sight, up to five reflections may be captured, depending on the scanning system type. As a result, laser-location images can be obtained that are more informative. The first responses will be received as a result of reflections from foliage of vegetation, wires and pylons of power lines, the edges of buildings, and the last response, which typically corresponds to the ground or another hard surface, such as the roof of a building, will be received due to reflections from these objects. The inbuilt GPS (GLONASS) receiver of the carrier keeps track of its trajectory. This makes it feasible to immediately extract the absolute geodetic coordinates of the scene components that reflected the probing beam when combined with the observed values of the slant range and scanning angle.

Conclusion. The following activities were completed during the article's authoring:

- revealed the geodetic support's material during cadastral operations;
- the following are the primary ways to get the topographic elements needed for the cadastre: Earth remote sensing and ground surveys;
- the fundamental building blocks, primary functions, and features of airborne laser facilities were examined;
- The primary benefits and drawbacks of airborne laser systems are listed.

The primary duties of geodetic assistance for cadastral work and difficulties pertaining to land surveying were taken into consideration while exposing its content. For built-up regions, it has been determined that the precision of identifying the boundaries of land plots and the real estate items situated on them should not be less than 0.20 meters.

The fundamentals of design, functionality, and primary attributes of airborne laser systems, as well as their primary benefits and drawbacks, were examined. The ALTM 3100 aerial laser mapping system and the RIEGL LMS-Q680 airborne laser scanner were both compared and their key features were highlighted.

Offering the end user a range of products that may be utilized in the development of geographic information systems, design, examination, and analysis of the condition of various objects, control of engineering work, regression analysis, etc. is made possible by the use of laser scanning technology.

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