UDC 528.7

MODERN METHODS OF REMOTE SENSING OF THE EARTH

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This article discusses the methods of remote sensing of the Earth for topographic and geodetic, cadastral purposes, presents the current trends in the industry.

Introduction. Topographic and geodetic, cartographic, as well as other sectors of the national economy, are trying to introduce and adopt modern discoveries, advanced research tools of physics, mathematics, information technologies, and methods and technologies of related industries to solve problems. On the other hand, new technologies should be analysed and investigated in order to estimate and think through the advantages and disadvantages compared with conventional methods.

Remote sensing of the Earth is the acquisition of information about the Earth's surface and objects on it, the atmosphere, the ocean, the upper layer of the earth's crust by non-contact methods, in which the recording device is removed from the object of research at a considerable distance [1]. In the narrow sense of the word, remote sensing refers to airborne and satellite surveys.

Remote sensing is an extremely valuable tool that is vital to many industries, from mining to fishing and farming to mapping and surveying operations, and the ways to use remote sensing just keep expanding [2].

The aim of the work is to study and analyze modern methods of remote sensing and processing of their results for use in topographic, geodetic, cartographic and cadastral activities.

Methods. Depending on the task, the sensors can be placed on different platforms and, accordingly, the following types of remote sensing can be distinguished: ground, airborne (aerial photography), space. Each of these types has its own capabilities, purpose and, accordingly, own characteristics and application.

Depending on the source of the registered radiation, the surveys are subdivided into active (using their own source of electromagnetic radiation to irradiate the objects being shot, e.g. radar survey), passive (recording solar radiation reflected by objects or own radiation of the Earth).

By the technology and the spectral range remote sensing methods are distinguished:

- in the optical range: in the visible and near infrared range (photographic and scanning), thermal infrared;
- in the radio range: microwave radiometric, radar.

In modern sensing systems, the multispectral principle is widely used. There are the following surveys using this principle:

- multisensor, in which imaging is simultaneously performed in several (3-7) spectral zones
- hyperspectral, in which imaging is carried out simultaneously in dozens or hundreds of narrow spectral regions,
- ultraspectral, in which imaging is carried out simultaneously in many hundreds of narrow areas of the spectrum [3].

In a radar survey, the multispectral principle is implemented using several microwave wavelengths and different polarization.

The world is changing very fast. The rapid development of information technologies, machine vision technologies, and an increase in the positioning accuracy of satellite navigation systems make it possible to introduce such methods as digital aerial photography from unmanned aerial vehicles (UAVs) and laser scanning.

The influence of the development of methods and technologies for performing topographic surveys is manifested and consolidated in technical regulations. With the entry into force building norms 1.02.01-2019 [4] in 21.09.2020, the relevance of using the aerial topographic method for surveying of large areas and long linear objects is preserved, if the required accuracy and economic feasibility are ensured In addition to traditional aerial topographic methods such as combined and stereotopographic surveys, described in the previously valid 1.02.01-96, it is allowed to perform such surveys for engineering and geodetic surveys as aerial laser scanning in combination with digital aerial photography and digital aerial photography using UAVs.

It should be noted that such changes have long been expected by the professional community, since the possibilities of the above methods can hardly be overestimated. The advent of low-cost UAVs has been a boon to surveyors. Now they can expand their business or add value to their company by collecting high-resolution imagery. Airborne remote sensing using UAVs will remain a key science and technology for data collection. While UAVs are not yet used for national-scale mapping, they have proven to be satisfactory for smaller urban areas, industrial zones or protected areas with higher densities, resolutions and frequencies [5, 6].

Another more up-to-date trend is the use of hybrid sensor systems already for aerial photography, combining a single-camera or multi-camera system in order to integrate multiple types of data. It leads to much richer datasets and better decision making for the final users. There may be the following combining of different sources of information, such as LiDAR and optical imagery, hyperspectral scanner or other [5, 6] as well as data of different spatial resolution. The use of multisensor data leads to more comprehensive information about the object under the study.

The modern development of data processing software has led to appearing of a lot of software products. Specialists expect the appearance of a new generation of easy-to-use software, the development of automatic methods for detecting and recognizing objects, which, in turn, leads to automatic mapping. Sophisticated image processing and analysis software including deep learning technologies are in great demand [6]. For processing remote sensing data, today it is important to solve the problem of big data to extract useful information.

As for satellite remote sensing an increase in the commercial availability of high-quality satellite remote sensing data, new sensor launches for surveys and re-surveys, growth of space constellation of satellites as well as radar satellites are expected [6]. New sensors and a higher re-survey rate provide the opportunity for advanced time series analysis, e.g. geodynamic analysis.

Analyzing the world experience in obtaining spatial information, and specifically performing topographic surveys, we see that in the last 10 years, laser scanning has experienced a boom in use for obtaining accurate and detailed information about objects. Although aerial laser scanning from UAVs is not widely used due to the weight-to-price ratio, serious progress in this direction is noticeable [7].

Results and conclusion. Thus, remote sensing is intensively developing, adapting to the stages of development of society. Various global processes have a significant effect on the development of society and remote sensing as well. However, there is an increasing need for detailed, accurate spatial information, processing large amounts of information, accessibility of information processing tools, simplifying the use of software products, simplifying the integration of various types of data. The development of new modern approaches to data acquisition, analysis and the presentation should not overcome the advantages of conventional methods.

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