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Information Monitoring of Transport

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Abstract

The article analyzes the information monitoring of transport facilities. Information monitoring is integrated monitoring, which includes geo-information monitoring, geodesic monitoring, space monitoring and mathematical modeling methods. Information monitoring also includes digital and information modeling. The article gives a classification of monitoring objects of transport. It is proved that modern information monitoring of transport facilities should be comprehensive. It is shown that the development of information monitoring is fully consistent with the Transport Strategy of the Russian Federation for the period up to 2030 and is included in the objectives of the development of the transport system of Russia.

Keywords: informatics, transport, management, infrastructure, monitoring, information monitoring, space monitoring.

1. Introduction

Development of the unified transport space of Russia on the basis of balanced development of transport infrastructure is one of the objectives of development of the Russian transport system. This objective was approved by the Transport Strategy of the Russian Federation for the period up to 2030.

The unified transport space of Russia must solve a variety of tasks. These tasks include: functioning of the balanced system of transport utilities; functioning of the integrated infrastructure of all means of transport; application of uniform standards of technological compatibility of various means of transport; harmonization of standards for technical compatibility of various means of transport; creation of the information environment of interaction of various means of transport. Creation of the information environment of interaction of various means of transport increases the value of information methods and technologies. The unified transport space will provide the growth of the Russian economy. It will strengthen the connections between the regions by removing structural imbalances in the transport sector. The unified transport space adds new territories to the economy through establishment of additional transport connections. Information space is the basis of the unified transport space. Information space is created technologically and technically. The information space status is supported by monitoring. Information monitoring is the most important thing for information space.

Information space is created through application of integrated technologies. Such integrated technologies include ground-based and space observation methods. Space technologies are currently contributing to development of various industries (Barmin et al., 2014; Bondur, Tsvetkov, 2015b). This is due to the fact that space monitoring is able to obtain information throughout the

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entire range of electromagnetic waves. Space monitoring technologies allow not only to receive information about objects on the Earth's surface, but also serve as the basis for monitoring and validating of ground-based data. It is important to stress that monitoring technologies are not fragmented, but are a complex, holistic technological system. Technological monitoring system has the property of self check, since it can duplicate information, obtained via different channels. Space methods are essential in global transport control and in support of intelligent transport systems (Wen et al., 2011). Space technologies contribute to creation of the spatial data infrastructure (Coleman, 2010). Development of state-of-the-art transport control is impossible without the use of space technologies and space monitoring. This is due to the space monitoring capabilities, which include (Bondur et al., 2015) greater visibility of space resources and prompt obtaining of information. One space image can replace up to 1,000 images, obtained during the aerial imaging (Savinykh, Tsvetkov, 2001). Space monitoring enables monitoring of the Earth's surface up to 24 times per day. Such space monitoring provides an opportunity for observations in any hard-to-reach areas. Space monitoring enables transmission of information in a wide range of electromagnetic waves to any users. Users of space-based information can be located anywhere in the world. Remote sensing methods are the basis of the space observation technology. Earth's remote sensing methods have proved to be effective over the past decade. Their evolution and adaptation to different tasks and different consumers led to creation of diversified space technologies of observation and research of the Earth's surface. Information monitoring combines space and ground-based technologies.

2. Results

Characteristics of Information Monitoring. Space monitoring has many advantages. However, space monitoring, as a means of information collection, obtains only aggregated, survey and generalized information. Generalized information is a summary survey information of a large volume, but not of a high accuracy. Ground-based methods provide collection of highly accurate information. High accuracy is provided by geodetic methods and photogrammetric methods. Combination of methods of geodesy, geoinformatics and photogrammetry has resulted in the emergence of an integrated geomonitoring (Wagner, 2016). Application of information and mathematical modeling methods has led to the integration of the geomonitoring with the information monitoring. Modern information monitoring is an integrated monitoring, including methods of ground and space monitoring, combined with digital and mathematical modeling methods.

Monitoring includes technological, technical and information factors. Technological factors of space monitoring include the following characteristics: monitoring object, monitoring purpose; monitoring field, monitoring methods, monitoring technologies and monitoring object models. The most important factors are: monitoring purpose; monitoring field; monitoring object; monitoring methods.

There are two types of monitoring object models: a priori model and a posteriori model. A posteriori model is built after conducting monitoring. A priori model is built prior to monitoring, if information about the monitoring object is available.

Monitoring object is located in the area, which affects it (Figure 1). It is the field (not the space) that changes the state of the monitoring object. Different technologies, selection of which depends on the monitoring object and purpose, are used during the monitoring.

Monitoring field is the type of information field (Tsvetkov, 2014b). The set of models, which are used in space monitoring, is large.

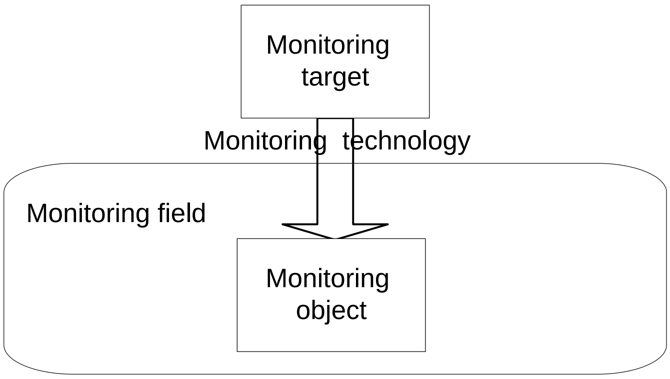

Fig. 1. Monitoring field and object

Information models of objects, processes and situations (Tsvetkov, 2014a), information construction (Rozenberg, 2016) (generalized models of objects and processes), communication models, models of information units, correlative models, models, opposition models and dichotomous models are used during the monitoring.

Figure 2 shows the result of space monitoring, namely railway junction as a fragment of transport infrastructure. This image was obtained in the visible spectrum.

Fig. 2. Fragment of railway station in Burgas, obtained during the satellite imagery
Source: http://earthexplorer.usgs.gov/

This image provides information about the state of the monitoring object. The combination of images allows to identify trends of the state. The combination of images allows to evaluate the results of control over the infrastructure objects.

Information monitoring includes space monitoring. It is used to address a variety of application tasks. It includes: research of the ecological condition of the soil; control of vehicle movement; control of real estate objects; analysis of fire hazardous situation; control of pipelines; control of transport infrastructure.

Monitoring can be considered as three types of complex systems – technological, technical and complex organizational and technical systems. Monitoring, being the complex technological system, provides not only observation, but also systematization of data and results of processing. Information monitoring provides integrated processing and representation of information. Such a possibility is created through the application of geoinformatics methods, which offer data integration.

The generality of monitoring allows to select the channel of electromagnetic waves for an active task. For example, when monitoring a fire hazardous situation, the infrared range is applied (Pereira et al., 2011). For this task, it is a key indicator. Other indicators are applied during the study of the Arctic or Antarctic Territories. Polar night or polar day are typical for low-latitude territories. In the latter case, the bright white background fills in the visible spectrum (Savinykh, 2012). This makes the transition from the visible spectrum to the radio range and the use of high-resolution radar images. The same channel is used in case of intense cloudiness above the surface (Zatyagalova, 2012).

Many transportation problems require the use of integrated monitoring, which includes infrastructure monitoring and monitoring of mobile objects. Technological diagram of diversified (Bondur, Tsvetkov, 2015a) integrated monitoring is shown in Figure 3.

Figure 3 shows that information is obtained in different ranges, for which purpose different types of satellites are used.

Integration of tasks of information transport monitoring results in the need for integration of methods. Special mention should be made of the remote sensing and geoinformatics, combined into a single system.

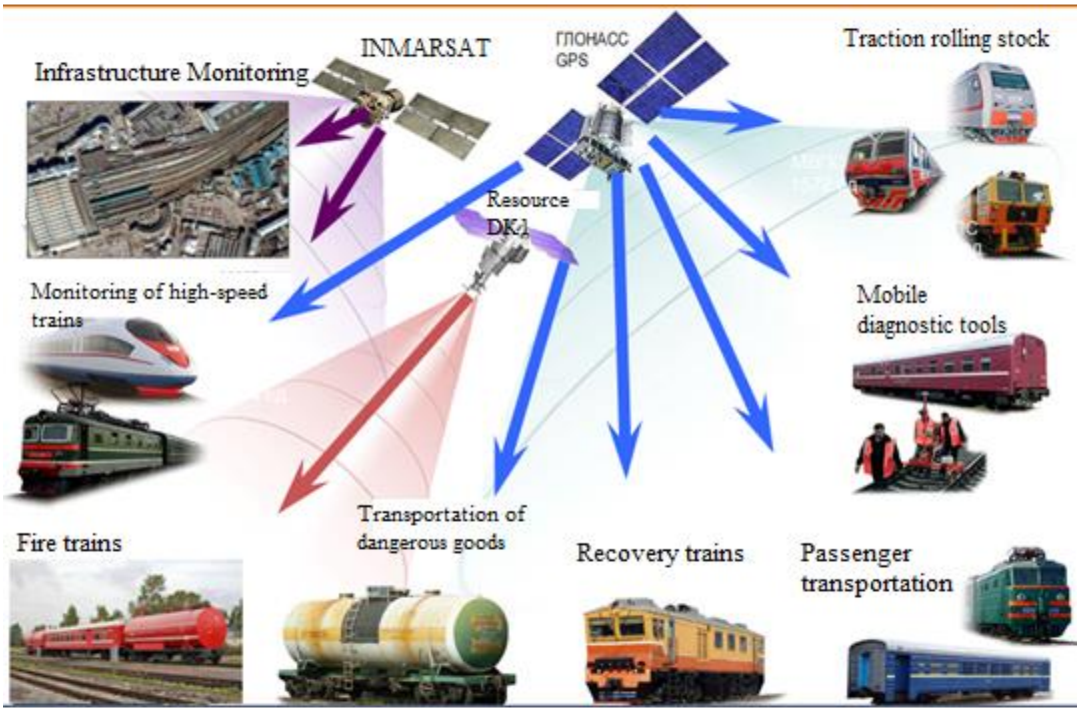

Fig. 3. Information Transport Monitoring

Application of geoinformatics defines the need for selection of geodata as the key data. Geodata is an integrated information base, including social, spatial and time-dependent information. Geodata represents the complementary data system and the information system resource (Savinykh, Tsvetkov, 2014). System resource exhibits characteristics of consistency and integrity. System analysis allows to conduct comprehensive analysis, which is impossible in case of using certain types of monitoring.

Types of Monitoring

The complexity of problems, solvable using the methods of information monitoring, makes necessary not only the use of special data, but also the use of the variety of modeling methods. The use of computer technologies as the primary modeling tool sets the information modelling to be the primary modeling tool in case of transport monitoring. Such modeling can be called common, because it summarizes different types of modeling. Modeling is related to the monitoring types.

Global monitoring is used for observations in terms of the globe. Planetary changes and state of the oceans and seas are studied using global monitoring (Tsvetkov, 2012). Global condition of the soil, flora and fauna dynamics of the entire world are studied using global monitoring. Global environmental monitoring is implemented within the framework of UN programs. Global monitoring is used for the global control of vehicles, which primarily include high tonnage tankers. Global monitoring is used for research of the near-Earth space.

International monitoring is implemented under the joint programs of different countries. It is used to study the phenomena, occurring within the territory of the continent or several countries. International monitoring is used for control of transit traffic.

National monitoring is used to study processes on the territory of one country. This can be the industry-based monitoring or interindustry monitoring.

Regional monitoring is the smaller-scale monitoring. It is used to monitor regional areas, which form separate regions and republics or territorial production complexes. The purpose of this monitoring is to monitor regional transport and traffic within the region.

Local monitoring (monitoring of local zones) is applied to separate large objects (metropolis), and means of transport (Kuzhelev, 2017). Control over the movement of transport objects is the major task for local monitoring. Local monitoring includes installation of on-board signaling units on means of transport. Using the satellite signal, the monitoring system determines the coordinates of the vehicle, that allows to control its movements. The relationship between terrestrial mobile technologies and satellite technologies is worth mentioning. Such monitoring of the route makes possible the real-time identification of vehicle malfunctioning and connects the so-called indicative monitoring.

Local space monitoring is also used for infrastructure monitoring. Metropolis Security program (Homeland_security, 2018) focuses on infrastructure. A modern city has many subsystems, the most important of which is the transport subsystem. All subsystems of the city operate and interact on the basis of the transport subsystem. Space information plays a crucial role for control over the operation of all subsystems.

Information transport monitoring is divided into different groups by the range of electromagnetic waves. They can be listed. Monitoring within the visible spectrum. Monitoring within the infrared spectrum. Radar monitoring. Monitoring within the x-ray range.

3. Conclusion

Development of international transport corridors ensures their competitiveness and efficiency. Information monitoring is required for control of the state of transport corridors. Modern information monitoring of transport infrastructure objects is a new research area, which is being currently developed in the applied aspect. Information monitoring is a broad concept and includes not only monitoring of individual objects, but also their infrastructure, environment and movement situation including forecast of the state of a mobile object. Information monitoring solves a number of important auxiliary problems, such as monitoring of road conditions, fuel consumption, control over operation of the rolling stock, control over transportation of vital cargo. Information monitoring uses a huge number of mathematical and information models, which significantly complicates its synthesis in this area. Information monitoring of transport objects is an integral part of control over the transport and requires further development and research.

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