Published in the USA
Russian Journal of Astrophysical Research. Series A
Has been issued since 2015.
E-ISSN: 2413-7499
2023. 9(1): 24-27

DOI: 10.13187/rjar.2023.1.24
https://rjar.cherkasgu.press

Satellite Monitoring

Viktor Ya. Tsvetkov [a, *]

[a] Research and Design Institute of design information, automation and communication on railway transport, Moscow, Russian Federation

Abstract

The article explores satellite monitoring. This technology is one of the space research technologies. The difference between space monitoring and satellite monitoring is shown. Two implementations of satellite monitoring are described. The systematics of satellite monitoring is given. The influence of Earth sciences on the development of satellite monitoring is described. The importance of the concept of the information field and information space on the concept of satellite monitoring is noted. The key concepts of satellite monitoring are described. The content of satellite monitoring is revealed through key concepts. The monitoring field, monitoring situation, monitoring methods, monitoring result models are described. The value of the information situation model for satellite monitoring is revealed. The difference between the information situation and the monitoring field is shown. Methods and models of monitoring are described. Object monitoring and process monitoring are described. The difference between active and passive satellite monitoring is shown. The difference between indicator and analytical monitoring is shown. Detective and interpretive monitoring is described. Prospective satellite monitoring is described, which, based on time series, makes it possible to make forecasts. It is shown that, unlike space monitoring, in which angular measurements predominate, satellite monitoring makes it possible to obtain the linear dimensions of objects. In relation to space monitoring, satellite monitoring is internal. Satellite monitoring is applicable in the study of other planets. In this case, it should be called orbital monitoring.

Keywords: space research, monitoring, space monitoring, satellite monitoring, spatial modeling, space geoinformatics.

1. Introduction

In the practice of space exploration and the Earth's surface, the term “space monitoring” is often used (Savinych, 2017; Kudzh, 2022) and less often the term “satellite monitoring”. There is a significant difference between these concepts. Space monitoring is aimed at studying near-Earth space (Barmin et al., 2014), at studying the Earth's satellite – the Moon, at studying the space of the Solar System, at studying near and far space. Space monitoring investigates the problem of astreoid-cometary hazard (Tsvetkov, 2016). Satellite monitoring is aimed primarily at studying the Earth from space. Satellite monitoring also investigates the problem of astreoid-cometary hazard.

Technologically, both monitorings are close. But the purposes of information processing differ. The connecting element between them is space geoinformatics. Therefore, both monitorings incorporate technologies and methods of Earth sciences and complement them with space

* Corresponding author
E-mail addresses: cvj2@mail.ru (V.Ya. Tsvetkov)

exploration technologies. The development of satellite monitoring is an indicator of the state of science and technology. Satellite monitoring has two implementations. The first is associated with the automatic registration of the earth's surface without human intervention. The second implementation is related to the use of orbital scientific stations (Savinych, 2018). This type of satellite monitoring uses cognitive technologies. In particular, they use technologies for visually instrumental observations.

The effectiveness of satellite monitoring is manifested when global observations are needed. This is a global ecology. Satellite monitoring is characterized by long observation distances and large objects of observation. This leads to the emergence of a big data problem (Allam, Dhunny, 2019). Satellite monitoring is divided into indicative, periodic and continuous. Continuous satellite monitoring also poses a big data challenge.

To improve the reliability of observations, multispectral observation of the earth's surface is used. Multispectral observation of the earth's surface creates the need for integrated data processing. Geodata is used for integrated data processing.

The modern development of satellite monitoring is characterized by the widespread use of Earth sciences, transformed into space research. Among these sciences: space geodesy (Bertiger et al., 2020), geodetic astronomy (Gospodinov, 2018), satellite altimetry, space geoinformatics (Bondur, Tsvetkov, 2015a). System analysis is used in satellite monitoring (Bondur, Tsvetkov, 2015b).

Satellite monitoring technologies and techniques use Earth science techniques. Satellite monitoring uses information methods in research. In addition to system analysis, the conceptual directions of space monitoring are the concept of the information field and information space. A feature of satellite monitoring is the use of various types of modeling, including metamodeling.

2. Results and discussion

Analysis of the content of satellite monitoring

The key concepts of satellite monitoring are: the object of monitoring, the field of monitoring, the monitoring situation, monitoring methods, models of the monitoring result.

The monitoring field is a subset of the information field. It sets the possible limits of monitoring and limits unnecessary observations. The monitoring field is characterized by spatial factors and spatial relationships. The monitoring field is a relatively stationary model.

The monitoring situation is related to the model of the information situation. In relation to the monitoring field, it is a subset. Unlike the monitoring field, the monitoring situation takes into account operational factors and the dynamics of the state of the monitored object. The monitoring situation takes into account the trends in the state of the monitored object. The monitoring situation is characterized by spatial and temporal factors. The monitoring situation is a dynamic model. These concepts complement each other. For example, the monitoring of a bridge from space is determined by the field where the bridge is in space. But the condition of the bridge and its collapse determine the monitoring situation (Milillo et al., 2019).

Models of the monitoring result are determined by the tasks of monitoring and the mathematical apparatus that the observer has. Models of the monitoring result are determined by the level of intelligence and knowledge that the specialist has.

Monitoring methods are related to technical means and methods of information processing. For example, if you have a small amount of data, you can apply direct algorithms. If you have big data, you need to use big data processing methods.

Systematics of various types of satellite monitoring is carried out on key aspects. It is possible to distinguish key aspects: the object of observation, monitoring activity, monitoring methodology, forecasting aspect, spectral characteristics, the relationship of the object to the earth's surface, types of object models and others.

The key indicator “object of observation” allows you to distinguish between the monitoring of objects and the monitoring of processes. Object monitoring examines the state of the object. Process monitoring investigates the dynamics of an object or situation and processes. For example, fire monitoring in a certain area is procedural monitoring. Object monitoring can be indicative. It is important for him to indicate the presence of an acceptable state or an unacceptable state. Procedural monitoring uses complex dynamic models of information processing. With comprehensive monitoring, objects and processes are simultaneously observed.

According to activity, satellite monitoring is divided into active and passive monitoring. An example of active satellite monitoring is radar surveillance. In this technology, the monitored object is irradiated and information is received in the reflection of the radar signal. Another example is laser sensing. An example of active monitoring is X-ray imaging. Passive monitoring is environmentally friendly. For example, the use of photography in the optical or infrared range is passive monitoring. Passive monitoring is preferable in the examination of unknown space objects, since active radiation from the monitoring system can be perceived as aggression to initiate unknown response processes.

According to the method of satellite monitoring, it is divided into different dichotomous pairs: indicative and analytical; discrete and continuous; detecting and interpreting. If satellite monitoring only records the presence or absence of a sign, then such a KM is called indicative. Analytical monitoring uses time series of observations and complex time dependencies. If satellite monitoring observes an object with time gaps, then it is called discrete. If satellite monitoring tracks a phenomenon in real time, then it is called continuous, although this continuity is conditional.

Satellite monitoring aimed at detecting an object is called detecting. Satellite detection monitoring often uses spatial logic. Satellite monitoring aimed at studying a known object and its condition by interpreters.

The forecasting aspect divides monitoring into perspective and retrospective. Long-term satellite monitoring based on time series makes it possible to build forecasts. It makes it possible to conduct a prospective analysis. Time-series-based retrospective satellite monitoring allows you to look into the past and look for cause-and-effect relationships. It makes it possible to conduct a retrospective analysis.

The peculiarity of satellite monitoring is that it is carried out from a mobile object in relation to objects on the surface of the Earth. This requires in some cases to take into account the dynamics of the movement of the satellite. At the same time, its advantage is the ability to observe the object from different points of view. Unlike space-based monitoring, which is dominated by angular measurements, satellite monitoring makes it possible to obtain linear dimensions of objects.

If the wave range is chosen as a criterion for monitoring characteristics, then this gives the following systematics: radar monitoring (Kozlov et al, 2020), optical monitoring (Huang et al., 2018), thermal monitoring (Martín et al., 2020), laser monitoring (Anthony et al., 2010).

Many types of satellite monitoring are characterized by the use of information and geoinformation modeling. According to the models of the monitored object in satellite monitoring, the use of statistical models of objects and dynamic models of objects are distinguished. Static models are usually independent of time for example. Flood or fire area Dynamic models have time as one of the arguments.

According to the models of the object, taking into account the information environment in space monitoring, the use of information models of the situation (situational monitoring) is distinguished. Application of models of information interaction of different objects (communicative monitoring).

Satellite monitoring is aimed at studying the surface of the earth and oceans from the orbit of a space station or satellite. In relation to space monitoring, it is internal. Internal monitoring explores the part of near-Earth space that lies between the satellite and the Earth's surface.

3. Conclusion

Satellite monitoring is a particular type of spatial monitoring and a type of space monitoring. Analysis of various types of spatial monitoring and satellite monitoring shows the feasibility of introducing the "information situation" model (Tsvetkov, 2012). The information situation during shooting exhaustively determines the conditions of shooting and allows you to compare different shooting situations with each other. Modern satellite monitoring is built on the basis of the integration of various technologies. Often satellite monitoring acts as an information measuring system. The final processing of information obtained using satellite monitoring is carried out in terrestrial conditions. Satellite monitoring is applicable to the study of other planets. In this case, it can be called orbital monitoring. Satellite monitoring evolves and evolves. Its evolution is close to evolution space monitoring (Savinych, 2017).

References

Allam, Dhunny, 2019 – *Allam, Z., Dhunny, Z. A.* (2019). On big data, artificial intelligence and smart cities. *Cities*. 89: 80-91.

Anthony et al, 2010 – *Anthony, W.Y. et al.* (2010). Space laser transmitter development for ICESat-2 mission. *Solid State Lasers XIX: Technology and Devices*. *SPIE*. 2010. 7578: 64-74.

Barmin et al., 2014 – *Barmin, I.V., Kulagin, V.P., Savinykh, V.P., Tsvetkov, V.Ya.* (2014). Near_Earth Space as an Object of Global Monitoring. *Solar System Research*. 48(7): 531-535.

Bertiger et al., 2020 – *Bertiger, W. et al.* (2020). GipsyX/RTGx, a new tool set for space geodetic operations and research. *Advances in space research*. 66(3): 469-489.

Bondur, Tsvetkov, 2015a – *Bondur, V.G., Tsvetkov, V.Ya.* (2015). New Scientific Direction of Space Geoinformatics. *European Journal of Technology and Design*. 4(10): 118-126.

Bondur, Tsvetkov, 2015b – *Bondur, V.G., Tsvetkov, V.Ya.* System Analysis in Space Research. *Russian Journal of Astrophysical Research. Series A*. 1(1): 4-12.

Gospodinov, 2018 – *Gospodinov, S.G.* (2018). The Development of Geodesic Astronomy. *Russian Journal of Astrophysical Research. Series A*. 4(1): 9-33.

Huang et al, 2018 – *Huang, C. et al.* (2018). Detecting, extracting, and monitoring surface water from space using optical sensors: A review. *Reviews of Geophysics*. 56(2): 333-360.

Kozlov et al, 2020 – *Kozlov, A.I. et al.* (2020). Radiolocation in Radio Polarimetry Navigation Systems. Introduction to the Theory of Radiopolarimetric Navigation Systems. Springer, Singapore. Pp. 323-325.

Kudzh, 2022 – *Kudzh, S.A.* (2022). Development of space monitoring. *Russian Journal of Astrophysical Research. Series A*. 8(1): 12-22.

Martín et al., 2020 – *Martín, A., Luján, R., Anquela, A. B.* (2020). Python software tools for GNSS interferometric reflectometry (GNSS-IR). *GPS Solutions*. 24(4): 1-7.

Milillo et al, 2019 – *Milillo, P. et al.* (2019). Pre-collapse space geodetic observations of critical infrastructure: the Morandi Bridge, Genoa, Italy. *Remote Sensing*. 11(12): 1403.

Savinych, 2017 – *Savinych, V.P.* (2017). Evolution of Space Monitoring. *Russian Journal of Astrophysical Research. Series A*. 3(1): 33-40.

Savinych, 2018 – *Savinych, V.P.* (2018). Evolution of the Salyut Space Research Program. *Russian Journal of Astrophysical Research. Series A*. 4(1): 19-33.

Tsvetkov, 2012 – *Tsvetkov, V.Ya.* (2012). Information Situation and Information Position as a Management Tool. *European researcher*. 12-1 (36): 2166-2170.

Tsvetkov, 2016 – *Tsvetkov, V.Ya.* (2016). The Problem of Asteroid-Comet Danger. *Russian Journal of Astrophysical Research. Series A*. 1(2): 33-40.