Proceedings of the 2023 International Conference on Environmental Geoscience and Earth Ecology
DOI: 10.54254/2753-8818/7/20230130

Present situation of satellite remote sensing technology in China

Zixiao Yang

School of Resources and Civil Engineering, Northeastern University, Shenyang, 110819, China

18990304218@163.com

Abstract. Satellite remote sensing technology has become widely used in all sectors of life as satellite equipment has improved and remote sensing technology has evolved. Satellite remote sensing technology has the advantages of objective acquisition mode, accurate picture information, rapid data acquisition, and a large number of applications, and is primarily utilized in a wide variety of dynamic monitoring and analytical work in diverse fields. China has achieved fruitful results in the development and application of remote sensing technology in recent years, launching a variety of satellites including land, meteorology, oceans, cities, water bodies, environment, ecology, disasters, mapping, and other series, and applying the information obtained in many fields, including land, agriculture, forests, grassland, meteorology, oceans, cities, water bodies, environment, ecology, disasters, mapping, and other fields. This study examines and summarizes the present application results of satellite remote sensing technology in environmental monitoring, urban planning, and finance, and serves as a reference for people interested in the field of satellite remote sensing technology. This technology has been widely applied in the field of environmental testing in water bodies, meteorology, land, and disaster; in urban planning, it is primarily used for building location selection and engineering supervision; and in finance, it is used for economic risk assessment.

Keywords: satellite remote sensing, environment, urban planning, finance.

1. Introduction

"Remote sensing" literally translates to "distant sensing"; broadly speaking, various non-contact, remote detection, and information acquisition technologies are remote sensing; narrowly speaking, remote sensing primarily refers to modern technical systems that identify the nature and movement state of ground substances through photography or scanning, information induction, transmission, and processing using visible light, infrared, microwave, and other deflection techniques. Remote sensing is classified into four types based on the platforms of remote sensing sensors: tower remote sensing, vehicle remote sensing, aerial remote sensing, and satellite remote sensing.

The rapid advancement of satellite remote sensing technology ushers humanity into a new era of multi-layer, three-dimensional, multi-angle, all-weather observation. A global geodetic observation system composed of various high, medium, and low orbits, large, medium, and small satellites in coordination, and high, medium, and low-resolution compensation can provide a variety of geodetic

DOI: 10.54254/2753-8818/7/20230130

observation data with spatial, temporal, and spectral resolution accurately, effectively, quickly, and timely.

China has successfully launched sixteen return satellites, which provide significant spatial picture data for resource, environmental, and national economic development, as well as an indispensable role in China's national defense construction. In addition to the remote sensing satellites mentioned above, China has established a number of national remote sensing application institutions, including the National Remote Sensing Center, the National Satellite Meteorological Center, the China Resource Satellite Application Center, the Satellite Ocean Application Center, and the China Remote Sensing Satellite Ground Receiving Station. At the same time, all State Council ministries and commissions, as well as provinces, cities, and municipalities, have built over 160 provincial and municipal remote-sensing application institutions.

This paper summarizes and discusses the role of satellite remote sensing technology in various fields based on existing application results and related research, with the goal of collecting, sorting out, and summarizing the practical situation of technology and providing a reference for future researchers.

2. Introduction to remote sensing technology

2.1. Principles and development of remote sensing technology

Satellite remote sensing technology is a science and technology that combines elements of electronics, optics, geography, computer communication, and space [1, 2]. The satellite remote sensing platform is a man-made satellite, and satellite remote sensing technology has advanced fast on a worldwide scale, transforming ground observation into an all-around, all-weather, multi-angle, multi-layer, three-dimensional new era. Global Earth observation systems have combined to establish a comprehensive orbital integration, satellite coordination, and resolution compensation system.

Satellite remote sensing technology is mostly used to identify ground objects using remote sensing sensors that collect object reflection spectrum or electromagnetic wave signals. The physical and chemical qualities of the object, as well as the wavelength of the incident light, affect the reflectance spectra. The basis of information received by remote sensing detection is an object electromagnetic wave. The electromagnetic wave characteristics of ground objects can be collected and recorded using the satellite remote sensing platform, and then the error of the original remote sensing signal is eliminated using optical instruments and computer equipment, and the information is extracted using induction and collation. Finally, the use of satellite remote sensing technology to acquire information makes it easier for humans to access, count, and evaluate target data. Satellite remote sensing technology is widely used in many fields due to its high efficiency and low cost.

Remote sensing technology and multi-field applications have advanced to a new level as a result of continual development. It can passively accept natural light reflected by the ground object, as well as long-wave infrared radiation emitted by the ground object, and can actively emit electromagnetic waves utilizing synthetic aperture radar and lidar to achieve all-weather ground observation. Remote sensing technology is also becoming more closely linked to the national economy, ecological protection, and national defense security, such as land resource survey, ecological environment monitoring, agricultural monitoring and crop estimation, disaster prediction and disaster assessment, marine environment survey, and so on. Remote sensing technology has evolved into the "three highs" of high spatial resolution, high spectral resolution, and high temporal resolution in the twenty-first century, opening up new fields of application.

2.2. Advantages and disadvantages of satellite remote sensing technology

Satellite remote sensing technology observes the ground from an "overlooking perspective", obtaining image information far beyond the human eye observation range via various sensors, and identifying, monitoring, tracing, obtaining evidence, and evaluating various phenomena occurring on the surface while recording ground objects' changes, providing technical support for environmental monitoring, disaster assessment, and urban planning.

DOI: 10.54254/2753-8818/7/20230130

The benefits of satellite remote sensing technology can be summarized as follows: First, in terms of objectivity, remote sensing image data are the detection and imaging data of electromagnetic wave radiation and reflection characteristics on the surface from a long distance of the sensor, and the raw data acquisition process is not influenced by human factors and is an objective and real electronic data record. Second, precision remote sensing images reflect the resolution of space, spectrum, radiation, and ground observation time pixel by pixel, and can identify and measure the location, distance, size, composition, type, and content of ground object objects, as well as the dynamic changes of the above target attributes at different observation times. Third, remote sensing implements surface imaging of the Earth's surface in a wide range and quickly via imaging sensors mounted on man-made Earth satellites, aviation, drones, and other platforms; rich and comprehensive information, free of ground restrictions, and no need to arrive at the scene are ten points efficient and comprehensive information acquisition means. Fourth, for traceability, the satellite remote sensing platform can return to the same area on a regular basis, and the produced remote sensing photos are time slices of ground changes that clearly document the surface's history changes. It can trace past surface conditions and offer data for surface studies based on stored data.

Of course, remote sensing has flaws, the most notable of which are: (1) Image interpretation, interpretation after acquisition is frequently an approximation of the ground object, or indirect information, which will differ from the actual situation. (2) In many circumstances, computer interpretation and interpretation produce more errors than skilled manual interpretation; nonetheless, all rely on manual interpretation, and the interpretation effort is heavy and the cycle is lengthy. (3) The social qualities of ground objects are required in urban planning, but they can only be gained indirectly through remote sensing and must be solved primarily through field inquiry. (4) Remote sensing information collecting and interpretation technology is still quite sophisticated, the cost is still relatively high, and it requires the collaboration of a variety of specialists to achieve. Some cities undertook remote sensing surveys, but the relevant technicians did not fully cooperate, or the planners did not participate sufficiently, resulting in a lack of usable information for planning. (5) Sensor control could yet be enhanced. Due to the influence of technical factors, some satellites have low accuracy in sensor settings, which causes some problems with monitoring information and image and cannot meet the requirements of engineering measurement, especially in large-scale mapping work, it is difficult to obtain accurate data information, which then affects the measurement effect. (6) Communication systems' heavy reliance. Satellites are transmitted by sensors, which increases their reliance on communication networks and global positioning systems. This creates opportunities for lawbreakers, such as hacking, which impacts satellite operating safety.

3. Application of satellite remote sensing technology in various fields

3.1. Environmental monitoring

In the ecological environment, satellite remote sensing technology is mainly used in water monitoring, meteorological monitoring, land monitoring and disaster monitoring.

With regard to a number of water body parameters obtained by satellites in water areas, such as bracketing water surface temperature, water depth, transparency, total dissolved solids, total suspended matter, etc., researchers can quickly obtain information on the geographical location, coverage, water body shape, evolution information, and hydrological characteristics of water bodies, providing convenience for the management and governance of various water areas, especially oceans [3]. With the independent construction and development of corresponding technologies for marine satellites of marine watercolor, marine dynamic environment and marine monitoring series in China, it has now constituted a complete marine space monitoring network and played an important role in marine resource and environmental monitoring, marine disaster prevention and mitigation, marine safety management and other maritime supervision work in China [4].

Meteorological satellites carry meteorological remote sensing devices that can receive and measure visible, infrared, and microwave radiation from the earth and its atmosphere, converting it into electrical signals and transmitting it to the ground, and ground receiving stations then restore the electrical signals and draw various clouds, surface, and ocean pictures, and the trends of weather changes can be analyzed after further processing. With a fast data collection rate, satellite remote sensing technology can portray climatic change in all directions using cloud photos, providing data for the spatiotemporal dynamic changes of the target [5]. Furthermore, because ozone, sulfur dioxide, carbon dioxide, methane, aerosol optical thickness, and respirable particulate matter concentration each have their own radiation and absorption spectra, the spectral eigenvalues of atmospheric scattering, absorption, and radiation provided by satellite remote sensing can be used for inversion, and the concentration values of each component in the atmosphere can then be extracted to achieve atmospheric environment monitoring [6, 7].

In terms of land, it is vital to understand first-hand and actual facts about land and resources in order to improve the use efficiency of land resources. The research of land and resources is a vital task for determining the particular number of diverse resources and clarifying the distribution and quality level of multiple resources. In terms of land resources, satellite remote sensing technology can efficiently analyze various forms of data information and detect various land resource problems like desertification, salinization, and erosion, thereby assisting front-line investigation personnel [8]. In the forest, technicians can use satellite remote sensing technology to obtain remote sensing images at various time periods and spatial resolutions, compare and analyze them, and obtain relevant information on forest cover changes to facilitate more effective management and protection of forest resources. In terms of mineral resources, satellite remote sensing technology is utilized to conduct targeted surveys in order to identify new mining sites and exploitable mining locations. The probable ore-bearing areas are recognized in the inquiry process by employing the information displayed by remote sensing images, such as ground object information related to mineral resources, tonal anomaly information, and thermal radiation anomaly display. The remote sensing pictures are then analyzed to gain further geology and mineral information in order to study the geological environment of the potential ore-bearing area and create the groundwork for the eventual delineation of the ore-finding area.

In disasters, satellite remote sensing technology has been widely used in landslide monitoring and analysis, seismic investigation, and dynamic monitoring of soil erosion due to its advantages of allowing for real-time monitoring and conveniently and quickly integrating various disaster information such as meteorological and geological changes [9].

3.2. Urban planning

The temperature of the city's surface is an important indicator of the balance and suitability of its economic development. An accurate understanding of urban heat distribution is critical in urban development analysis, urban planning, and urban safety. Because the city is in a confined environment, determining the surface temperature of different regions of the city is challenging. The inaccuracy is considerable and the reliability is low since traditional visible light is employed to analyze the surface air temperature. Multi-band satellite remote sensing data are utilized to swiftly examine urban surface temperature variations via thermal infrared radiation to isothermal blackbody radiation calibration, resulting in a more accurate map of urban surface temperature distribution. This method plays an important reference role in urban space planning and urban construction [10].

Satellite remote sensing technology is also commonly utilized in facility locating and dynamic monitoring. Using the airport as an example, most of the traditional measurement data utilized in the pre-selected site stage are older and rely primarily on manual experience, and the following issues exist: (1) The terrain data are insufficient; (2) The mapping data provide only two-dimensional plane coordinate data, which is insufficient for understanding the terrain of the target area; (3) the clearance measurement effort is heavy and the speed is slow; (4) The data for the candidate field site excavation filling are incorrect. Satellite remote sensing photos offer an aerial bird's-eye view of the entire geographical environment. Images from high-precision three-dimensional remote sensing can help regional geological surveys. The detailed information concerned by policymakers can be extracted using special technical ways of processing to provide a reference for site selection. Following site selection, satellite remote sensing photos can be used to trace the airport's construction progress in real time and dynamically monitor its geological, environmental, and runway state, giving information support for airport aviation emergencies.

3.3. Financial assessment

The use of satellite technology in financial services, with digital technology as a link, can enable a completely new way of understanding and serving customers. At the moment, an increasing number of commercial banks are utilizing satellite remote sensing technologies to address credit evaluation and risk management issues in agricultural finance. At the moment, several large-scale applications of satellite remote sensing technology in agriculture have been accomplished in China, providing the financial industry with a technical foundation and experience to tackle the credit evaluation and risk management concerns of farm-related finance [11]. Crop classification, crop planting area calculation, growth and yield analysis, natural disaster and pest assessment, and agricultural greenhouse distribution, quantity, area, and other estimates were realized using remote sensing satellite and meteorological satellite data combined with artificial intelligence technology. Because the recognition target has significant spectral characteristics, the use of medium and low-precision remote sensing images can quickly obtain a wide range of crop types and distribution, providing an important basis for financial risk assessment. In particular, staple crop monitoring, such as rice, wheat, corn, and other field crop planting scene application effect is obvious. A number of commercial banks have formed a relatively mature agricultural credit management application mode, while the application scenario has gradually evolved to diversify development, sea fishing, new energy, industry, infrastructure, and other fields of credit management application have also successively entered the layout exploration stage.

4. Conclusion

This study covers the application and utility of satellite remote sensing technology in environmental monitoring, urban planning, and finance in China based on an analysis of the current results. Among these, satellite remote sensing technology has been widely employed in water areas, meteorology, land and catastrophe environmental monitoring direction has been aggressively promoted by the state, particularly in the land and ocean field. Surface temperature inversion, site selection, and subsequent management of key building facilities are the primary uses of urban areas. By leveraging its benefits of fast information capture, high data volume, and objective and true information, the technology also provides data assistance for corporate credit evaluation in the financial area. Although this paper introduces satellite remote sensing technology's applicability in numerous industries, it does not discuss the core technologies used in those fields. Furthermore, researches in the future direction of technological development are lacking, and no recommendations on the direction of technological progress have been made, such as novel remote sensing data processing technologies that combine advanced computer technologies such as deep learning, neural learning, and migration learning [12]. In future study, these components will be needed to be developed and refined.

References

[1] Na Li, Hang Gao. Satellite remote sensing technology makes "pitch all beautiful" [N]. Prosecutorial Daily, (012):06-28 (2023). DOI:10.28407/n.cnki .njcrb.2023.002602.

[2] Yanmin Ma, Ying Wang, Yan Gao. Application and Development of Satellite Remote Sensing Technology in Meteorological Service for Agriculture [J]. Heilongjiang Grain, (05): 59-61 (2023).

[3] Xin Chen. Application of Satellite Remote Sensing Technology in Monitoring Forest Resources and Ecological Environment Changes [J]. Rural Science and Technology, 14 (10):151-154 (2023). DOI:10.19345/j.cnki .1674-7909.2023.10.025.

[4] Jian Jun, Long Liu, Yingxiang Zhang, et al. Application of Domestic Satellite Remote Sensing Technology in Maritime Supervision [J]. China Maritime, (03):11-14 (2023). DOI:10.16831/j.cnki .issn1673-2278.2023.03.004.

[5] Liqiang Xu. Application practice of satellite remote sensing technology in meteorological disaster investigation [J]. Science, Technology and Innovation, (15):152-154 (2022). DOI:10.15913/j.cnki .kjycx.2022.15.049.
[6] Sixiao Guo, Xiao Zhang, Sining Zhou, et al. Application of Atmospheric Environmental Monitoring Technology Based on Satellite Remote Sensing [J]. Brand and and Standardization, (01): 101-103 (2022).
[7] Fengyun Guo, Bo Liu, Yongli Ji, et al. Application of Satellite Remote Sensing Technology in Environmental Protection [J]. Geospatial Information, 19 (06): 39-41 + 45 + 4 (2021).
[8] Fengcheng Xu. Discussion on the application of satellite remote sensing technology in land and resources survey [J]. Engineering Technology Research, 8 (07):228-230 (2023). DOI:10.19537/j.cnki .2096-2789.2023.07.073.
[9] Jiawang Yang, Jianping Qian, Siyuan Long, et al. Application of remote sensing technology in geological disasters in China [J]. Journal of Disaster Prevention and Mitigation, 38 (04):17-25 (2022). DOI:10.13693/j.cnki .cn21-1573.2022.04.003.
[10] Xiangnan Chen, Geng Li. Urban Surface Temperature Inversion Based on Satellite Remote Sensing Technology [J]. Popular Science and Technology, 23 (04): 29-32 (2021).
[11] Yu Lin. Application of Satellite Remote Sensing Technology in Financial Field [J]. China Financial Computer, (05): 53-54 (2023).
[12] Jibao Lai, Xudong Kang, Xukun Lu, et al. A Review of Remote Sensing Applications of a New Generation of Artificial Intelligence-Driven Terrestrial Observation Satellites [J]. Journal of Remote Sensing, 26 (08): 1530-1546 (2022).