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Geophysics and Geology, 2024, 1(1), 1-4
https://www.hillpublisher.com/Journals/geo/
ISSN Online:
ISSN Print:

Research on Geological Hazard Monitoring Technology for Transmission Lines Based on Beidou Satellite Navigation Technology

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How to cite this paper: Yunlong Liu, Tao Ma, Cong Wang, Fang Yan, Wenping Xiang, Zhen Zhong, Lin Yi, Liang Ding, Bin Zhou, Zixin Nie. (2024). Research on Geological Hazard Monitoring Technology for Transmission Lines Based on Beidou Satellite Navigation Technology. *Geophysics and Geology*, 1(1), 1-4.
DOI: 10.26855/geo.2024.12.001

Received: October 10, 2024
Accepted: October 31, 2024
Published: November 21, 2024

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Abstract

Due to the vast geographical area of China, power transmission lines also have some characteristics such as wide coverage and long transmission distance. Therefore, the lines along the way will be affected by complex terrain and bad climate, which makes the inspection of power transmission lines difficult, long cycle and incomplete monitoring data. Once a geological disaster occurs, it will pose a great threat to the safe and stable operation of the transmission line. Therefore, in the operation of the transmission line, it is necessary to fully combine meteorological forecasts, geotechnical geography, satellite remote sensing, etc. to dynamically monitor the power grid facilities and surrounding geological disasters, and build a regional early warning system, so as to realize the integration of transmission line disaster early warning monitoring and disaster reporting. This paper mainly explores the application of Beidou satellite navigation technology in geological disaster monitoring of transmission lines.

Keywords

Beidou Navigation; Geological hazards; Transmission line; Early warning

Introduction

My country is a country with frequent geological disasters. Disaster monitoring, prediction and assessment are important in the process of disaster prevention and mitigation, which can provide sufficient information support for later disaster relief decisions. The Beidou Navigation System is a satellite navigation system with independent intellectual property rights in my country. Positioning systems have been widely used in various fields. Since the emergence of the Beidou navigation system, it has played a huge role in various fields such as building displacement monitoring, urban building disaster prevention and mitigation, and geological environment monitoring. With the development of informatization and automation, the State Grid officially began to use the BeiDou system to carry out disaster monitoring of transmission lines in 2010, which provided great support for the development of informatization of power grid operation and maintenance in my country.

1. Overall architecture of the monitoring system

Figure 1 below is a schematic diagram of the overall architecture of the transmission line geological disaster monitoring and early warning system.

Note: The article was originally published in the *Journal of Electrical Engineering and Automation*, and this is an authorized translation of it.

1.1 System application architecture

The vertical line disaster monitoring and early warning system based on the Beidou system can realize the integration of authority management, disaster early warning, and disaster monitoring, and can also realize data interaction with the intelligent platform. Through the application inspection and management personnel of the intelligent platform, the implementation monitoring of the regional power grid operation status can be realized, and the power grid operation data can be automatically collected through the system. Based on this, the power grid operation status can be grasped in real time, and the operation parameters of each regional power grid can be queried through the platform, thereby providing sufficient data support for the later disaster prevention and mitigation work.

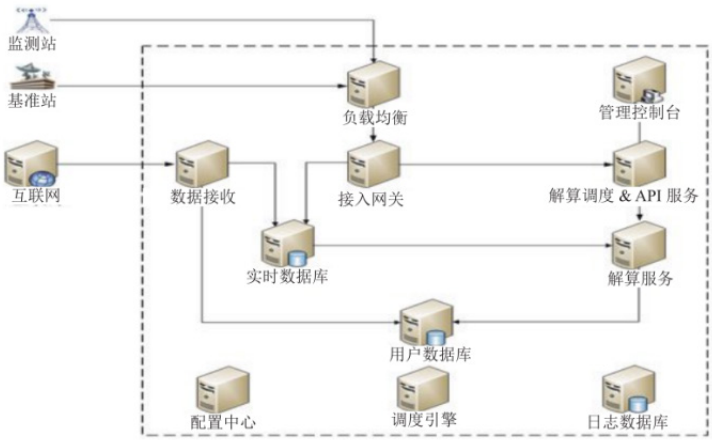

Figure 1. Schematic diagram of the overall architecture of the monitoring system.

The transmission line disaster early warning monitoring system based on Beidou navigation mainly includes several important components such as the site subsystem, communication quasi-system, user subsystem and data center. The site subsystem is mainly composed of the cup soybean milk monitoring station and the Beidou ground augmentation system. Beidou monitoring stations need to be set up around the towers that need to be monitored on the transmission lines. The real-time monitoring of the tower position data can be achieved through the displacement monitoring technology of the Beidou system. At the same time, the monitoring data can be uploaded to the database through an encrypted channel for storage and processing. At this time, the processed and stored data can be synchronized with the main station system of the power company, so that the company can get effective data support in the work of disaster prevention and mitigation of the power grid in the later stage.

1.2 System functional architecture

(1) **Infrastructure.** The normal operation of the entire monitoring system is based on the technical implementation of each site. A wideband dual-screen GNSS measurement antenna can be set up in the site infrastructure. The measurement antenna can ensure that each site can receive and transmit signals in real time. In addition, the application of wideband dual-screen GNSS measurement antennas can effectively avoid signal interference caused by multipath effects. The site technical equipment can collect data on climate conditions and geological changes around the tower to be tested in real time, and transmit it to the receiver. After chip data encryption, it can be sent to the central station system using the Beidou system short message communication or wireless communication network. The base station of the Beidou system receives satellite navigation signals in real time, and the positioning signal can be generated in time. The positioning signal is transmitted to the terminal device through mobile communication or flight system, thereby completing the positioning service.

(2) **The core module.** Beidou high-precision settlement module is the core of the whole system. This settlement module uses advanced technologies such as extended Kalman filter calculation model and least square method, which can efficiently process the data transmitted by the front end. At the same time, the module can efficiently solve the calculation of coordinates and tropospheric parameters by interactive calculation, so its positioning system can fully meet the actual high-precision requirements.

1.3 Decision evaluation

The transmission line geological disaster monitoring system based on Beidou satellite navigation technology can comprehensively analyze the disaster monitoring data around the towers through the comprehensive application of big data, artificial intelligence and other technologies, and then predict the development trend of geological deformation. At the same time, the system platform can display the development status of geological deformation in three dimensions. Once a geological disaster is found, early warning information will be issued in time. At this time, the background staff can issue a notification work order in time according to the specific situation, and it can also provide high-precision navigation and positioning services during the disaster relief process of the staff. In the later decision-making process of line repair, high-precision data can also be used to provide evaluation and decision support.

2. Monitoring station design

2.1 Monitoring site selection

In the process of selecting monitoring sites, the following principles should be followed: ① For areas with geological hazards, the geological deformation of transmission line towers should be comprehensively monitored; ② Monitoring stations should be established in the geological disaster landslide belt around the transmission line towers as much as possible to directly reflect the development trend of landslides and subsidence trends; ③ In order to ensure the actual monitoring needs, it is necessary to avoid obstructions as much as possible; ④ It should be fully guaranteed that the basic equipment should be easy to install, the monitoring point should have a wide field of view, and the ground elevation angle should be maintained above 15 degrees; ⑤ The ground foundation should be fully guaranteed to be flat and stable, so as to ensure the long-term preservation of the benchmark stone; ⑥ The local environment around the measuring point should be kept as consistent as possible with the surrounding environment, so that the representative error of the meteorological elements can be effectively controlled.

In the process of designing monitoring points, it is necessary to strictly conduct field surveys. In this process, the landslide points must be tested strictly according to the standard process, and the basic conditions such as the location and communication of the measuring points must be recorded in detail, and field calibration must be carried out. The raw data of each monitoring point can be pre-processed by software to analyze the overall data quality of the satellite signal in detail. At the same time, the geological and hydrological and meteorological conditions of each monitoring point must be discussed in detail to fully explain the necessity of monitoring the point.

2.2 Design

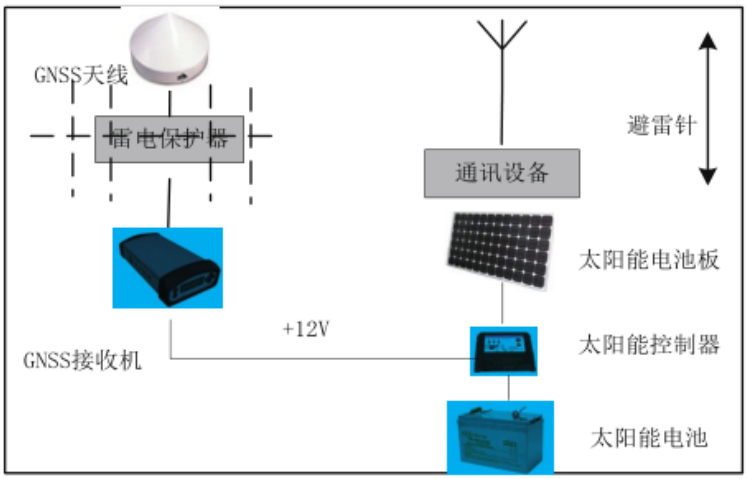

Figure 2. Schematic diagram of the basic framework of the monitoring station.

The main function of the monitoring station is to monitor the surface deformation and displacement of the surrounding environment of the power tower. The collected information is mainly transmitted through wireless mobile communication and Beidou satellite messages. The entire equipment box needs to be equipped with corresponding

call protection, communication equipment, GNSS receiver, etc. The Beidou satellite system antenna is installed at the top of the instrument monitoring pole. Since most monitoring power stations are in the wild, the equipment uses solar panels and batteries to power the entire system, so as to ensure the stability of the power supply of the monitoring station. Figure 2 below is a schematic diagram of the basic framework of the monitoring station.

2.3 Monitoring site power supply system

Since most of the detection stations focus on monitoring around the transmission line towers, they cannot be powered directly by the mains. In order to ensure the stability of the monitoring station system operation, a solar power generation system was introduced for power supply during the design of the scheme. When selecting a solar power generation system, various factors such as its load power, feed supplement, parameter design, and surrounding environment should be comprehensively considered. Solar panels should also strictly follow the basic principles of reliable performance, economic rationality, and environmental considerations. At present, the solar panels of the Beidou satellite navigation transmission line monitoring system monitoring station of the State Grid Corporation of my country are mainly monocrystalline silicon solar panels, and the batteries are mainly 200AH lithium phosphate batteries.

2.4 Lightning protection design

During the construction of the transmission line geological disaster monitoring station based on Beidou satellite navigation technology, it is necessary to fully consider lightning protection measures. Lightning will produce huge electromagnetic pulse shocks. If corresponding protection measures are not taken, the monitoring station will be seriously harmed and the power cable will be seriously damaged. Therefore, lightning protection grounding groups must be involved for various electronic equipment in the monitoring station. Lightning shielding is performed using metal chassis surgery, and DC capacitor protectors need to be installed inside the monitoring station. In addition, if the surge protector is damaged by lightning during the operation of the monitoring station, it needs to be replaced in time.

3. Conclusion

This article mainly discusses the design and application of the geological hazard monitoring system for transmission lines based on Beidou satellite navigation technology. After the application of the Beidou navigation system, the system has an excellent foundation, which can provide new development ideas for geological disaster early warning and monitoring of transmission lines. It is also the main way to promote the comprehensive informatization of China's entire power grid construction. However, the current transmission line geological hazard monitoring system based on Beidou satellite navigation technology still has certain limitations in practical application. In the future, continuous improvement is still needed to increase the promotion, application and upgrade of the system.

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