Research on Monitoring and Early Warning System of Tailings Dam Deformation Based on Wireless Sensor Network

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Abstract: There are many tailings reservoirs in China, but the average safety level is low. Some small and medium-sized tailings are in great danger. Tailings reservoir is usually caused by deformation of dam body, which is a developing process from gradual change to sudden change. The physical data of disaster occurrence can be obtained by monitoring dam deformation. Effective judgment of tailings reservoir disaster risk situation, timely early warning and protection of people's lives and property safety. Based on the analysis of the function, hardware and software structure of the dam body deformation monitoring and early warning system based on wireless sensor network, the research on the deformation monitoring and early warning system of tailings dam body based on wireless sensor network is completed. The simulation experiment proves that the deformation monitoring and early warning system of the tailings reservoir based on the wireless sensor network can prevent the safety accident of the tailings pond, ensure the safety of the life and property of the staff and the production safety of the enterprises downstream of the reservoir area.

1. Introduction

With the rapid development of the national economy, the mining and mining industry is also developing rapidly. The problems of environmental safety and safe production of tailings ponds, which are used for the discharge of tailings after ore sorting, are increasingly apparent. According to the survey, the tailings reservoir accidents are ranked 18th among public hazards, which seriously affects people's lives and property [1]. At present, the safety production situation of tailings reservoirs in China is still grim, which has attracted great attention of the whole society. The traditional wired safety monitoring system for tailings dam deformation relies on power supply equipment, communication cables and sensors. Because most of the tailings reservoirs are located in remote mountainous areas and the surrounding environment is harsh, it is difficult to monitor the deformation of tailings reservoir dam by using wired safety monitoring system. The tailings reservoir dam deformation monitoring and early warning system based on the wireless sensor network is powered by solar energy, does not need to lay cables, and has the advantages of low power consumption and environmental protection. At the same time, it is convenient for the safety supervision department to quickly grasp the latest development of the tailings pond to ensure the safety of the tailings pond.

2. Function Design of Monitoring and Early Warning System for Tailings Dam Deformation

Tailings reservoir refers to the place where metal and non-metal tailings are stored by enclosure or dam interception. Tailings reservoir can produce high potential artificial debris flow, which is a dangerous source of dam break. Once the deformation of tailings dam body causes dam break, it will cause serious accidents. It seriously affects people's lives and property security. Based on the wireless sensor network, the tailings reservoir dam deformation monitoring and early warning system integrates "sensing, transmitting, knowing and using", effectively monitoring the tailings pond and realizing remote warning.

The monitoring and early warning system for the deformation of the dam body of the tailings pond based on the wireless sensor network determines whether there is danger by monitoring the

water level and osmotic pressure of the reservoir. Based on the wireless sensor network, the tailings reservoir deformation monitoring and early warning system can monitor the safety situation of the tailings reservoir in real time, and research and analyze the collected data. According to the results of research and analysis, appropriate safety assessment is made, and safety early warning is carried out on the basis of safety assessment. Perfect workflow has become a prominent feature of the monitoring and early warning system of tailings dam deformation based on wireless sensor network [2].

The monitoring and early warning system of tailings dam deformation based on wireless sensor network is powered by solar energy. Using C# as the upper computer, using SQL Server 2000 as the background database, and using C/S mode of work, all of these ensure the sTable operation of the whole system. The specific functions of the monitoring and early warning system for tailings dam deformation based on wireless sensor network are as follows:

The monitoring and early warning system of tailings dam deformation based on wireless sensor network collects data through sensors. To monitor whether the water level of tailings dam body is within the safe range, and realize the real-time detection of the water level of tailings dam body. The monitoring and early warning system of tailings dam deformation based on wireless sensor network is to bury sensors at a certain depth of tailings dam. Sensors are used to monitor whether the dam body of tailings reservoir seeps, and to monitor the saturation line of the dam body of tailings reservoir. The dam body deformation monitoring and early warning system based on the wireless sensor network transmits the detected danger information to the management personnel's mobile phone in time via the wireless network. After receiving the warning information, the management personnel can timely process the tailings dam body and realize the real-time warning function of the tailings dam body.

Based on wireless sensor network, the tailings reservoir dam deformation monitoring and early warning system has real-time water level detection, saturation line monitoring and real-time warning function. The latest developments in the tailings pond can be quickly mastered to ensure the safety of the tailings pond.

3. Design of Monitoring and Early Warning System for Tailings Dam Deformation Based on Wireless Sensor Network

The monitoring and early warning system of tailings dam deformation based on wireless sensor network is composed of hardware system and software system.

3.1 Hardware Design

The hardware system of monitoring and early warning system for tailings dam deformation based on wireless sensor network consists of wireless acquisition terminal, sensor, acquisition computer and server, early warning device and short message module. The hardware system schematic diagram of the monitoring and early warning system for tailings dam deformation based on wireless sensor network is shown in Figure 1.
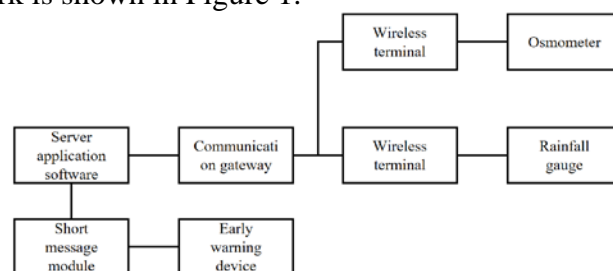

Fig.1 Schematic diagram of the hardware system structure of the deformation and early warning system for the dam body deformation of the tailings pond based on wireless sensor network

The hardware system of the deformation monitoring and early warning system of the tailings reservoir based on the wireless sensor network is responsible for the "sensing and transmitting" function, which is responsible for "perceiving" the change of the physical quantity of the tailings

dam body, and "transmitting" the "perceived" physical quantity data. Go out. The sensor is responsible for monitoring the seepage flow of the dam and the regional rainfall. Commonly used monitoring sensors are rain gauges and osmometers. Due to the dam break in the tailings pond, it is often due to the increase of seepage in the dam. The main cause of the increase in seepage flow in the dam is rainfall. Rainfall has become the main external factor when the internal conditions of tailings reservoir are sTable, such as geology and topography. A large amount of rainfall or heavy rain has become the main external factor of dam break in tailings reservoir. Therefore, the rainfall gauge installed on the top of the tailings dam can accurately collect the rainfall data of the environment in which the tailings reservoir is located. The seepage rate of tailings dam body can be accurately and comprehensively monitored by installing the seepage gauge at each monitoring section of tailings dam body.

Because most of the tailings reservoirs are located in remote mountainous areas, and the surrounding environment is bad. It is difficult to use wired safety monitoring system to monitor the deformation of tailings dam. Therefore, the wireless data acquisition terminal is used for data acquisition. The wireless data acquisition terminal has small volume and fast transmission speed, and is suiTable for the field without power supply environment. Utilizing solar energy as a power source can ensure continuous operation for several months without maintenance. The wireless acquisition terminal is composed of wireless communication module, measurement module and power module. The function of the wireless communication module is to transmit the data detected by the sensor to the data acquisition software. The function of the measurement module is to measure the effectiveness of the data transmitted by the wireless communication module. The function of the power module is to convert solar energy into electrical energy, and the converted electrical energy provides power for the wireless collection terminal to work.

The early warning device in the hardware system of the tailings reservoir deformation monitoring and early warning system based on the wireless sensor network is composed of a power module, a remote short message receiving module, a remote short message control module and an early warning signal module. The remote short message receiving module and the remote short message control module together form the core software of the early warning device. Both of them can convert the received remote authorized short message instructions into control short message instructions. Then it is connected to the early warning signal module to realize the function of direct early warning.

The collection computer in the hardware system of the monitoring and early warning system of tailings dam deformation based on wireless sensor network can check the data of the field terminal sensor and store the tested data in the database. The server is responsible for publishing information and visualizing the received data. The monitoring and early warning system can accurately analyze the data and draw early warning conclusions. The SMS module can be connected to the computer server to send the warning signal to the relevant management personnel and the early warning device in a timely manner.

The wireless collection terminal, the sensor, the acquisition computer and the server, the early warning device and the short message module jointly form a hardware system for the deformation and early warning system of the tailings reservoir deformation based on the wireless sensor network. The hardware system greatly enhances the effectiveness of the monitoring and early warning system.

3.2 Software Design

The software system of monitoring and early warning system of tailings dam deformation based on wireless sensor network consists of data acquisition software, data receiving and analysis software, database software and early warning analysis software. The software system of tailings dam deformation monitoring and early warning system based on wireless sensor network is responsible for the function of "knowing and using". That is, through the graphical representation of the data, the deformation of the tailings dam body is visually displayed, and the conclusions of the analysis are transmitted to the early warning device in the form of data.

The data receiving and analysis software adopts the C/S working mode, receives and analyzes the field data collected by the data acquisition software, and then stores the analyzed data into the database. The early warning analysis software adopts the B/S working mode to process the on-site monitoring data information. It is displayed in a graphical form, so that the monitoring and early warning system can accurately analyze the data and draw early warning conclusions. The software system of monitoring and early warning system for tailings dam deformation based on wireless sensor network has the function of drawing single curve and multi-curve. The data of all monitoring points in the monitoring and early warning system can be plotted with curves, and the deformation data of tailings dam body can be inquired according to the measuring time and sensor number.

Rainfall is the main reason for the increase of seepage in tailings reservoir, which is often due to the increase of seepage in dam body. Rainfall has become the main external factor when the internal conditions of tailings reservoir are sTable, such as geology and topography. A large amount of rainfall or heavy rain has become the main external factor of dam break in tailings reservoir. Based on the wireless sensor network, the software system of the deformation and early warning system for the dam body deformation of the tailings reservoir utilizes statistical model analysis and correlation analysis methods. The correlation between rainfall and tailings dam shape variables is analyzed, and the rainfall statistical model is established to obtain the rainfall threshold for the early warning system to start working.

The data acquisition software, data receiving and analysis software, database software and early warning analysis software together constitute a software system for the deformation monitoring and early warning system of the tailings dam body based on the wireless sensor network. The software system can effectively monitor the tailings pond and realize remote warning.

4. Simulation Experiment

In order to ensure the validity of the proposed monitoring and early warning system for tailings dam deformation based on wireless sensor network, a comparative experiment of effective early warning efficiency is carried out. The traditional monitoring and early warning system is used as the comparison object, and the effectiveness of the early warning is analyzed according to the different deformation of the dam body of the simulated tailings pond. The results of the two comparison experiments were presented in the same data chart for comparative analysis.

4.1 Experimental Preparation

In order to eliminate the difference of the deformation of the tailings dam body and the particularity of different tailings ponds, the simulation experiment is used to simulate the deformation of a certain tailings dam body, and the effective early warning efficiency analysis is carried out. Simulating a fixed tailings pond can avoid comparative analysis errors caused by environmental factors.

4.2 Result Analysis

Using the data statistics tool, the effective early warning efficiency comparison curve is shown in Figure 2.

According to the effective early warning efficiency comparison curve, the early warning effectiveness of the traditional deformation monitoring system increases with the degree of deformation of the tailings dam body. For tailings ponds with little deformation, the early warning efficiency is very low. The monitoring and warning system of tailings dam deformation based on wireless sensor network has high warning ability for different deformation degree of tailings dam body. Through data analysis, it is concluded that the monitoring and early warning system of tailings dam deformation based on wireless sensor network can improve the effective early warning efficiency of tailings dam deformation by 40%.
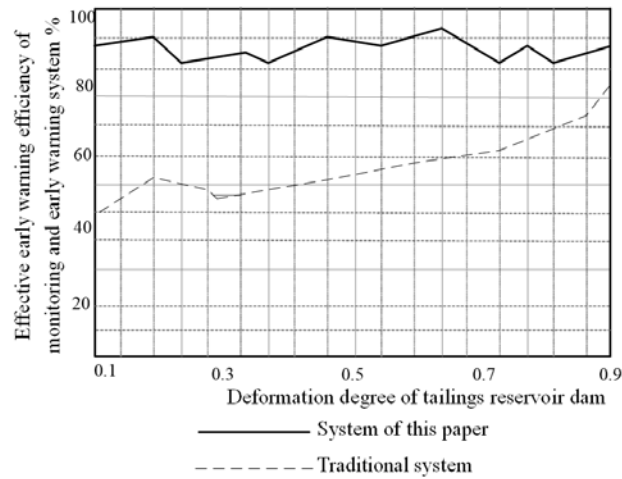
Fig. 2 Effective warning efficiency comparison curve

5. Conclusion

People are used to using IQ as a standard for measuring talent, and modern research shows that only high IQ does not guarantee the happiness of life and the success of the cause. The new hybrid learning model advocates the introduction of web-assisted instruction beyond traditional classroom teaching. The educator insists that each student is a talented person, makes full use of a wide range of reading information sources, and connects students' cognitive psychology, cognitive potential, and cognitive patterns in a lively and instructive manner. The "three-dimensional integration" of College English teaching improves the teaching link and effectively improves the teaching effect and quality of College English. It is a new way to integrate information technology and English teaching. College English teachers should make full preparations for knowledge and technology as soon as possible, take the initiative to improve their professional quality and teaching skills, and enhance their information technology ability. Students' questions can be answered online by teachers, which greatly improves students' satisfaction with the use of mixed teaching. At the same time, we should attach importance to teaching practice, actively carry out teaching research, promote teaching through scientific research, and promote our professional development. The external environment in which teachers live, that is, the school's educational management departments, should actively explore strategies to promote teachers' professional development and provide strong support for teachers' professional development.

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