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Application of Wireless Sensors and Their Networks in Monitoring Landslides

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Abstract: Since the 21st century, wireless sensor network technology has been rapidly developed, and this technology has been widely concerned not only in military, medical, education and other aspects, but also in disaster prevention and control has been well applied. This paper firstly analyzes the necessity of landslide monitoring, discusses and compares the more commonly used technical means of landslide monitoring, then analyzes and compares the systems based on wireless sensor network technology in monitoring landslides in China and abroad, and finally puts forward the application defects of wireless sensor network technology.

Keywords: Wireless sensor, Wireless sensor network, Landslide monitoring.

1. Background and Significance of Monitoring Landslides

Landslide is a serious natural disaster, which often occurs in the vast territory and complex terrain of China. It seriously threatens the safety of people's lives and properties, also destroys the infrastructure facilities, and affects the normal production and economic activities of the society, according to statistics, the number of people who died from geological disasters in 2020 alone reached 117, and the direct economic loss caused reached

5.020 billion yuan. In addition, at 00:30 on August 12, 2015, a sudden landslide in Shanyang County, Shaanxi Province, was rescued after rescue, 14 people were rescued and more than 60 others were missing. July 10, 2013, a large landslide occurred in Chengdu Dujiangyan City, Sichuan Province, resulting in 18 deaths and 107 people registered missing or lost contact. The probability of survival is very small, and it is not possible to carry out large area excavation to prevent landslides if you want to search and rescue.Fortunately, on December 10, 2019, Yichang City successfully forecast a landslide, which occurred in the afternoon at 4:50 pm in the front part of the landslide body 380,000 cubic meters overall decline, resulting in 135 meters of road damage, power supply line water supply pipe damage, fortunately did not cause casualties, which is inseparable from the successful forecast and evacuation of the relevant personnel, which can be illustrated for special locations dangerous locations Landslide monitoring is very necessary, and we should also note that landslides are no "gap" it can happen at any time, and the existing technology can be fully effective monitoring, to predict the occurrence of disasters in a timely manner, to prevent before it happens, to minimize the damage caused by landslide disasters.

Entering the post-PC era, the third wave of the information revolution represented by the Internet of Things is coming, and wireless sensor networks are one of the technologies that will have a huge impact in the 21st century. Wireless sensor network is a distributed self-organizing network integrating data collection, processing and communication functions, that is, composed of a large number of miniature sensor nodes scattered in the monitoring area, theoretically we can put these nodes in a certain form scattered in the mountain to be monitored, through the communication, sensing, data processing and storage functions of these sensor nodes even if the information is transmitted to the terminal can be achieved The ability to monitor landslides is reached through wireless sensor network technology[1].

2. Comparison of Techniques for Monitoring Landslides

2.1. GPS monitoring technology

At this stage, people also use GPS technology from time to time to monitor mountains and forecast geological disasters, and there are certain advantages of using GPS technology. First of all, compared with traditional mapping methods, GPS can cover a larger area, and the accuracy is at the centimeter level, and the results obtained from continuous measurements are consistent, while the precision GPS instruments are not expensive and easy to operate. In modern times, and because of the development of fast static method and real-time dynamic method, the accuracy of monitoring mountains by GPS technology has been qualitatively improved. However, at the same time, we have to see the disadvantages of using GPS technology, which is susceptible to weather, and when geological disasters occur, they are often accompanied by bad weather, which may lead to a decrease in monitoring accuracy and untimely forecasting. And in the field environment, the satellite signal of GPS is easily blocked by natural factors such as tree canopy[2]. Then with the use of wireless sensor network technology to monitor the mountain, GPS instruments are more expensive.

2.2. Remote sensing detection technology

Remote sensing is "distant perception", remote sensing technology can play a huge advantage in the event of disasters: it can quickly carry out large-scale, three-dimensional disaster monitoring, it can grasp the overall disaster information, large amount of information, high efficiency, for complex and changing landslide monitoring is very advantageous, can get rid of the shortcomings of GPS It can get rid of the shortcomings of GPS monitoring and is highly adaptable[3]. At the same time, continuous dynamic monitoring can be

carried out. But its drawbacks are also obvious. Since remote sensing is a comprehensive technology that has to involve many fields, the depth and breadth in application still need to be improved, and the application of remote sensing technology also faces several technical difficulties such as how to extend the point to the surface and the construction of the application module model. These uncertainties increase its riskiness in landslide monitoring.

2.3. Wireless sensor network technology

Application of sensors to detect landslides should be the most mainstream monitoring methods, mainly wireless and limited two ways, and the use of unlimited sensors greatly overcome the traditional limited sensors in the installation of complex terrain in mountainous areas, equipment power supply, line laying and facilities maintenance may encounter difficulties. And wireless sensor network by arranging numerous wireless sensor nodes in the mountain to be monitored, in order to obtain real-time information about the monitored area, and the information will be processed and sent to the designated terminal through the adjacent contacts[4]. see Figure 1 below.

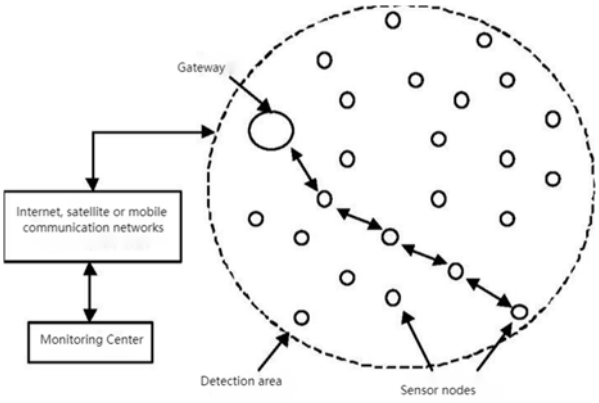

Figure 1. Wireless sensor network communication architecture diagram[4]

The use of wireless sensor network technology greatly solves the difficulties encountered in the process of monitoring the mountain: first, in the monitoring interval can be arranged at the same time temperature, humidity, water level, tilt angle and other types of sensors, timely access to landslides related to changes in geological information, coherently and in real time to complete the forecast and early warning. Wireless sensors can also minimize the impact of the environment on data collection and data transmission, greatly ensuring the stability of wireless sensor networks, the current stage of research and development and application of wireless sensor network technology tends to mature, whether in the wireless sensor network routing protocols or positioning implementation or network data fusion, there are rich conclusions and gains[5]. Finally, the low price of wireless sensor nodes can meet the overall wide range of mountain full coverage, economically, technically, usability, are useful for strong applications. However, the disadvantage of using infinite sensor network technology for mountain monitoring is also obvious, that is, the energy problem of wireless sensors, node power consumption also represents the end of the life of the node, how to optimize the data collection and transportation processing capacity of wireless sensors, and improve the life of infinite sensor nodes, is now facing an important problem[6].

3. The Wireless Sensor Network Applied to The Field of Landslide Monitoring at Home and Abroad Research Status

The application of wireless sensor network technology in the field of landslide monitoring has become the key research content of various countries, and some companies and scientific research institutes have achieved good results in these aspects。

3.1. Review of foreign research status

India leads the world in the number of deaths from landslides every year. To effectively reduce casualties in 2008, India's first landslide laboratory was established at amrita University. As a testbed for system development and validation in landslide-prone areas, it can create small landslides under controlled conditions and serve as a feedback system for field deployment. And the three-tier landslide warning system developed by the university shines in practical use. The first-tier landslide warning model is based on precipitation thresholds, but when precipitation reaches a certain threshold, an alert for potential landslides is issued; for the second-tier landslide warning, the system is based on safety factors generated by various wireless sensor nodes on the mountain, combined with rainfall thresholds from the first-tier warning system, and then based on moisture sensors, and pore pressure data obtained from the sensors are fused to provide more specific reporting.In the third level warning model, the system issues landslide warnings based on the data obtained from motion displacement sensors and vibration sensors. Japan has been a country prone to natural disasters since ancient times, and Ritsumeikan University has developed a self-organizing and self-healing wireless sensor network landslide monitoring system with nodes that work in three modes: initialization mode, measurement mode and emergency mode. The nodes choose the mode of operation according to the specific environment, and use acceleration sensors to and soil moisture sensors to monitor the condition of the mountain. A three-step forecasting algorithm for monitoring landslides based on wireless sensor networks has also been proposed at Johns Hopkins University in the United States: In the first step, wireless sensor nodes arranged in the monitoring area will divide the sliding and stationary zones by monitoring the surface displacement of the mountain. In the second step, the sensor nodes in the sliding area will perform node localization and calculate the displacement of the nodes. The third step is to create a model to predict the probability of landslide and the possible time of landslide by combining the displacement direction of the nodes with the information transmitted by wireless sensors such as moisture sensors and pore pressure sensors[7].

3.2. Review of the current status of domestic research

Southwest Jiaotong University in China also proposed a system based on wireless sensor network technology to monitor the mountain, firstly, in the monitoring area, the sensing nodes are scattered at appropriate locations to collect various types of soil information and transmit the collected information to the aggregation node, which will fuse the collected collection with GPS positioning information and

time information, and then transmit the user side with the wireless data system built by GSM (Global System for Mobile Communication) for timely alerts. The aggregation node will fuse the collected information with GPS positioning information and time information, and then transmit the information to the user by the wireless data system built by SMS (Short Message Service) of GSM (Global System for Mobile Communication), and make alerts in time.In addition, China University of Metrology has also designed a wireless sensor system to monitor landslides through tilt angle sensors. The system mainly involves installing tilt angle sensors in key monitoring areas, transmitting the measured data to the monitoring server for intelligent analysis through wireless communication in the form of zigbee, and reporting the analysis results to relevant personnel to achieve forecasting[8].

As one of the most influential technologies in the 21st century, wireless sensor network technology is becoming more and more mature and its application is becoming more and more diversified, and the use of wireless sensor network technology to monitor landslides is becoming more and more common.

4. Future Prospects and Concluding Remarks

Wireless sensor network technology in landslide monitoring technology, practical and price advantage is the main reason why it is loved by people at this stage, but its disadvantages in the application can not be ignored. As the basic unit of wireless sensor network - wireless sensor nodes, its battery capacity and the degree of use determines the life, monitoring the nodes of the mountain once the arrangement is completed due to the terrain is difficult to replace the battery, and on the other hand, because the mountain will be in a more stable static most of the time, if the wireless sensor has been in working condition, will be a lot of On the other hand, since the mountain will be in a more stable static state most of the time, if the wireless sensor is always working, it will consume a lot of power, how to reasonably deal with the relationship between the sensor work and dormancy is particularly important, the transport of data between nodes is also an important part of the power consumption, if the detection area between the sensor nodes repeatedly transmit the same information, it will cause unwarranted energy consumption, how to design the wireless sensor network structure is also a key research direction.And for some mountainous areas, the monitoring area is vast and the nodes arranged will become many, while it is not as good as GPS monitoring technology from the economic point of view. In the above examples, the designed systems also have shortcomings, such as the self-organizing and self-healing wireless sensor network landslide monitoring system designed by Ritsumeikan University in Japan, which applies acceleration sensors and generates a large error in calculation, so the accuracy will be much lower in actual application. The three-step forecasting algorithm of Johns Hopkins University in the United States is difficult to get the positioning of displacement nodes under the interference of the external environment, which will affect the accuracy and stability of the system. In the case of the program of Southwest Jiaotong University, the topology of the designed wireless sensor network leads to redundant and invalid data transmission between nodes, which wastes the energy of each node[9].

For each case, scientists have come up with optimization ideas and practice them, for example, optimizing algorithms and topologies of wireless sensor networks to stagger the time between working and sleeping modes of neighboring nodes for the purpose of node ground power consumption. There is also to improve the accuracy of information and increase the range of monitoring by one node by installing the node to a location 15 meters below the ground, etc.

The current wireless sensor network technology in the mountain monitoring application is not perfect, but it is indeed the most widely used, the best practicality, the highest economic benefits of a class of technology, with the development of human technology, infinite sensor network technology in the development of the difficulties encountered will certainly be overcome one by one.

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