



Geological Landslide Disaster Monitoring Based on Wireless Network Technology

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Abstract

With the comprehensive influence of natural evolution and human activities, the damage degree of geological disasters is increasing. How to effectively early warning geological disasters has become a problem of concern. How to effectively provide early warning of geological disasters has become a concern of people. This research mainly discusses the geological landslide disaster monitoring based on wireless network technology. First, establish two important early warning indicators of rainfall and geological landslide displacement. The monitoring system is powered by a rechargeable 12V lithium battery, combined with solar panels, which can be charged when the sun is full to ensure the stable operation of the system. The AT45DB161B chip with 16M bytes storage capacity is selected to store data such as geological landslide displacement and rainfall. Use Microsoft SQL Server 2008 database management system to complete database content query, addition, modification, and deletion operations. The TLP521-2 photocoupler is used to isolate the GPIO interface of STM32 from the external unit to improve the anti-interference ability. The communication between the field data collector and the monitoring center data server adopts the GPRS packet data transmission method based on the TCP/IP protocol. Currently, the PDU in the network is an IP data packet. The realization of the TCP/IP protocol at the field data collector is all completed in the master single-chip microcomputer. Use SIEMENSMC35GSM/GPRS module as data transmission terminal. The monitoring results show that the absolute error of the test data does not exceed 6mm in the horizontal distance, the vertical height difference does not exceed 9mm. The results show that the monitoring of geological landslide based on wireless network technology improves the accuracy of distance estimation and reduces the positioning error, which can provide scientific guidance for the planning, monitoring and early warning of landslide area.

Keywords: Wireless Network Technology; Geological Landslide; Disaster Monitoring; Disaster Warning

1.Introduction

Our country is one of the countries with the most serious geological disasters and the most threatened population in the world. With the comprehensive influence of natural evolution and human activities, the degree of development and destruction of geological disasters has continued to increase, which has brought serious impact and damage to the safety of people's lives and property and economic development, making the living environment of mankind greatly threatened. Complicated geological conditions, frequent tectonic activities, and abundant rainfall brought by the eastern monsoon climate have caused disasters such as collapses, landslides, mudslides, ground fissures, ground subsidence, and ground subsidence to be widely distributed in my country.

Compared with general industrial monitoring and control, geological disaster monitoring has more disadvantages. The wild environment is relatively harsh, the basic conditions are poor, and the power supply and communication are not guaranteed. The sensors are distributed in different monitoring points. The traditional wired communication method is time-consuming and difficult to achieve, and the wired transmission is easily damaged by the geological disaster itself, so the monitoring data Transmission usually needs to be wireless. Explore how to reduce life safety issues and social property losses caused by geological disasters, improve public safety protection capabilities, and

promote the process of information management. Remote users can access the monitoring server through the Internet to obtain real-time monitoring information and historical monitoring data. When the monitoring data exceeds the set threshold, the system can send SMS, email, voice, and sound and light alarms according to the settings and the specific equipment configuration.

Under the influence of complex conditions such as lithology, geology, hydrogeology, and mining areas, slope stability monitoring and early warning problems need to be solved urgently. Sun G designed a slope monitoring and early warning system based on slope geological analysis. The system consists of sensing layer, transport layer and application layer. His research lacks experimental data [1]. Wang M studied the geological safety monitoring system of mountain substations based on TEM. First, the mechanism of geological instability of substations in mountainous areas is analyzed. Finally, taking a substation in a mountainous area in Yunnan as an example, the results of apparent resistivity imaging reflecting the development trend and distribution of substations in mountainous areas were obtained through transmission electron microscope. This is a convenient and effective method to detect landslides in mountainous substations by transmission electron microscope. His research lacks concrete practice [2]. As a software service architecture, SOA is different from the traditional object-oriented model design, which is based on the service orientation with standardized interfaces and loose coupling characteristics. Li Z believes that SOA makes the software architecture more flexible and easier to access heterogeneous data services. He has established a monitoring and early warning platform based on the SOA architecture, which integrates real-time monitoring data, disaster early warning services and geographic information, and has good business compatibility and scalability. His research lacks experimental data [3]. Landslides in the reservoir area of the Three Gorges Reservoir are a frequent type of geological disasters. The landslides are caused by water level fluctuations and rainfall. Guodong Z believes that how to analyze landslide deformation is worthy of discussion. He analyzed the deformation characteristics of the landslide through monitoring, water level and rainfall, and studied the deformation mechanism of the landslide. His inquiry process lacks data [4]. Wang YP believes that landslide instability prediction is an important part of geological disaster prevention and control. Through rheological tests, he analyzed the time-lapse curve characteristics of actual landslide monitoring, analyzed, and compared the deformation characteristics of the deformation point and the deformation point of the deformation point. The method he proposed is not accurate enough [5]. Zhang S believes that landslide identification is very important for disaster prevention, monitoring and other applications. He has developed methods to predict and analyze disasters, including earthquakes, landslides, mudslides, and other geological disasters more accurately. The main findings of his geological hazard identification (GHR) analysis and evaluation have become the main guide for disaster mitigation and implementation. His research is not detailed enough [6].

This research first analyzes the classification and hazards of geological disasters in my country and uses the TLP521-2 photocoupler to isolate the STM32 GPIO interface from the external unit to improve the anti-interference ability. The communication between the field data collector and the monitoring center data server adopts the GPRS packet data transmission method based on the TCP/IP protocol. Currently, the PDU in the network is an IP data packet. The realization of the TCP/IP protocol at the field data collector is all completed in the master single-chip microcomputer. The research includes GPS measurement, close-range photogrammetry for surface displacement monitoring, and various types of data acquisition and alarm equipment are introduced.

2. Geological Landslide

2.1 Wireless Network

Wireless network virtualization is a technology that can share physical wireless infrastructure and RF slices, which can not only improve the capacity and coverage of wireless networks, but also improve wireless security. Combining the views of three emerging technologies: SDN, EC, and blockchain technology for wireless network virtualization. With the help of the controller, SDN can dynamically configure network resources for effective management. EC not only helps to process user signals and queries on each base station with the shortest possible delay, but also helps to avoid establishing a high-speed backhaul link between the base station and the centralized controller. Blockchain technology protects wireless infrastructure owners from double-spending attacks that allocate the same wireless resource to multiple virtual wireless networks [7-8].

The end of the wireless sensor network is the sensor that can perceive the environment or monitor the object information. These sensor nodes are randomly scattered in the network deployment area. Wireless sensor networks are widely used in military and civilian fields because of their large-scale coverage, remote monitoring, strong

adaptability, and high fault tolerance. In order to avoid signal collision, P reserves an arbitrary period of time for compensation from receiving the request to returning the request[9]. Then there are:

$$\frac{d_{M,P} + d_{P,M}}{2} = \frac{c}{2} [(T_{M2} - T_{M1}) - (T_{P2} - T_{P1})] \quad (1)$$

Obviously, once the mobile anchor node M speeds up, it will cause ranging errors[10-11]. The large scale of wireless sensor network can be reflected in two aspects. On the one hand, it is the coverage. Because the sensor nodes are randomly scattered, it can even be broadcast by aircraft, and its self-organizing characteristics can cover a large area; on the other hand, it refers to the high node density, the wireless sensor network The number of nodes is huge, which may be hundreds, thousands, or even more. The rapid topological changes caused by a large number of sensor nodes require strong adaptability of the software and hardware of the sensor network, and corresponding adaptive strategies for node positioning. The energy supply of sensor nodes is generally supplied by batteries with limited energy, and sensor nodes are generally deployed one-time and work independently. Some nodes are distributed in harsh environments that are difficult to reach by humans. These factors have caused difficulties in network maintenance. Once the node energy is exhausted, it cannot continue to work. Therefore, low power consumption has always been a research hotspot in sensor networks[12]. In the wireless sensor, with node i as the center, assuming that the outer boundary of ring $n-1$ and the outer boundary of ring n are b_1 and b_2 respectively, then:

$$S(r_{n-1}^j) = b_1^2 \cos^{-1} \left(\frac{d^2 + b_1^2 - R^2}{2db_1} \right) + R^2 \cos^{-1} \left(\frac{d^2 + R^2 - b_1^2}{2dR} \right) - \frac{1}{2} \sqrt{4dR^2 - D} \quad (2)$$

It can be seen from b_1 that the bigger $S(r_{n-1}^j)$ is, the bigger it is[13-14].

2.2 Landslide

Landslide is a kind of geological disaster caused by man-made or natural factors[15]. Change detection is an important technique for extracting landslide areas from pre-disaster and post-disaster images. Since landslides are spectrally similar to bare ground, and it is difficult to absolutely calibrate the radiation of multi-temporal images, the detection method may cause major errors or omissions. By modeling the relative relationship between adjacent pixels from multi-time images, errors or omissions in the detection process and lighting effects can be reduced. In order to extract landslides through an automatic and robust process, a practical method based on multi-temporal data and spatiotemporal models is usually adopted. First, generate the normalized difference vegetation index (NDVI) and built-up area existence index (PanTex) characteristic sequence, which can reflect the changes of vegetation area and built-up area respectively. Then, the landslide is detected from the feature sequence, and finally, the landslide map can be obtained[16-17].

2.3 GPRS Communication Technology

GPRS breaks through the functional bottleneck of the GSM network that only provides circuit switching. Due to the use of data packet switching, GPRS does not have a fixed wireless channel. It is allocated immediately when needed, and the channel is released immediately after use. The tariff for its use is based on its actual amount of information sent is calculated. The transmission rate of GPRS can be increased up to 172Kbps, which can meet most data communication needs, and the information transmission is safe and stable, suitable for long-distance transmission. The GPRS wireless communication method has the advantages of being online at any time, wide coverage, cost-effective, and supporting IP protocols. It is very suitable for the application of data monitoring systems. The use of this communication method can also save manpower and material resources and improve the automation level of monitoring. Future communication upgrades provide redundancy. If the monitoring range is expanded, it will be more convenient to add remote data collection terminals[18]. So the long-distance wireless communication method originally designed chooses GPRS communication finally[19-20]. The distance from the satellite to the central station r_1, r_2 is known, c is the speed of light, then:

$$r_1 = \sqrt{(x_{s1} - x)^2 + (y_{s1} - y)^2 + (z_{s1} - z)^2} \quad (3)$$

$$r_2 = \sqrt{(x_{s2} - x)^2 + (y_{s2} - y)^2 + (z_{s2} - z)^2} \quad (4)$$

Among them, x_{s1} and y_{s1} are the distance between the two satellites[21].

2.4 Geological Disaster Data Transmission Technology

Compared with general industrial monitoring and control, geological disaster monitoring has more disadvantages[22-23]. The wild environment is relatively harsh, the basic conditions are poor, and the power supply and communication are not guaranteed. The sensors are distributed in different monitoring points. The traditional wired communication method is time-consuming and difficult to achieve, and the wired transmission is easily damaged by the geological disaster itself, so the monitoring data transmission usually needs to be wireless[24]. The wireless sensor network can be used in a monitoring target area. In fact, the application development of wireless sensor networks in all aspects has increased significantly. The specific implementation with more applications is ZigBee; from the target area to the data processing center existing mobile communication network can be used, or satellite communication and other technologies can be used to achieve; a series of processing such as data compression, verification, and encryption are also involved in the transmission process[25-26].

Earth disaster monitoring and early warning system is very large, the field environment is harsh, the transmission distance is long, the equipment is many, the function is complicated, so stability is a very important indicator. To ensure that the front-end collected information can be accurately reported, the monitoring center receives the data for comprehensive analysis, and can make accurate and stable forecasts based on the monitored data information[27].

3. Geological Landslide Disaster Monitoring Experiment

3.1 Determination of Early Warning Indicators

Rainfall index: less than 20mm, the possibility of geological disasters is very small. The rainfall index also needs to consider the current accumulated rainfall, such as the accumulated rainfall in the previous 24 hours, 12 hours, and 6 hours, and then combined current rainfall intensity is established as an early warning indicator.

Displacement index: displacement is an external reaction of the landslide body. Part of the rock and soil on the slope will be affected by gravity and undergo a slow and continuous slight decline. When the landslide surfaces are slowly connected to each other, the sliding rate of some of the rock and soil on the slope accelerates and slides displacement also gradually expands. When the landslide surface is fully connected, the sliding resistance of the landslide body decreases, the landslide rate increases, and the sliding displacement rapidly increases. When the energy of the landslide body gradually decreases, it will reach another new balance and gradually stabilize. Therefore, the displacement index can reflect the change process of the landslide body and is one of the key parameters in the early warning process.

3.2 Design in Power Supply Module

The power supply is a very important part of a complete system. A stable power supply can ensure the reliable operation of the system. Since geological disasters often occur in the field, it is generally difficult to supply city power. In this case, the system uses rechargeable Powered by 12V lithium battery, combined with solar panels, it can be charged when the sun is full to ensure the stable operation of the system. The sensor is responsible for collecting environmental information, which is processed by the signal processing circuit and then sent to ZigBee for upload, and sent to the on-site early warning terminal.

3.3 Memory Selection

Since the on-site early warning terminal needs to record a large number of data uploaded by wireless smart sensors during the monitoring process, it needs a huge storage capacity and requires the storage to have the characteristics of not being lost after power failure. Based on the above factors, this system uses Atmel's AT45DB161B chip with 16M bytes of storage capacity to store data.

3.4 Obtaining Monitoring Data

Install surface displacement gauges, deep displacement gauges, soil pressure gauges, soil moisture meters, etc. on the monitoring site. The on-site collection terminal sends the field power data to the remote control command center through 3G communication. The command center can realize the frequency setting of the collection equipment, remote switch control, working status query. In the rainfall collection and disconnection monitoring circuit, it is mainly the processing of pulsed digital signals. The rainfall in a period of time is calculated by the number of digital pulses during this period. Similarly, the disconnection detection is also based on whether there is a pulse interrupt input. To judge whether a disaster occurs. In the application system, in order to prevent electromagnetic interference, photoelectric isolation technology is generally used to process the front-end input signal to obtain a stable digital signal. This system uses TLP521-2 photoelectric coupler to isolate the GPIO interface of STM32 from the external unit to improve the anti-interference ability.

3.5 Data Sheet Design

The spatial database uses ArcSDE database, which contains basic geographic information layers, such as water system, traffic, and landslide hazard points. Common attribute information uses SQL database, such as three card information, daily work information, etc. Spatial data mainly includes basic geographic data layers, geology, rock and soil layers, and geological disaster layers. According to the consistency principle of the database design principle, the same type of data and closely related data are regarded as the same layer, so that the properties and attributes of each layer are unified. The space and attribute table index is shown in Table 1.

Table 1: Main spatial information table

Serial number	Space table name	Comment
1	RAINPOINT	Rainfall site layer
2	ZHOI 1081	Layer of qualitative hazard points
3	LA011081	Annotation layer
4	LA211081	Administrative village layer
5	LA011081	Township layer

3.6 Database Platform Design

The data storage, management and maintenance of the landslide monitoring and early warning system in this study adopts the Microsoft SQL Server 2008 database management system. Complete operations such as querying, adding, modifying, and deleting database content, while providing database backup and restore, data upload, data migration, and import and export functions.

3.7 GPRS Data Transmission Module Design

This system uses SIEMENSMC35GSM/GPRS module as the data transmission terminal. The GPRS data transmission module and the SGSN use the SMDCP (Subnetwork Dependent Convergence Protocol) protocol for data transmission. The transmitted data is the PDP (Packet Data Protocol) protocol data unit PDU (Packet Data Unit), and the PDP context is identified by the temporary logical link (TLLI: Temporary Logical Link Identity) and Network Layer Service Access Point Identifier (NSAPI: Network Layer Service Access Point Identifier) for unique identification.

GGSN and SGSN use the tunneling protocol (GTP: GPRS Tunneling Protocol) to transmit data. The transmitted data is the encapsulated PDP protocol data unit, denoted as GTPPDU. The GTPPDU data header contains the GSN address for easy addressing. The header of the GTPPDU also includes a tunnel identifier, which is used to uniquely identify a PDP context. The router and the background server are connected by a 2M dedicated optical cable.

4. Monitoring and Analysis of Geological Landslide Disaster

4.1 Analysis of Monitoring Results

The displacement monitoring accuracy test is that the antenna of the reference station is not moved, and an observation is made every time the antenna of the observation station is moved, and the error relationship between the observation result and the amount of movement is compared. The monitoring results are shown in Table 2. The system stability test has been tested under three conditions of different observation time, different baseline length,

and different observation period length. From the data in Table 2, it can be seen that the absolute error of all test data does not exceed 6mm in the horizontal distance; the vertical height The difference does not exceed 9mm. The relative error level does not exceed 0.05%; the vertical does not exceed 1.9%. From the perspective of the error distribution, except for the large deviation of the 8th period, the errors of the other periods are uniformly distributed. This shows that the system works normally, the absolute value of the error is less than 50% of the design accuracy range, and the stability meets the design requirements. The system displacement monitoring accuracy test is to keep the original test conditions unchanged, take the above-mentioned experimental position as the origin, and accurately move the antenna position of the observing station one by one to make observations. Among them, the displacement value refers to the distance that the GPS antenna of the observation station moves on the test platform. The value is directly measured by the scale on the platform, and the accuracy can reach millimeter level. The measured displacement value refers to the relative displacement value obtained by subtracting each observation value from the average value of the distance and the average value of the height difference in Table 2 respectively. This is because the actual distance measured with a tape in the actual measurement can only achieve centimeter-level accuracy. Analyzing the test data in Table 2 shows that for 10 observations, the maximum absolute error of horizontal displacement is 6mm; the maximum absolute error of vertical displacement is 11mm. Fully meet the design requirements of horizontal accuracy of 1cm and vertical accuracy of 2cm.

Table 2: Monitoring results

Time period number	Period length	Measurements		Absolute error		Relative error	
		(m)		(mm)		%	
		Distance	Height difference	Distance	Height difference	Distance	Height difference
1	20	18.440	0.552	-2	-1	0.01	0.20
2	20	18.442	0.574	0	4	0	0
3	20	18.443	0.679	-3	0	0.01	0.70
4	20	18.439	0.603	0	2	0.02	0
5	20	18.442	0.533	3	-2	0	0.34
6	20	18.445	0.521	4	3	0.01	0.35

4.2 Monitoring and Analysis of Surface Displacement

The monitoring situation of the surface displacement monitoring point is shown in Figure 1. It can be seen from the figure: From January 25 to October 24, the cumulative displacement of this point has an overall upward trend, of which the acceleration from January to May In the deformation stage, the cumulative displacement is about 27mm, and the deformation rate is about 5.4mm/month; May-October is in the deceleration stage, the total cumulative displacement is about 45mm, and the deformation rate is about 3.5mm/month; October to December, the displacement The amount is significantly retracted, and the deformation rate is about -12.29mm/month. According to on-site investigation, the retraction is due to the strengthening of the building; there is almost no displacement from December to February of the following year; February 21 to March 29 It is in a new round of accelerated deformation stage, the deformation rate is about -13.65mm/month; there is no obvious deformation increment from March to August, and the total cumulative displacement is about 35mm. The M05 surface displacement monitoring point located near the construction area has changed significantly from January 24 to mid-March, with a deformation of 37mm, and the cumulative deformation from late March to the end of August is about 60mm, from September to February 20 of the following year There was no obvious deformation, and a slow deformation process began at this point from March to August. The direction of the deformation at this point is very obvious, always changing between 30°-40°. Through the analysis of the monitoring data of the above-mentioned surface displacement monitoring points, it is concluded that the main reason for the deformation of this area is the construction excavation. In the early stage of monitoring, the deep foundation pit excavation in the construction area caused the deformation of the houses in the area. After the construction was stopped and the supporting measures were implemented, the deformation was significantly reduced. In addition, the difference in building foundation quality is also related to the measured displacement. The two monitoring points of M5 and M6 are closest to the construction excavation area, but from the perspective of deformation, the deformation of M5 is the largest, with a cumulative amount of about 95mm, and the direction is obviously toward the direction of the excavation; while the deformation of the M6 monitoring point does not exceed 10mm, and there is no direction fluctuates within the measurement error range; the deformation of M2 and M3 farther from the excavation area are both about 35mm, and the deformation direction fluctuates between 300°-400°, which is completely related to the excavation direction.

Therefore, the amount of surface displacement in this area is relatively related to the building foundation, the deformation of the foundation difference is obvious, and the deformation of the stable foundation is not obvious.

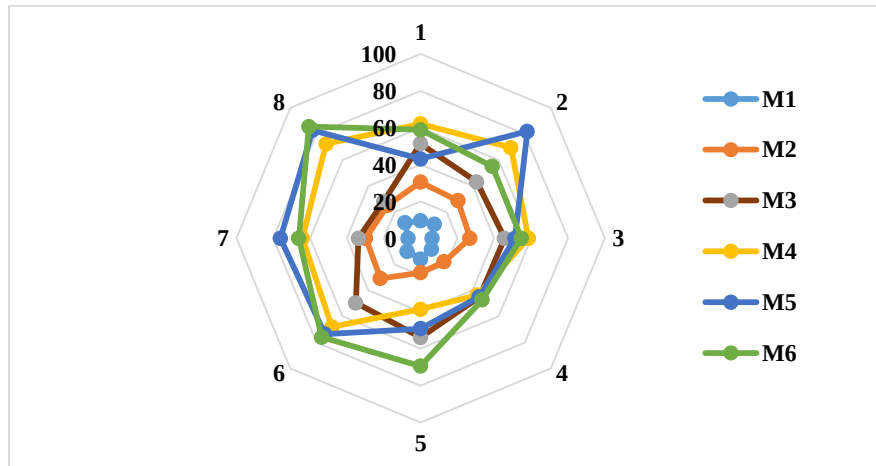


Figure 1: Monitoring of surface displacement monitoring points

4.3 Analysis of Landslide Monitoring Data

The monitoring points are mainly arranged on the buildings with obvious deformation and the parts where the ground fissures are generated. There are 8 monitoring points for surface displacement. Among them, M01, M05, M07, M08 and other four surface displacement monitoring points have changes or fluctuations. M01 is located behind the landslide. The results of landslide monitoring data are shown in Figure 2. It can be seen from Figure 2 that the deformation at this point has been increasing until August, and the cumulative deformation from April to the beginning of August reached about 250mm, indicating that the stability of this region during this period is relatively poor. This point shows a clear direction of deformation on the radar chart, and the angle is between 291° and 300° . After mid-August, the amount of deformation slowed down significantly and did not continue to expand. M05 is located in the front part of the landslide. It can be seen from Figure 2 that the curve of point M05 fluctuates within 10mm, and there is no obvious deformation. This point does not show obvious directivity in Figure 2. It can be considered that the front part of the landslide is basically in a stable state, with little deformation. M07 is located on the slope in the middle of the landslide. It can be seen from Figure 2 that continuous deformation occurred from June to September at this point, the displacement no longer increased significantly after August, and the cumulative deformation was about 98mm. It can be seen from the radar chart that the deformation direction of this point is obvious, which is basically the same as the main sliding direction of the landslide, and the angle is between 291° - 300° . M08 is located in the middle of the landslide. It can be seen from Figure 2 that the monitoring curve has a large fluctuation. It is estimated that the reason is that the monitoring point is blocked by the building. The overall curve can be seen to have a clear upward trend, indicating that the stability of the region is poor. At this point, the deformation rate is greater from June to August, and the deformation rate slows down significantly after August. The total deformation from June to September is about 95mm, which is equivalent to that of M07, and the overall deformation direction is about 310° . It can be seen from the results of surface displacement monitoring that during the period from June to September, significant surface displacement changes occurred in the middle and rear parts of the landslide. The displacement change in the middle part is about 95mm, and the displacement change in the rear part is about 120mm; the direction of the landslide deformation It is basically the same as the main sliding direction of the landslide, and the angle is between 290° and 300° .

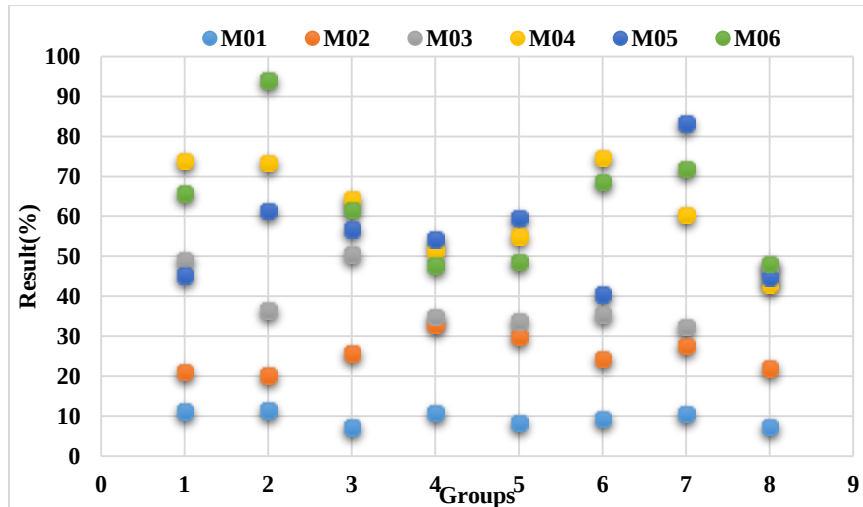


Figure 2: Results of landslide monitoring data

4.4 Analysis of Rainfall Monitoring Results

This design is to use this principle to monitor rainfall. The program accumulates the pulse count sent by the rainfall sensor, saves the value in the corresponding counting unit, and responds to each pulse interruption program, and finally stores the data in fixed address unit of the external data memory, the timer program is responsible for checking the rainfall counting unit at regular intervals. If its value is not equal to zero, the data will be sent to the outside (host computer or central station monitoring room) once, if the rainfall counting unit value is If it is zero, no data will be sent, and it will wait for the arrival of the rainfall pulse. The rainfall monitoring results are shown in Figure 3. Landslide zoning is essential to prevent and reduce landslide areas triggered by rainfall. A shallow landslide evaluation model was established in the demonstration area, and the potential landslides were reasonably predicted by simulating the stability of large-area slopes, and the influence of rainfall on the landslides was quantitatively determined through the evaluation of migration and conversion laws. Different rain warning levels. The results show that all 169 recorded landslides are classified as low defensive stability using the SINMAP model, and the distribution of susceptible landslides in low-lying areas is consistent with areas with relatively high topographic precipitation. As the rainfall intensity increased from 10 mm/h to 56 mm/h, it was found that the landslide and rainfall showed an increasing power function relationship. The potentially unstable area is always the highest area, which highlights a key issue. In addition, as the basically stable area and the potentially unstable area gradually transition to the unstable area and the extremely unstable area, respectively, the landslide potential gradually increases and the degree of danger is getting worse. Therefore, the potential threat is more serious. When the hourly rainfall exceeds 20 mm, the stability of the slope in the stable area will gradually weaken, and then gradually migrate to the unstable area, causing landslides, debris landslides and flow. When the hourly rainfall exceeds 32 mm, due to quantitative changes, the degree of hazard has undergone a qualitative change, and the degree of geological hazard has increased significantly. The research can provide scientific basis for landslide zoning, monitoring and early warning in the demonstration area.

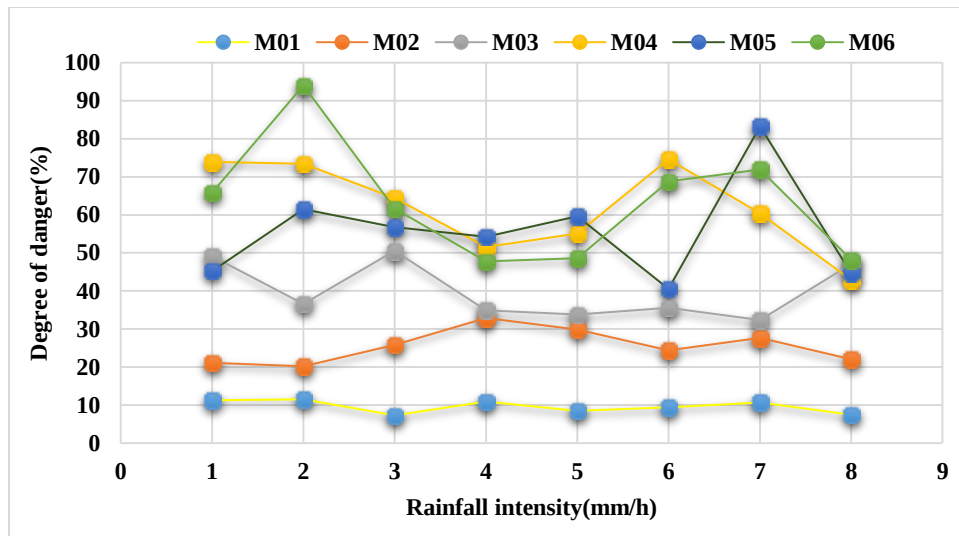


Figure 3: Rainfall monitoring results

4.5 GPRS Module and Host Computer Communication Test Analysis

When the GPRS module and the host computer communication test system work normally, the communication stability is very important. This system requires that the real-time, accuracy and stability of data and commands must be guaranteed during the monitoring process. The features and advantages of GPRS communication have already been introduced in the previous article, so I will not describe them here. The following is the communication between the GPRS module and the upper computer under the conditions of the laboratory. The upper computer is used as a TCP server, and the GPRS module is used as a client of the lower computer. The data can be uploaded to the server and the corresponding independent public network must be specified. IP address and port number, the laboratory is in the internal network environment, so to achieve communication, you need to find the corresponding public network IP. The method used is to use third-party software to solve this problem through port mapping. The designated IP address in the lower computer is 122.228.19.57, port number: 17496, the IP in the TCP server is 192.168.0.100, port number: 7654, and finally the communication module is initialized by AT command for communication test. GPRS module and host computer communication test result is shown as in Figure 4. It can be seen from Figure 4 that the AT command is set successfully, the network connection is successful, and a piece of data is sent: TCP connection test, showing that the TCP connection test is successful. In the last line, the data information sent by the upper computer to the lower computer (the upper computer sent the data successfully received) has been sent continuously for 3 times, and it has been successfully received 3 times. Then test the network settings, sending and receiving of the host computer. It can be seen from Figure 4 that the protocol used is TCP, the IP address is 192.168.0.100, and the port is 7654. After connecting to the network, the message sent by the GPRS module is successfully received. After a long time of testing and continuous improvement, the final system can run stably for a long time to achieve the design purpose. In the monitoring area, the alarm bell on the ARM board indicates that there are detectable wireless sensor nodes nearby. The temperature, humidity, and soil pressure collected by the sensor node are already within the alarm range. Click the alarm information of the view point, and the system will collect the node information at the convergence node when the temperature, humidity and soil bearing pressure meet the warning conditions. The information is transmitted to the vehicle system in real time via wireless Ethernet, and the parameter changes of the alarm information can be observed. Because the convergent node processor is partially written into the geological disaster model, the system can predict the time of the disaster. When the soil displacement changes and exceeds a certain threshold, geological disasters may occur.

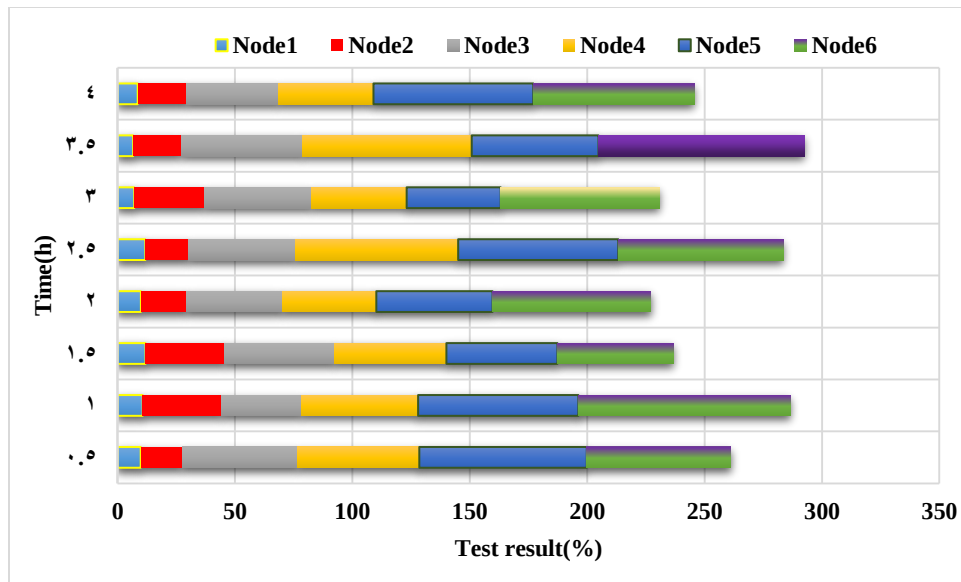


Figure 4: GPRS module and host computer communication test results

5. Conclusion

The geological monitoring station uses domestic mature and stable sensors in the front end of the monitoring system, and then uses a multi-functional data collection terminal to achieve real-time and timing collection of sensor data, and transmits it to the monitoring server through the GPRS wireless network, and the monitoring server processes and stores the received data, remote users can access the monitoring server through the Internet to obtain real-time monitoring information and historical monitoring data. When the monitoring data exceeds the set threshold, the system can send SMS, email, voice, and sound and light alarms according to the settings and specific equipment conditions. The system has established a monitoring project and corresponding monitoring demonstration points, collected real-time monitoring information of surface displacement, landslide displacement, water level, rainfall and other aspects. Analysis shows that the monitoring data can reflect the actual situation of the area in time. Establish a regional geological disaster prediction and forecasting system based on GPRS technology, establish a spatial database of geological disasters based on the survey and monitoring results of the demonstration area, and analyze the formation and development of regional geological disasters.

There are many types of geological disasters. This research mainly focuses on the monitoring and early warning of debris flow in geological disasters. First, it introduces the research background of the geological disaster monitoring and early warning system and the status quo of development at home and abroad in recent years, and proposes the significance and significance of the research based on the current development. purpose. Then the overall plan of the geological disaster monitoring and early warning system is described. The system is installed in the areas prone to geological disasters, which can carry out long-term monitoring and grading forecast of disasters in the areas prone to debris flow disasters. The monitoring and early warning system is mainly divided into two parts: a monitoring station and a monitoring center. The monitoring station performs data collection and transmission, mainly composed of front-end sensors and remote monitoring terminals. Landslide monitoring is a very complex system engineering involving multiple disciplines such as electronics, computers, communications, surveying, and geological engineering. The effective implementation of landslide monitoring needs to have a complete set of long-term planning and deployment, which requires the concerted efforts of multiple parties and multiple departments, so that group prevention and management can be effective. The landslide monitoring system studied is limited to the monitoring methods and monitoring devices of the entire landslide monitoring project.

In the study, the classification and influencing factors of common geological hazards were analyzed, monitoring methods were discussed, equipment and technology for measurement and collection were studied; the network transmission and data processing of real-time monitoring of geological hazards were studied; software development technology was done discussed, proposed the use of dynamic compilation technology for the monitoring system, and used the new framework and new technology to realize the monitoring system. Finally, a set of accurate, effective

and stable intelligent monitoring and early warning system was designed and developed, which has certain research significance and practical application value. Because the communication method used in this research is GPRS communication, it needs the support of mobile companies. GPRS communication cannot be realized in remote areas without mobile base stations. This has caused certain regional limitations for the application of the entire system. One problem can be solved by adding satellite communication to the system.

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