Design and implementation of tailings dam security monitoring system

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Abstract

Combined with modern computer technology, network technology, image and Video transmission technology and GPS satellite positioning technology, the factors that affect the safety of tailings dam are given. In this paper, the author proposes solutions for tailings dam safety monitoring, designs a software structure which include visualization, automation and intelligent, discusses some critical technologies in this system. The security monitoring system of Fengshuigou tailings dam is developed, which offering a reference for researching and developing tailings dam security monitoring system.

Keywords: tailings dam; security monitoring; monitoring system; GPS

0 Introduction

Tailings storeroom is the very important establishment of production and environmental protection in mining enterprises, the security of tailings dam directly influences the normal operation of mining, environmental protection and the security of the downriver people’s life and property.

In our country, Tailings major accidents have occurred from time to time. On April 30, 1986, Huangmei mountain of Anhui tailings dam-break accident had killed at least 19 people and injured more than 100 people. On May 24, 1992, Luanchuan county of Henan province Chituidian countryside tailings collapsed when the tailings was repaired. 12 people were killed. In 1993, Panluo of Fujian province, iron mine reservoir area happened a massive landslide, 14 people were killed and 4 wounded. On July 16, 1994, Hubei Daye non-ferrous metals company Longjiao mountain copper, due to heavy rain impact, tailings dam collapsed, causing 28 people died, 3 missing. On October 28, 2000, Nandan County in Guangxi giant town acid water bay dam collapsed suddenly, causing the 28 deaths, One million homes were destroyed. Every time tailings dam accident not only causes casualties, but also financial disastrous...
Therefore, tailings dam safety monitoring has been more emphasized heavily by people, with the rapid development of computer technology, it produces an automatic monitoring method, namely through the automated monitoring instrument, observational data is collected in data acquisition instrument, and through the automatic monitoring software for data analysis and processing, achieve real-time monitoring purposes. Tailings dam automatic monitoring and security warning is the need of modern management, advanced computer monitoring system should follow the development of contemporary high technology.

1 The development of tailings dam safety monitoring

The earliest tailings dam monitoring are generally artificial way, observations of deformation, seepage, crack etc materials are achieved through the artificial regularly or irregularly observation. With the rapid development of computer technology, automatic monitoring method is produced: the sensor is arranged in tailings dam appropriate location, data acquisition instrument (MCU) real-time monitoring data read sensor and stored in dam server, those dates are transmitted to the tailings dam management office through the network. People can see internal saturation line, the dam reservoir water level, dry beach length, the dam deformation amount. Tailings dam safety assessment system according to the monitoring data can be automatically give tailings dam safety coefficient. If the tailings dam safety coefficient is less than the threshold, automatically set an alarm [2].

2 Influence of tailings dam safety index and its realization

Impact of tailings dam safety index basically has: the tailings dam displacement monitoring(surface internal), tailings dam saturation line, rainfall and dry beach length, the realizations of monitoring index are as follows [3]:
(1) Dam saturation line monitoring:
Drilled dam for embedding the PVC pipe, osmometer can be put in pipeline, the water level data of the real-time can be collected, and the system software data automatically draw the dam the distribution of saturation line. Managers can control the actual circumstances of the dam saturation line at any time, and the disadvantages of artificial not measuring or artificial measurement inaccurate can be avoided when harsh conditions in flood season. Artificial hole is reserved around measuring point to verify the accuracy of the sensor.
(2) Library water-level monitoring:
Adopt water level gauge to monitor the reservoir water level, water level gauge is buried in the library, Chambers by polyurethane cables and MCU data acquisition instrument are linked together, can monitor the water level [4].
(3) Horizontal displacement of dam monitoring:
Inclinometer is installed in the pipe string, layer and structure movement caused inclinometer displacement, forced the inclinometer tube deformation from the initial position to a new location. Inclinometer sensor by measuring the rake of its own slope (inclination) changes can be obtained the displacement. Inclinometer tube from the bottom of the deepest embedded starting point of each segment and reflects the displacement of soil test level deformation.
(4) Monitoring the vertical displacement of the dam:
The Vibrating multi-variable testing meter vertical displacement of the dam, using a vibrating wire displacement sensor as a measuring head, measure head through a fibreglass rod and anchor head are connected, anchor head according to design requirements at different depths in the borehole and the surrounding soil with its mobile, connected with the anchor head along with equal amount of mobile measuring rod, measuring rod installed at the other end (port hole) of the vibrating wire displacement sensors that produce equivalent relative displacement.
(5) The length of dry beach monitoring:
According to the reservoir water level and dry beach slope, conversion can get the length of dry beach.

(6) Video surveillance:

Video surveillance system allows managers to keep abreast of more intuitive and dry tailings dam beach scene. To replace the artificial tour on the dam play a significant role, so in terms of monitoring system for the entire automation, video monitoring system is a good additional tool.

(7) Dam surface displacement monitoring [5]:

Since the mid-eighties, GPS (Global Positioning System) was put into civilian, who has been widely available in navigation; positioning and other applications in various fields, especially in the measurement of community control measure play an epoch-making role. Because it is static relative positioning its high accuracy, high efficiency, all-weather, without the advantages of visual communication to make people use it to replace the conventional triangle, three sides, corners and other methods, and in theory, practice have achieved remarkable results. Deformation monitoring in precision engineering has gradually been widely used. As GPS technology continues to mature, GPS automatic monitoring system has been in the dam, construction, earthquake, bridge and other industry applications and achieved very good results, the system structure shown in Figure 1.

![Fig.1 The structure of the GPS system](image)

3 Multi-user real-time monitoring network

Because of the importance of dam safety, Qidashan Concentrator, Anshan Iron and Steel Group Mining Company, Safety Production Supervision Bureau of Liaoning Province have automated real-time observation of the dam safety monitoring results, based on this we have adopted a multi-user real-time monitoring network [6].

3.1 Multi-user real-time monitoring features

The author adopts C/S structure to achieve real-time monitoring of multi user network. Server-side to achieve the following main functions:

1) Data acquisition, Put the data collected saved to the database.
2) Real-time monitoring client's various commands (such as real-time acquisition command, the client data update command, parameter setting commands, etc.) and according to the specific orders and make corresponding processing.
Clients achieve the following functions:
1) Real-time data collection.
2) According to the data collected to draw a variety of real-time curves and real-time animations, such as real-time collection point saturation line, dam displacement curve, animation, real-time reservoir water level.
3) Various statistical features of historical data and print reports.
4) Dam safety evaluation system module based on monitoring data to assess the safety of the dam.

3.2 The characteristics of multi-user real-time monitoring

1) Multi-level user management
   Client Login under the different levels, divided into administrators and ordinary users. Administrators can realize the remote server management and server settings (such as setting time data acquisition time, set the server port, etc.), ordinary users can only carry on data and state of the curve browse.
2) Multi-user network communications
   Allows multiple users to server on command request to get the data. Each client connects to the server successfully, the server will assign to each client a customer ID, and to the ID stored in a linked list within the system structure, the same time the ID back to the client. Every time when the client sends the command to the server will bring the ID Numbers, so that the server will be able to identify different client command requests.
3) Multithreading
   This system uses a sine wave pressure sensor and many points, so it is slow, every traverse again all the point probably needs two minutes, during this time the server can't make any other treatments. So, this system uses multithread technique to solve the problem, every time data collection, create a responsible for data acquisition work thread, server main thread still responsible for monitoring client request, such as accept to command corresponding processing.
4) Server fault-tolerant processing and error records
   Server a necessary feature is stable. And to ensure the stability of the server, it needs to handle some unpredictable error. In the execution of the program, prone to unpredictable error is generally in data collection, server client communication between and database access these places, so when in realizing these functions must be added error handling function, to ensure that the server and stable operation and unapt system paralyzed. Meanwhile must realize function is that when application error occurred, the time and cause of error must be reported, so that later record analysis and processing make the system more robust program [7].

4 Engineering example

According to production safety supervision and administration documents in Liaoning province Liao Ann supervision [2009] 12 letter, "about building province administrating tailings on-line monitoring system", combining with the stipulation of notice of tailings dam safety influence factors of tailings dam developed Fengshuigou safety monitoring and warning system automation.

4.1 Project summary

The fengshui ditch for national large type I tailings dam, affiliated Qidashan concentrator, the dam serve for Qidashan concentrator and Tiaojuntai concentrator. From the repository of Qidashan
concentrator, surrounded by 7.5 kilometres around a closed form foothills, good valleys. All about 2.5 kilometres wide field north-south 4.5 km in length, the initial dam of Qidashan concentrator is good early rock fill dam that permeable performance. Dam is 505 metres long, wide top 4 meters, the elevation of 55 meters, and the top elevation 76 meters, 21 meters dam. Ziba tailings dams, upstream method 85 meters tall slope 1:5, extended service period, the late may, tailings dams to 150 meters, may heightening total tall 95 meters. Eventually period dam 13.6 meters long, bottom shape wide 424 meters. Such high dam in accordance with national standards and national production safety supervision and administration requirement must be installed tailings dam safety monitoring and warning system automation. This to ensure downstream, tuning of Qidashan concentrator stope platform, Qidashan concentrator and people's lives and property safety of Qidashan town is of great significance.

4.2 The general structure of the monitoring system [8]

The overall structure of observation system employs the Internet WAN, the mining company local area network, and the monitor instrument scatter net as main information construction. Site distributional data acquisition meter transmits the collected primary date to the dam team’s server, whose function is storing primary data in database and meeting all requests from client side. Client-sides of Qi Xuanchang and the mining company are located in the mining company's local area network, which enables direct visiting to the builds team’s server to carry on real-time monitoring and analyzing. The other function of mining company’s main server is uploading information to the internet to meet the servicing request from Province Safety Production Surveillance and Administrative Bureau.

Qidashan tailings dam safety monitoring system, overall automation can be divided into the following function module:

1. Data acquisition. Using osmometer of GKcompany to survey water level of tails dam, then carrying on the communication in the server end through the serial port same data acquisition meter, reading date of each sensor from the data acquisition meter.

2. Data communication. Using the VC++ development server end procedure and the client side procedure, realizing network communication by using MFC’s Socket, and realizing network information communication interactive between the server and the client side.

3. Network video monitoring. 16 the key part of tailings dam installed a security camera, using haikang hard disk realize the real-time online video 16 road on-line browsing. Video surveillance video surveillance system can make managers more intuitive understand the locale of tailings dam and dry beach. It is important to replace artificial searching dam, so for the whole of automatic monitoring system speaking, Video monitoring system is a very good supplementary means.

4.3 Layout of sensor

The sensors lay out just as Fig.2
4.4 Visual interface

The Fengshuigou tailings dam safety monitoring system realizes the interface visualization. Users can be in the process of real-time monitoring of information check monitoring and the main operations are in graphical operation completes. The interface design principle is: concise, convenient and practical, the greatest degree of beneficial to the user study, operation. Software used everyone very familiar with Microsoft Visual Studio integrated environment (IDE) interface style, Use the shortcut menu, sidebar, such as status bar in software and user, as shown in figure 3.

From the chart can be seen from the main interface besides title, menu, toolbars, such as status bar outside the WINDOWS programs routine part, view area is divided into three parts: the left part of the process is fast operation part and the traditional toolbar want to match, the right section for corresponding bottom button views. In FIG. 3 corresponding plan button for the view, it is shown in each point of the plane and dam bury place, this can make software users of this project has at the direct-viewing understanding. View for a row button at the bottom for data acquisition, respectively, in different sections
of saturation line, displacement, maps, the water, and line pressing, these button call database data, the accuracy of inspection display.

To the dam plan, simulation data diagram, online video and other means, Omni-directional reflect the actual operation of the excavated dam; guarantee the monitoring information of comprehensive and accurate and timely. According to the system's safety evaluation module of earth-rock fill dam monitoring index concentration monitoring data analysis and interpret the single or multiple warning, make to ensure the safe operation of the dam.

5 Communication

Communication of the tailings safety monitoring system is important, responsible the data transmission of on-site safety monitoring part and the monitoring center.

The Fengshuigou tailings automation safety monitoring communications system includes three parts:

(1) The communication of Tailings dam monitoring centre of the sensor and the data—wireless, Optical fibre etc.
(2) The communication of Tailings dam monitoring centre and concentrator plant.
(3) The communication of security production supervision administration and monitoring center.

6 Conclusions

Combined with the modern computer technology, network technology, video images transmission technology, GPS satellite positioning technology development, the paper points out that the influence factors of tailings dam and put forward the current safety monitoring solutions, designing a set visualization, automation, intelligent in one of the software structure, combined with high-performance PC and Server, Data acquisition instrument MCU of America jikang company, inspires string type seepage pressure gauge, the fixed inclined instrument series, osmometer of Vibration string type, the fixed clinometers multipoint displacement plan, accuracy of GPS system in millimeters level, efficient fiber network, photoelectric conversion module together make up the wind ditch the automation tailings dam safety monitoring and warning system in the actual operation, the effect of received few, this to raises the level of tailings dam safety monitoring of importance.

According to the tailings dam safety monitoring system of the data collected to comment on the safety of DAMS, so that in emergency situations, not an early catastrophic failure. Due to the intervention of the monitoring instruments automation, the precision monitoring instruments can be observed intervention dam water level and displacement variation within the data, monitoring data is more rich, the more accurate, more is coherence, kind of nature than the artificial observation data, make tailings safety monitoring index more reasonable and reliable, it provides technical support for the safe operation of the tailings.

Automatic monitoring system will provide scientific basis for ziba of the tailings dam heightening and ore tail library expansion. Accurate grasp the water level and dam after ZiBa heightening dam deformation, make tailings over term service. Over term service of tailings is very remarkable economic and social benefits.

References:


