Research on the Application of Automatic Monitoring Software for Seismic Observation Instruments

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Abstract. Combining with the actual monitoring work of seismic geophysical observation stations, a seismic monitoring instrument automatic monitoring software was developed. The software is suitable for real-time or regular automatic network monitoring of IP instruments and equipment under different network environments. Automatic monitoring of the clock, status and observation data of geophysical observation instruments, which can automatically identify invalid data and abnormal amplitude changes in the observation data of the day, interference, earthquake and amplitude limitation, etc. Without other hardware and software, the alarm information can be sent to the duty personnel and management personnel by SMS, which can realize automatic backup and manual recovery of the original observation data of the instrument, and One-click restart and clock correction and other control operations, you can view the integrity and validity of the observed data curve and analysis data of the day without cross-platform operation, thereby achieving unified and efficient management of the instrument.

1. Introduction
Observation data is the basis of seismic scientific research, and the continuous and stable operation of observation instruments is the basis for producing high-quality observation data. The rapid detection and timely resolution of instrument and equipment failures is an important part of the daily operation and maintenance of seismic stations. During the operation of seismic observation instruments, data recording is often interrupted due to power failure, network interruption, instrument or probe failure, etc. If the monitoring personnel cannot find and process it in time, it will lead to a reduction in the operation rate of the instrument and seriously affect the data integrity rate. At the same time, factors such as the inaccuracy of the instrument clock and the untimely discovery of data errors will also affect the quality of the observed data. At present, the method adopted by most stations is to manually check and calibrate the instruments one by one at regular intervals, which wastes manpower and material resources and has low accuracy of observation data. Therefore, the use of existing mature technical means, through the development of monitoring software, to achieve automatic monitoring of instruments and equipment, timely or real-time grasp the operating status of seismic observation instruments and equipment, strengthen the maintenance and management of instruments and equipment, can improve the authenticity of data And effectively reduce the labor intensity of earthquake monitoring personnel. In recent years, many scholars have developed their own software to monitor the network, instruments, or databases. Some seismic stations use Nagios free open source software or HostMonitor commercial operation and maintenance management software to monitor and manage servers and networked instruments. In addition, the survey found that some seismic stations use different development languages, cooperate with hardware equipment such as SMS cats with telephone cards, and develop remote monitoring software for power supply and seismic observation instruments or
equipment. Many instrument manufacturers develop corresponding management software, such as communication control software for underground fluid comprehensive measuring instruments, body strain communication control software, etc., which have relatively complete management and control functions for related instruments, but generally do not have automatic monitoring functions. On the whole, the above software is mostly aimed at a certain network station, a certain type of instrument, to achieve a specific function, or required hardware support, etc [1]. to monitor or control the instrument and equipment, the scope of application is relatively narrow, and the promotion and application are limited. Due to the lack of a dedicated software platform, each link usually needs to be completed with different tools. The lack of effective connection and integration leads to cumbersome workflow and low efficiency. Therefore, the author draws on and perfects the functions of the previous monitoring software, adopts an integrated monitoring method, and realizes the unified monitoring and management of various types of stations, stations, and equipment as much as possible to improve the efficiency of operation and maintenance. Based on the above reasons, the automatic monitoring software for seismic observation instruments (referred to as SIAM software) was developed to monitor the network, operation and data status of the networked observation instruments in real time and regularly, and analyze the effectiveness of the observation results in order to send SMS messages. In this way, the earthquake monitoring personnel can quickly learn the fault phenomena and possible causes of the equipment, so as to eliminate the fault in the shortest time and improve the management and disposal capabilities of the observation equipment [2].

2. software design
SIAM software uses Visual Basic as the development language, the overall architecture uses a single process, multi-threaded working mode, and the geophysical instrument timing automatic monitoring function adopts a process structure design. The software modules fully consider the principles of functional independence and code reuse. Each module encapsulates its own parameters and methods independently and compiles them separately. Sensitive information such as user login and instrument security are stored using an encrypted Access database. In the process of software development, a large number of controls, class libraries and API functions are used to enhance operability, and relevant functions can be realized without installing auxiliary software. Most users can set their own according to the actual situation, and the applicability of the software is improved [3].

3. Software functions and implementation
SIAM software sets related functions for monitoring, management and tool modules. Among them, the core functions include real-time and timing automatic monitoring of IP instrument equipment network, timing automatic monitoring of geophysical instruments and SMS alarm [4].

3.1. Network real-time and timing automatic monitoring
The network failures of seismic observation instruments mainly include communication line failures and network equipment failures. The power supply failures and crashes of the instrument will also be diagnosed as network failures at the far end. Therefore, real-time and regular automatic monitoring of the network is essential to determine the network status and instrument operating status. PING Internet packet explorer, which is part of the TCP / IP protocol, is a program for testing the amount of network connections. Use the "ping" command to check whether the network is connected, which is helpful to analyze and determine network failures [5]. This function executes the ping command in batch, which can realize the real-time diagnosis of IP observation instruments, that is, the network status is detected by scanning the IP address of the instrument equipment. When the diagnosis result is abnormal, it will be sent to the duty personnel and management personnel in the form of an alarm message, which can effectively solve the problems of tediousness and untimeliness of the manual diagnosis network. SIAM software has the function of correcting the clock of the instrument. The premise of this function is that the computer clock installed with this software is accurate enough. The software automatically times the local computer by acquiring the network time. After testing, the error is less than 1s. When the software...
runs for the first time, it automatically detects the current network environment of the computer, and determines the time service and SMS sending method based on the network connection method. In the "single earthquake industry network" mode, the C / S architecture is used, that is, SIAM software as a client program to access the time and SMS servers deployed in the industry network with a WAN environment, and the server accesses the time server and SMS server, Realize time service and short message sending service to local computer (Figure 1). The communication between the client and the server adopts the TCP / IP protocol, the head and tail of the string are agreed and encrypted, and the outbound and inbound rules are set on the server firewall to ensure the security of data exchange. In the "seismic industry network + wide area network" mode, the software directly accesses the wide area network short message server and time server.

![Fig.1 C/S mode timing and topology structure of short message service](image)

### 3.2. Automatic timing monitoring of the instrument

Geophysical instruments can be automatically monitored at regular intervals and the start time and time interval can be set arbitrarily. The monitoring steps are divided into hierarchical diagnosis of the instrument network, instrument status monitoring and observation data monitoring [6]. Among them, the instrument status monitoring and observation data monitoring are via Ethernet, using the special equipment of the precursor network connected by the SOCKET based on the TCP / IP protocol to exchange data information with the client, and using the HTTP or FTP protocol based on the SOCKET connection for data transmission [7].

### 3.3. Manual monitoring and control functions

Clock management, including reading clock and correcting clock functions. It can read the current clock of the instrument and use the local computer clock to correct the instrument clock. The log description information is automatically generated when the clock is corrected. It can be directly copied and filled in the work log of the management system, avoiding the inaccuracy and cumbersomeness of manually correcting the clock one by one on the instrument homepage, and greatly improving the work efficiency. The instrument restarts. Realize the one-key restart operation of the instrument. Data management, including viewing the current data of the instrument and the data display of the current day. On the same day, the data drawing display function does not require cross-platform operation, and the collected data is automatically drawn into a graph, and the data integrity and validity analysis is automatically completed to facilitate the user to visually view the observation data and analysis results. Acquire instrument status information, including instrument clock, clock status, device zero point, DC power status, AC power status, self-calibration switch status, zero adjustment switch status, number of event triggers, abnormal alarm information, etc.

### 3.4. Management functions

The management function settings are as follows: ① Duty management. Add and delete staff on duty, managers and corresponding mobile phone numbers; ② Instrument management. Including adding, inserting and deleting instruments; ③ Network monitoring and management. Set the IP instrument
information of the network real-time monitoring; ④ Router management. Set the shared router and station router information between the local computer and the instrument.

### 3.5. Main functions of tools

1. The original data backup and recovery of the instrument. During the daily operation and maintenance of the precursor network, it was found that some instrument crashes and restarts will cause data loss on the same day and cause irreparable losses. Based on the characteristics of software automatic monitoring, the instrument’s original data automatic backup function has been developed to maximize continuous and complete data. The software automatically backs up the original data downloaded during each automatic monitoring process. Using the data recovery function, you can manually restore the original data backed up by empty data or merge the data files. Use FTP software to upload the recovered files to the original file directory of the instrument and use China Earthquake. The manual collection function of the physical network data management system realizes the recovery data storage. (2) Remind daily tasks. Users can set up one-time or periodic tasks (such as periodically correcting the instrument clock, submitting abnormal zero reports, monthly reports and annual reports, etc.), and send them to the corresponding personnel by SMS to remind them to handle. (3) Software backup and recovery. Users can back up and restore the saved configuration information. When the local computer is reinstalled or other computers are first installed, the configuration files that have been backed up can be imported with one click, without having to set them one by one again. (4) Online upgrade. Adopt C / S architecture, regularly check whether there is a new version of the server released, if there is a new version, you can choose to upgrade online.

### 4. software application examples

Taking the regional earthquake geophysical network of the Institute of Earthquake Prediction, China Earthquake Administration as an example, the actual use effect of the software is introduced. There are 9 stations under the regional earthquake geophysical network of the Institute of Earthquake Prediction, China Earthquake Administration, 24 instruments and 57 measured items. Since the use of SIAM software in 2017, after a power outage or network communication failure occurred at the station, the staff received the alarm message and repaired it in time, which greatly improved the efficiency of troubleshooting. The task reminder and instrument clock correction function of SIAM software can improve the efficiency and accuracy of instrument time calibration. The Regional Earthquake Geophysical Network of the Institute of Earthquake Prediction, China Earthquake Administration has therefore become the only regional center in the 34 provincial-level regional networks in the country to have a digital instrument with an accuracy rate of 100% in 2017.

### 5. software applications

Due to limited resources, the software could not be used to test all types of instruments in the system. At present, there are 24 32 models of tested instruments, including deformation, underground fluid, geoelectricity, geomagnetism, gravity and auxiliary observation instruments. At present, the software has been used in 48 seismic surveys in 13 provinces and municipal earthquake bureaus and research institutes. The station network or station has been initially applied, realizing 140 sets of monitoring instruments and a total of 426 items. Since the application in various units, the staff can get the warning SMS of the network failure of the seismic observation instrument equipment, the abnormal working status of the instrument, and the lack of data detection. The maintenance and repair according to the alarm message has greatly improved the timeliness of the fault resolution, avoiding the serious lack of data recorded by the observing instrument due to the failure to detect the power outage and the number of crashes in time, and some stations use the data recovery function. The observation data is saved to the greatest extent. Therefore, the seismic monitoring level and management efficiency of stations in the seismograph network have been improved to a certain extent.
6. Conclusion
SIAM software has a reasonable structure design, friendly interface, stable and reliable operation, and reduced false alarms and false alarms. The software is suitable for different network environments and has rich functions. It realizes real-time network monitoring of IP instruments and equipment and automatic timing monitoring of clock, status and data of geophysical instruments, which improves the monitoring capabilities and operation and maintenance of instruments and equipment. Work efficiency, instrument equipment operation rate, data integrity and effectiveness are effectively guaranteed, and unified management and control of geophysical instruments are realized, reducing the complexity and inaccuracy of cross-platform, one-by-one logging on the instrument page for manual operation. It should be noted that not all geophysical instruments have perfect control functions. For example, the LN-3A water level meter does not support the HTTP protocol command mode to modify the clock. Such problems cannot be solved by software alone. The software is not yet perfect, and it is necessary to continuously expand and improve various functions and patch BUGs during the actual operation of seismic stations, so as to play a greater role in earthquake monitoring in the future.

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