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# Design of Simple Landslide Monitoring System

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**Abstract.** The simple landslide monitoring system is mainly designed for slope, collapse body and surface crack. In the harsh environment, the dynamic displacement data of the disaster body is transmitted to the terminal acquisition system in real time. The main body of the system adopt is PIC32MX795F512. This chip is to realize low power design, wakes the system up through the clock chip, and turns on the switching power supply at set time, which makes the wireless transmission module running during the interval to ensure the maximum battery consumption, so that the system can be stable long term work.

## 1. Introduction

In China, a series of disasters are caused by geological disasters, especially landslides. Natural weathering, water erosion, engineering construction, which making the slope of the force is damaged, landslide displacement is prone to occur. In recent years, there have been many technical means for remote landslide disaster monitoring in China, and the dynamic changes of landslide hazard are monitored by computer, remote sensing and other technical means in real time. From the two aspects hardware selection and software design, the landslide disaster monitoring technology continues to achieve integrated development, and gradually tends to high precision, improving the security and stability of the system.

The simple landslide monitoring system mainly adopts the parameter of landslide displacement to design, selects PIC32MX795F512L as the main chip to realize the low power design, and satisfies the long-term field operation. The system has been increased the self-test, error function and the control terminal to feedback the information resetting or restarting which achieves part of the intelligent. The system has increased the anti-theft warning. It is designed to avoid the human factors bring about by the failure of the equipment causing the lack of data. So it can protect the monitoring equipment and data integrity. At the same time, for the field of landslide disaster monitoring early warning project, it provides a more reliable technical services and support.

## 2. System composition and characteristics

The simple landslide monitoring system sends the displacement parameters of the landslide hazard and the operation of the instrument to the monitoring terminal. The system mainly carries out data collection, analysis and processing, electricity and anti-theft inspection. Through the 4G network, it transmits the information to the terminal. The receiving terminal feedbacks signal to achieve parameter reset, sleep, and inspection and so on. The system mainly implements the data sending, receiving and forwarding function. With the 4G module of Huawei, the on-site monitoring data is sent



to the PIC32MX795F512L through the protocol RS232, and the data is sent to the data monitoring terminal through the 4G network.

## 2.1. System hardware

### 2.1.1. Data processing unit.

Using the minimum power theory, the system uses the commonly used PIC32MX795F512L master chip. The chip has USB, CAN and Ethernet high-performance 32-bit flash memory, multiple power management modes and independent configurable watchdog timer. The chip has a low power RC oscillator and fault protection monitor. The chip supports RS-232. It has hardware decoding 6 UART, 5 external interrupt pins, many I / O pins which can be configured for missing open outputs etc... The application of the chip is to ensure that the simple landslide monitoring system is more reliable. Setting the real-time clock and calendar, the displacement of the landslide disaster body can be monitored. The monitoring data is larger than the initial value stored in the chip and is lower than the early warning value. The early warning value is the current value - initial storage value in the chip. The stored value in the original chip is discarded and replaced. Simultaneously, PIC32MX795F512L gives an order to start the 4G module. The 4G module sends alarm information to the control center. Using ultra-low power built-in amplifier and reference voltage AD7793 analog-to-digital conversion chip, the common mode signal interference can be effectively reduced. The signal error is also reduced. The system can get the displacement of digital signals and voltage signals more precisely. Once the data's transmission delivery failed three times, the monitoring data will be stored in the external TF memory card. When the monitoring terminal can't control and receive the information from the monitoring equipment, the staff will extract the data to the monitoring point to prevent the data from losing. (Figure 1)

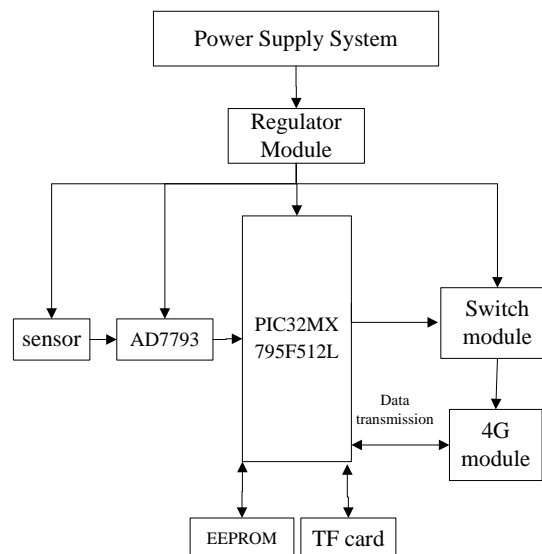


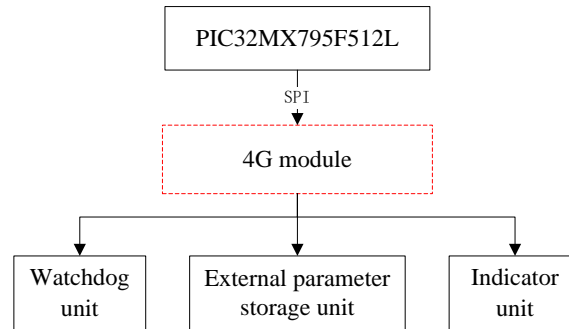
Figure 1 Hardware system

### 2.1.2. Power supply system.

In the landslide monitoring system, it is designed to use 12V solar charging controller to protect the 12V lead-acid batteries, to avoid over-voltage damage to the battery. The system uses 60W thin film polysilicon solar panels which are Easy to be carried and installed in the field. The solar panel's peak voltage is 17.2V. Its short circuit current is 3.85A; this kind of solar panels is compression which suitable ambient temperature is  $-40^{\circ}\text{C} \sim 85^{\circ}\text{C}$ . Because of the difference voltage of PIC32MX795F512L, AD7793, 4G modules and other power requirements, the power supplies are

various. Using LM2596S, the voltage converts from 12V to 5V for the displacement sensor. LM117-3.3 converts the voltage from 12V to 3.3V for other hardware

### 2.1.3. 4G module.



**Figure 2.** Communication system

Landslide is caused by earthquake, cooling, freezing and thawing, man-made and many other factors. The occurrence of landslides is induced by the role of immediate activities. During the slow movement, the landslide body's displacement is monitored by the simple landslide monitoring system. The monitoring data can be accurate to 0.1mm. Once the landslide displacement value is greater than the warning threshold, the landslide warning device will immediately start transmitting the monitoring data and send an alarm signal to the monitoring center.

Voltage values and external hardware are measured in order to avoid failure of the monitoring equipment if the insufficient power supply or for human or other reasons. The measured voltage is less than the voltage of the normal operation of the instrument or the external device is measured. The monitoring device will send the information to the monitoring center promptly to the staff that the labor cost is reduced to a certain extent, and the staff can't be dispatched for a long time.

## 2.2. System software design

### 2.2.1. System initialization.

When the installation is completed, the system is initialized. The control center sends instructions to set the internal parameters of the instrument through in the form of SMS, which contains the control information, the independent identification code, time value, timing, displacement warning value, voltage alarm value, displacement initial value, end flag and so on. When the system is set up successfully, the system goes into the low power mode. During system operation, the terminal system receives irregular displacement, voltage, time or monitoring cycle, the control center can also send adjustment instructions to reinitialize the monitoring parameters to ensure normal operation.

System monitoring operation. Data monitoring terminal software as the main data receiving, analysis and processing platform, it receives the site data through the Internet network which comes from wireless sensor network coordinator. The monitoring center needs to receive the collected data stored in the database SQL Server, So that the data can be achieved historical data query and real-time view. You can set the corresponding warning value in the monitoring software. When the scene of a certain collection of data exceeds the warning value, the alarm message will be issued to cause the attention of the monitoring staff. (Figure 3)

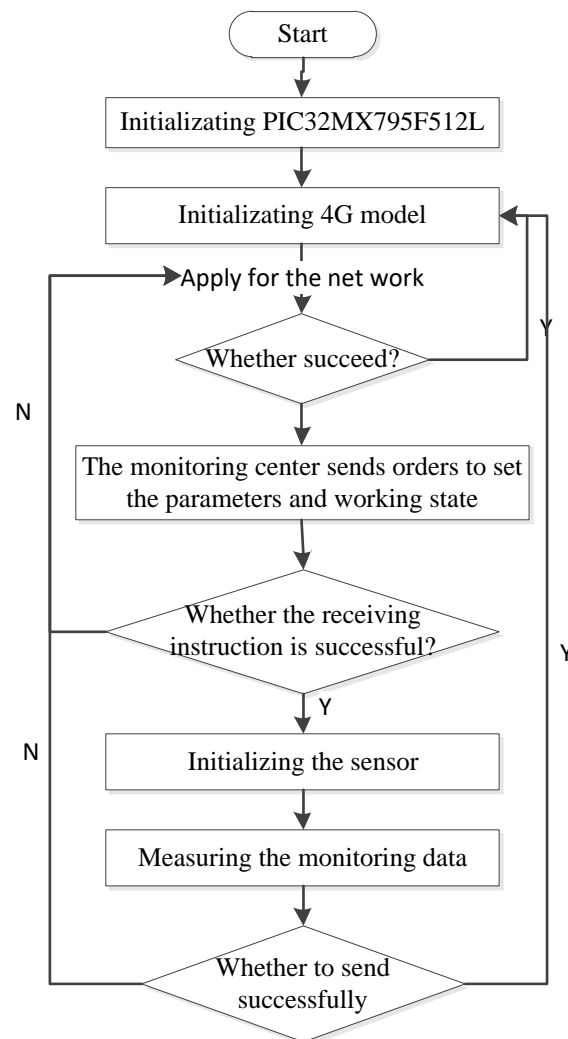


Figure 3 Communication system

### 3. System build implementation

#### 3.1. High-precision, regular monitoring transmission

Using micro-power 16-bit AD analog-to-digital conversion module, the way achieves field unattended acquisition displacement data and voltage values. The system is timing to transfer data through the 4G module to the monitoring center on the host. 4G mobile communication network covers a wide area; the signal is strong that making the test data transmission by the distance limit is small, sending high efficiency.

#### 3.2. Low cost, low power consumption, high reliability

Choosing low-power components, the system fully considers the low power requirements in the software design process. In a short time, the monitoring task is completed into the dormant state that can save energy. Power supply system is mainly used 12V battery-powered, solar automatic charging system.

#### 3.3. Easy installation of equipment

The overall design of the instrument is used in the form of snap card from the connector to the overall support. The installation process is simple and easy to operate. To avoid long-term field operations, the uncertainties of environmental factors affect the field of installation work.

#### 4. Conclusions

Simple landslide monitoring system is to achieve low power consumption, simplicity, serialization, and intelligent that it is more suitable for field unmanned monitoring. The traditional cost-effective PIC32MX795F512L microcontroller is used as a control module. The 4G communication system is used to remote data monitoring. The system uses PIC32MX795F512L internal timer to wake-up microcontroller that it can improve the monitoring accuracy and speed and makes lengthen sleeping time to further reduce the system power consumption. The 4G module connects to the computer terminal through the 4G network, receives the data and sends the instruction. The design of the landslide monitoring system provides more reliable hardware support for long-term field monitoring.

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