Safety Monitoring System Design of Cold Storage Based on Single Chip Microcomputer

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Abstract. In order to solve the rising labor cost of cold storage management in China, and to improve the safety factor of cold storage, this paper designs a simple cold storage safety monitoring system. It is mainly to reflect the real-time monitoring information in the cold storage to the central background for unified processing, which not only reduces the harmful operations in the cold storage to save labor costs, but also improves the safety factor in the cold storage to reduce property losses. The monitoring system is fully automatic, which greatly reduces the staff's effort in cold storage management.

Keywords: Cold storage management; Safety monitoring system; Real-time monitoring.

1. Introduction

With the rapid development of modern agriculture, along with the information revolution and the introduction of modern technology, the agricultural industry further carried out structural upgrading and adjustment. Traditional Chinese medicine, fresh fruit and vegetables and other agricultural and sideline products have higher requirements on their quality preservation. Since fruits are seasonal, since the total output of fruits is far greater than the demand for direct sales, a large number of fruits need to be stored in the appropriate conditions for fruit production and off-season sales, ensuring the annual supply [1]. In order to make up for the demand of off-season, it is an urgent problem to develop high level and high quality storage and preservation technology for fruits and vegetables [2]. As the storage of valuable Chinese medicine and fresh fruit and vegetables in the cold storage, so there is also a security risk. Therefore, aiming at the above problems, this design designs a security monitoring system for cold storage to solve the security of cold storage property, ensure the personal safety of the staff in the cold storage, and can monitor the temperature and humidity of the cold storage in real time.

2. Research Status of Cold Storage Monitoring at Home and Abroad

At present, domestic cold storage users began to realize the importance of automatic control of cold storage, on the one hand, China's domestic labor costs are rising, enterprises are suffering from labor shortage, labor costs and other reasons. On the other hand, to improve the production efficiency, improve the technical content and production grade and other factors, the discovery of automatic technology for cold storage provides convenience for people to improve the technology. However, from the perspective
of the current practical engineering application, the automatic control of cold storage stays at the control level of a single device, and the control function of the automatic control platform of cold storage is not fully utilized, so the automatic control platform of cold storage is an important means to realize energy saving and consumption reduction, and there is still room for deepening the automatic control system of cold storage [3]. The operation mode of cold chain logistics starts from "production-supply-transport-sale" at the very beginning to "place of origin - primary pre-cooling - cold storage - refrigerated transportation - cold storage at wholesale site"[4]. Now most of the domestic retail malls and large seafood market, flower market, fresh vegetables market have cold storage or small cold storage, and the cold chain logistics is further developed. Japan adopts highly mechanized and highly automated facilities in cold chain logistics [5]. This paper sets out on the national conditions of our country, because the refrigerator door usually adopts the structure of sliding door, namely the left and right two doors along the slide to pull open or close, the door outside the refrigerator door USES the door bolt and padlock to lock, in order to achieve the purpose of theft prevention, but still can't completely solve the problem of theft prevention of the refrigerator. The door lock of the cold storage is on the outside of the cold storage door, and it is impossible to open the cold storage door inside the cold storage. Once negligent, the staff will be locked in the cold storage, which will threaten the life of the trapped people. Therefore, it is necessary to design a cold storage security monitoring system that can prevent theft and ensure the personal safety of the staff.

3. System Design

3.1. The Design Structure Block Diagram
The security monitoring system of cold storage designed in this paper includes card reader, vibration sensor, infrared sensor, temperature and humidity sensor, field controller, control center, alarm and data storage processing display screen. Structure diagram of monitoring system in the text as ‘fig. 1’

![Structure diagram of monitoring system](image)

**Figure 1.** Structure diagram of monitoring system
The whole system takes the field controller as the core, other sensors as auxiliary test components are used to measure various dynamic data in the cold storage, and the monitor and alarm are used to monitor and measure the whole cold storage in real time as the main output components.

3.2. Body Sensor Module Design
Pyroelectric infrared sensor is a new type of high sensitivity sensor. It can detect the infrared ray which the human body sends out and output the electrical signal, can be used to prevent the invasion alarm and various automatic device. When the pyroelectric infrared sensor detects the infrared radiation source, the temperature of the loaded sensitive material increases, the polarization strength decreases, and the
surface charge decreases. The charge released in this part is usually called thermoluminescent charge [6]. Objects in the cold storage emit very little infrared energy, so the alarm will not be triggered. However, once the movement of people is detected, the sensor will receive different amounts of heat, thus giving the alarm [7]. Body sensor module in the text as ‘fig. 2’

![Figure 2. Body sensor module](image)

3.3. Vibrating Sensor
Vibration sensor is a kind of spring - type non - directional vibration sensor which can be triggered at any Angle. When at rest, any Angle is in the open circuit disconnection state. When impacted by external forces or violently oscillated, the spring deformation and contact conduction of the central electrode cause the two pins to conduct instantaneously to the ON state. When the external force disappears, the circuit returns to the open-circuit OFF state [8]. The signal is filtered through the comparator and fed into the intermediate port of the controller. The trigger sensitivity of the vibration sensor can be changed by adjusting the adjustable resistance. Vibrating sensor in the text as ‘fig. 3’

![Figure 3. Vibrating sensor module](image)
3.4. Temperature and Humidity Sensor
The temperature and humidity sensor detects the temperature and humidity in the air and inputs the electrical signal to the CPU. After issuing a set of measurement commands, the controller waits for the end of the measurement [9]. The detection data can be stored so that the controller can continue to perform other tasks and then read the data as needed. When the confirmation bit is received, the communication ends. If no calibration is used, the controller can terminate the communication by keeping the ACK high level after measuring the value[10]. Temperature and humidity sensor in the text as ‘fig. 4’

![Temperature and humidity sensor module](image)

Figure 4. Temperature and humidity sensor module

4. Cold Storage Security Monitoring Device and Work Flow

4.1. Installation and Arrangement of Cold Storage Monitoring System
The card reader is installed on the wall outside the refrigerator. The swipe control end is connected with the automatic lock signal input end of the refrigerator door, the card reader is connected with the field controller, and the vibration sensor is installed on the floor of the refrigerator door. The vibration sensor is connected to the control center by the remote transmission module of the field controller (STM32 MCU). The infrared sensor is connected to the control center through the remote transmission module of the field controller. The temperature and humidity sensor is connected to the control center through the remote transmission module of the field controller. The field controller is connected to the monitor, the monitor is installed on the wall of the cold storage and the control center is connected to the alarm.

4.2. Operation Mode of Cold Storage Security Monitoring System
When someone needs to enter the cold storage, open the door by swiping the card and cut off the circuit of the vibration sensor to ensure that there will be no alarm when the worker enters. If a non-crew member breaks in, the vibration sensor picks up the signal, triggers an alarm and transmits it in real time to the central control center. The infrared sensor is connected to the control center through the remote transmission module of the field controller, and infrared imaging is carried out through the contactless temperature measurement, which can monitor the situation in the cold storage in real time. Temperature and humidity sensors are evenly distributed in the four corners of the cold storage, and the measured temperature is fed back to the system for its average value. If the temperature is abnormal, the control center will be notified when the threshold is exceeded and an alarm will be issued to remind the background monitoring personnel that the cold storage is abnormal.
5. Conclusion
In this paper, a cold storage security system is designed by integrating infrared sensors, vibration sensors and temperature and humidity sensors into a full-function security system. Suitable for installation in small and medium-sized cold storage, playing a real-time monitoring of the dynamic situation in the warehouse. The installation of this system can greatly reduce the complexity of the staff to manage the cold storage, and the safety coefficient of the cold storage has been greatly improved. However, this safety system is only limited to the protection of the property in the cold storage and the protection of the staff, but it ignores the management of agricultural and sideline products. When storing fresh fruits, different fruits and vegetables need different temperature and humidity, oxygen and carbon dioxide content, and ethylene (fruit ripening catalyst) content in the refrigerated environment. Therefore, fresh fruits and vegetables have higher requirements for self-regulation of the cold storage environment. Therefore, this design has its limitations and fails to guarantee the nutrition and freshness of fruit in long-term storage.

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