

# Design of Intelligent Storage System Based on Internet of Things

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**Abstract:** With the development of science and technology and network information, people's awareness of improving the quality of life is gradually increasing, among which, the requirements for storage systems are also increasing. For the storage system, in addition to ensuring its most basic security, it is also necessary to provide a more intelligent system so that people can manage the system more easily and clearly to achieve the purpose of saving human, material and other resources. Therefore, the intelligent storage system based on the Internet of Things adds an intelligent environment detection system and RFID electronic tag to the original storage system to achieve the purpose of real-time detection of environmental parameters and inventory information, making all data in the warehouse clear at a glance, more convenient and fast.

**Keywords:** Intelligent System, Storage Management, Environmental Monitoring, Sensor, Electronic Label.

## 1. Introduction

With the rapid development of the Internet of Things technology, the application of the Internet of Things has become more and more extensive, making people's life more and more convenient. The Internet of Things has a wide range of applications, such as smart home, smart agriculture, smart medical care, etc. However, the application of the Internet of Things in storage management is rare. As a country with a large population, China needs a large base of resources and services, and both the storage of grain and the storage of daily necessities are big projects. Every year, a lot of human resources are used to manage storage.

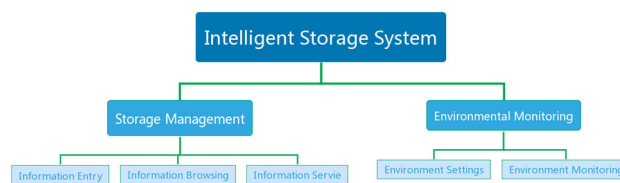
Taking drug storage as an example, the process of drug production is very strict, and the storage of drugs is also very particular. The effect of drugs on human body is not only restricted by the production and development process, but also affected by the drug storage status. In order to achieve the best therapeutic effect of drugs, it is necessary to make them play an influential role to the maximum extent. However, drugs can play their therapeutic role to the maximum extent only when they are within the period of validity and well preserved. If the drug is improperly stored, it will lead to the decrease of drug effect or even complete failure. Expired drugs may not only produce unknown side effects, but also produce toxins. Once used to treat diseases, it may not play a therapeutic role, affecting the health of patients, or even endanger life. There are many potential safety hazards in the process of managing and storing drugs. In order to ensure the safety of medication, it is necessary to standardize the management of drugs. Once the storage environment changes, there will be major security risks for vaccines. Therefore, the storage management of drugs requires environmental monitoring at any time, and many additional personnel are needed. The role of intelligent storage system is to realize intelligent environment monitoring, thus optimizing storage management and reducing human consumption.

## 2. System Design

### 2.1. Overall design

The system uses DHT11 temperature and humidity sensor

and RC522 RFID sensing device to collect information, uses STM32F103 series development board to connect the sensing device, processes the data, and transmits the data to the PC through RS232 serial port to realize real-time monitoring and storage environment, so as to achieve intelligent monitoring effect. The system mainly uses Qt Creator, Navicat Premium database, Keil uVision5 and other development platforms, in which C language and C++ language are used to complete the system development. The main functional modules of the system are defined by analyzing the requirements for storing items. It is mainly divided into two categories, one is the storage management module, and the other is the environmental monitoring module. The storage management module includes the entry of goods information, the view of warehouse information, and the query of goods information. The environment monitoring module includes the setting of storage environment and the monitoring of storage environment.



### 2.2. System hardware design

#### (1) Main control module

The system uses STM32F103C8T6 as the main controller. STM32F103 is a low-end 32-bit ARM microcontroller, packaged by LQFP48. The chip integrates ADC, Timers, IIC, SPI, USART, CAN and other peripheral functions. With various conventional communication interfaces, it can connect many sensors and then control many devices. It is mainly responsible for collecting data, processing data, and coordinating the tasks to be completed by each functional module [1]

#### (2) Sensor hardware

The system uses DHT11 digital temperature and humidity sensor. DHT11 is a temperature and humidity composite

sensor whose output signal has been verified, including an NTC (Negative Temperature Coefficient) temperature measuring element, a resistive humidity sensing element and an 8-bit microcontroller. It is made of a high-performance microcontroller as the connecting element of the main control chip, with strong anti-interference ability and extremely fast response speed. To ensure the long-term stability and reliability of the product, the system adopts special digital acquisition and sensing technology, and each DHT11 digital temperature and humidity sensor has been accurately calibrated [2]. DHT11 has high monitoring accuracy, small size, low power consumption, simple circuit design, simple and convenient integration, and can monitor the occasions with harsh environment.

#### (3) RFID hardware

RFID uses MFRC522 highly integrated contactless communication series chips, and fully integrates all types of passive contactless communication methods and protocols at 13.56MHz using advanced modulation and demodulation concepts, with the advantages of convenient use and low cost [3].

#### (4) Serial port design

The serial communication interface adopts RS232 standard interface, which is the technical standard of serial binary data exchange interface between data terminal equipment (DTE) and data communication equipment (DCE). RS232 has 25 signal lines, including two signal channels. The full-duplex communication process can be easily realized by using the signal lines. It has the characteristics of less signal lines, long transmission distance and low cost.

#### (5) Temperature and humidity acquisition module

The system acquisition module uses DHT11 temperature and humidity sensor, which is composed of a resistive humidity sensing element and an NTC (Negative Temperature Coefficient) temperature measuring element, connected to an 8-bit high-performance single chip computer, and has the advantages of strong anti-interference ability, rapid response, low power consumption, small size, and easy integration.

#### (6) RFID module

The RFID module uses 3.3V voltage, and can directly communicate with the main control module through a few simple lines of SPI interface, which can ensure the stable and reliable operation of the module, and the limit distance of card reading is also relatively far [4].

#### (7) Serial port module

The download of PC commands and the upload of information of SCM control equipment modules are realized through serial communication programs. In terms of function, the serial communication program is divided into single-chip computer program and PC program. The function of the single-chip computer program is to complete the information collection of the module it controls and upload it to the PC. The task of the PC-side program is to further send the command information for device control according to the user demand status [5].

## 3. System Function Realization

### 3.1. Management function realization

#### (1) Add/delete function implementation

For the entry of item information, it is necessary to brush

the electronic label first, take the number of the electronic label as the number of the item, and enter the item information into the database and the electronic label at the same time, so as to carry out the warehousing operation of the item. Item information includes item number, item name, storage method, storage temperature, storage humidity, inventory quantity, storage warehouse and other information. The information entered must be filled in completely, otherwise the information entry failure will be displayed, and you will be prompted to complete the information. When the entered electronic tag swipes the card again, the information cannot be re-entered, and the system will prompt that the item already exists. Please swipe the card again. Only unused tags can successfully add item information. The administrator can delete the item information after the goods are delivered.

#### (2) View function

Users can query the item information in the following two ways. One is to click Warehouse View from the main interface to enter the warehouse interface, where you can see all item information. To query the specified item, you need to enter the name of the item to query in the search box, and the query result will be displayed below. If there is no item information to query in the warehouse, the query result will be displayed as empty. The second is to click the item information reading from the main interface to enter the reading page. After entering the page, just swipe the label of the item information you want to view, and the item information will automatically appear on the page. If the label is a label that has not entered information, the system will prompt that no information is found.

#### (3) Realization of item query function

When the number of items stored in the warehouse is large, it will be very difficult to find the required item information by looking at the warehouse. At this time, you can fill in the name of the item to be searched in the search box at the top of the search warehouse page, and click the search button to find the relevant information of the item.

## 3.2. Monitoring function realization

#### (1) Monitoring environment settings

Click the storage environment setting icon from the main interface to enter the warehouse temperature and humidity setting page. There are four areas, which correspond to four warehouses respectively. Each warehouse has its own temperature upper limit, temperature lower limit, humidity upper limit and humidity lower limit settings. Make specific settings according to the storage method, temperature, humidity and other conditions for storing items in the warehouse. After modifying the storage environment in the warehouse, click the "Set" button below to set successfully.

#### (2) Storage environment monitoring

Click the storage environment monitoring icon from the main interface to enter the warehouse environment monitoring interface. There are prompt boxes for warehouse 1, warehouse 2, warehouse 3, and warehouse 4 at the top left of the page. Click the prompt text to select the warehouse to view. After clicking, the temperature and humidity of the warehouse will be displayed at the top, and the information of the items stored in the warehouse will be displayed at the bottom. The temperature and humidity of the warehouse are updated at any time, so the temperature and humidity range set by the user for the warehouse is the standard. Once the

temperature is higher or lower than the set value, the system will give an alarm prompt, so that the administrator can find and deal with it in time.

#### 4. Innovation Points of The Project

The system adds environmental monitoring function to the traditional storage system. Compared with the traditional storage system, the system can store items with high environmental requirements. In addition, we have added RFID electronic tags, which enables the system to update the inventory information in real time and facilitate the management personnel to carry out data statistics. Compared with the traditional storage system, it greatly improves the work efficiency of the management personnel and saves a lot of manpower and material resources.

#### 5. Conclusion

With the development of the network era, we pay more and more attention to the cultural heritage of our own nation. Our Chinese nation has excellent cultural heritage of up to 5000 years, and the unearthed cultural relics are naturally not a minority. According to statistics, there are more than 3 million cultural relics unearthed every year in China, most of which need to be repaired, but few professionals can complete the work. At the same time, the unearthed cultural relics have strict requirements for the preservation environment, resulting in the slow pace of restoration. According to the Statistical Yearbook of Chinese Cultural Relics, as of 2017, China has 48.5066 million pieces of cultural relics, most of which have extremely strict storage requirements. At the same time, the number of cultural relics institutions and employees has increased by 132% and 90% respectively in the past 10 years, and the demand for human resources has also increased significantly. In addition to the unearthed cultural relics, there are many intangible cultural heritages in China, such as the Longquan Inscription as we know, which is on the verge of being lost due to its cumbersome production techniques. During the production process, the preservation environment of materials is also very high, and the finished products need to be stored in a strict environment.

However, the storage of these cultural relics needs to be supervised by the management personnel at all times. In addition to the increasing number of unearthed cultural relics, the workload of the management personnel is undoubtedly

huge. At the same time, cultural relics have valuable value and research significance, and the security of their storage is also a major requirement, which is undoubtedly a big problem for managers. Therefore, the design of intelligent storage system becomes very necessary. The emergence of intelligent storage system can not only reduce the error rate in the storage process of cultural relics, but also reduce the time spent in checking and storing cultural relics, facilitate operation and management, significantly reduce the workload of management personnel, reduce the demand for human resources, and provide a more secure and complete storage environment, so that the storage environment can be remotely monitored and improve the efficiency of cultural relics management. In a word, the intelligent storage system has a wide range of applications, ranging from cultural relics medicine to rice flour oil and salt. It can be seen that the intelligent storage system has a broad prospect and will create high application value for the society in the future.

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