Research on Vaccine Cold Chain Monitoring System based on RFID Flexible Temperature Tag and 5G

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Abstract: To meet the demands of vaccine cold chain logistics, a vaccine cold chain monitoring system based on RFID flexible temperature tag and 5G is designed by integrating Internet of Things (IoT) technology. This system enables real-time monitoring of vaccine temperature and geographic location information, allowing for instantaneous tracking and querying of vaccine cold chain data. The implementation of this system enhances the intelligence and efficiency of vaccine cold chain monitoring, effectively safeguarding the safety of vaccines and ensuring public health security.

Keywords: Vaccine Cold Chain Monitoring; Internet of Things; RFID Flexible Temperature Tag; 5G

1. Introduction

Vaccine refers to a special kind of biological products used for vaccination, which are very sensitive to temperature, and the whole process of production, storage, transportation and use must be in the specified temperature range to ensure its quality and efficacy[1]. The storage temperature of most vaccines produced in China is 2~8 degrees Celsius. In order to ensure the safety and effectiveness of the vaccine, any link from the production to the use of the vaccine needs to keep the vaccine in this temperature environment, so as to prevent the vaccine from failing due to too high or too low temperature. The Regulations on the Administration of Vaccine Circulation and Vaccination promulgated by the State Council require that the storage and transportation of vaccines shall not be separated from the cold chain to ensure the safety of vaccines in the circulation process[2]." This paper studies the workflow of vaccine cold chain, and studies the vaccine cold chain monitoring system based on RFID flexible temperature label and 5G technology to avoid the failure of vaccines due to high temperature during storage and transportation.

2. The Key Technology of the Vaccine Cold-Chain Monitoring System

2.1 The RFID Technology

RFID (Radio Frequency Identification) is the radio frequency identification technology, is a non-contact automatic identification technology, belongs to a communication technology, through the RF signal identification of target objects and read and write the transparent management of related data, is the core technology of the Internet of Things[3]. The RFID system consists of three parts: reader (Reader), electronic tag (Tag) and application software system. Compared with traditional barcodes, RFID tags have a larger storage capacity and can store more data information. Strong anti-interference ability, can work in a long-term stable environment, not easy to damage or aging. It can be encrypted through encryption algorithms to ensure data security and easy integration[4]. Widely used in logistics, warehousing, manufacturing, medical care, intelligent transportation and other fields.

This project design of the RFID flexible temperature label is an electronic vaccine temperature control label, with paper battery as power supply, organic combination of RFID communication mode and temperature sensor technology, make the flexible RFID temperature label on the vaccine bottles, and record the production of the vaccine data, monitoring products from factory, transportation, to use the whole temperature information, monitor any link temperature limit, fully ensure the safety of the cold chain vaccine.

2.2 The 5G Technology

5G is the fifth generation of mobile

communication technology, with high speed, low delay and large capacity, 5G communication facilities is to realize man-machine object interconnection network infrastructure, 5G network architecture of cloud, distribution, micro service can meet the mobile medical, car networking, smart home, industrial control, environmental monitoring and other Internet application requirements. This project takes advantage of the advantages of 5G high speed, low delay and large capacity, and combines with FRID temperature labeling technology to design an efficient vaccine cold chain monitoring and management system based on 5G technology and RFID technology to complete the real-time monitoring of vaccine temperature and geographical location[4].

3. The Overall Scheme Design of the Vaccine Cold-Chain Monitoring System

Vaccine cold chain system scheme design as shown in figure 1, cold chain car is equipped with beidou positioning module, the vaccine factory packing RFID temperature labels, real-time acquisition vaccine temperature information, and do the threshold alarm, through communication technology to 5G gateway, using 5G high speed, low delay, large capacity, and vaccine cold chain monitoring system information fusion, the vaccine temperature parameters, location information periodic fast to the Internet of things cloud platform, realize the vaccine temperature parameter data and location information real-time monitoring, when the temperature exceeds the threshold timely alarm and temperature control. The real-time tracking and query of the cold chain information of vaccine products is realized. The temperature label is used to detect the temperature changes in the process of vaccine transportation and storage[5], And can be traced through data, once the problem vaccine is found, can be accurate accountability. Any relevant interest groups concerned about the temperature change in the process of cold chain logistics, including manufacturers, distributors, logistics providers, government regulatory departments and medical institutions, can easily and quickly query the temperature change in the whole cold chain logistics transportation through mobile phone monitoring and cloud platform.

Figure 1. Overall Scheme Design of the Vaccine Cold Chain Monitoring System

3.1 Architecture of the System

The system architecture of the vaccine cold chain vehicle monitoring system based on RFID flexible temperature label and 5G technology is designed based on three parts: "terminal, transmission management network and cloud computing platform". The terminal includes two parts, the user terminal and the on-board terminal. The user terminal includes the user's mobile phone terminal or the computer terminal. The medical institution or the cold chain transportation enterprise can view the real-time temperature information of the vaccine through the APP or WEB and conduct remote control. Car terminal includes three parts: part is the temperature acquisition control unit, including vaccine bottle, paste on the vaccine bottle using the paper battery power supply RFID flexible temperature label, vehicle temperature control system, the second is the RFID reader, after receiving the vaccine temperature information, can through the wireless communication technology to send the temperature data to the computer for processing and analysis. Realize the wireless, digital and intelligent vaccine temperature measurement. The third is the 5G gateway, which is composed of the control unit module, the Beidou positioning module, the 5G module, the alarm module, and the display unit module. The gateway analyzes

and processes the temperature data of the vaccine and dynamically displays it on the display screen. When the temperature data exceeds the set temperature range, start the alarm and automatically adjust the on-board temperature control system.

The function of the transmission management network is to transmit the information read by the on-board terminal to the cloud computing platform with the 5G network and conduct information processing. At the same time, the on-board terminal can also receive instructions or query information from the cloud computing platform and perform corresponding control operations. The cloud computing platform, as the center of data storage, processing and analysis, receives data from each node of the on-board terminal, and provides real-time monitoring, data analysis, alarm notification and other functions.

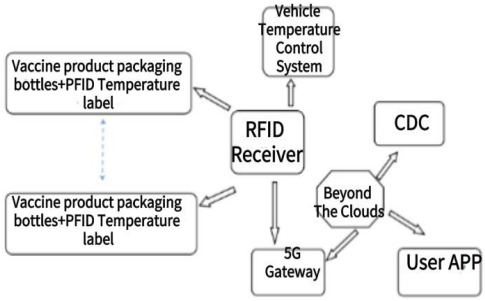

Figure 2. System Architecture of the Vaccine Cold Chain Vehicle Monitoring System based on RFID Flexible Temperature Label and 5G Technology

3.2 Software Design of the System

The software system mainly includes four parts: RFID real-time monitoring of vaccine packaging bottle temperature, on-board temperature control management, cloud data storage and vaccine information tracking and query[5].

Cold chain car layout vehicle temperature control system, vaccine bottles with flexible RFID temperature label, RFID receiver, by the main control unit module, 5G module, beidou positioning module, the gateway module of alarm module, display unit module, RFID real-time monitoring system using RFID receiver used to read the vaccine bottle temperature information, pass to the gateway module, then by the intelligent gateway to the cloud platform server. The information tracking and query system on the server will count, analyze and store the data, and store the data into the database for cooling chain management. Through the comparison of the vaccine temperature, if it exceeds the standard, you can send text messages or WeChat alarm reminder to the relevant staff. At the same time, the vehicle temperature control system will organize and collect the data, and conduct regular self-inspection of the system to automatically adjust the temperature to ensure that the temperature of the vaccine is within the appropriate range.

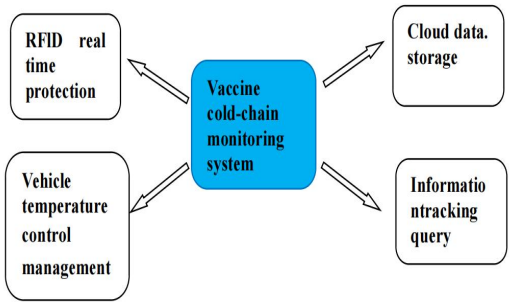

Figure 3. Block Diagram of the Software System

4. Conclusion

This paper designed a vaccine cold chain monitoring system based on RFID temperature tag and 5G, RFID temperature tag real-time temperature and geographic location, RFID receiver receive vaccine real-time temperature and position, intelligent gateway system based on 5G technology using the advantage of 5G high efficiency, low delay, low power communication service, to complete the acquisition of vaccine temperature parameters and geographical location, and the parameter data to the Internet of things cloud platform, to complete the real-time monitoring of vaccine temperature parameters, users can set the device software through mobile phone or computer, query the corresponding data records. At the same

time, the information management system on the server will make statistics, analyze and store the data, and compare the parameters of the collected vaccine temperature, geographical location information and the predicted alarm value through the cloud computing information fusion algorithm. The combination of the RFID receiver and the on-board temperature control system, when the temperature of the vaccine exceeds the upper and lower limit threshold, the alarm is made, and the on-board temperature control system automatically adjusts the temperature to ensure that the temperature of the vaccine is within an appropriate range, making the monitoring of the vaccine cold chain more information and intelligent. The system can monitor the quality, safety and status of vaccines in real time, and can trace back all the information of vaccines from production to vaccination. Vaccination manufacturers, cold chain transportation enterprises and medical institutions can share information through the information vaccine cold chain monitoring system, and jointly monitor the quality and safety of vaccines, so as to reduce the safety risk of vaccines[1].

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