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Design of tobacco storage environment monitoring system based on Lora technology

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Abstract. Lora (Long Range) wireless communication technology is unique in IoT communication solutions with its advantages of low power consumption and wide coverage. In the process of cigarette production, the storage environment during storage will affect the quality of tobacco leaves, and the tobacco leaves themselves will cause greater attenuation during signal transmission. By analyzing the storage environment of tobacco leaves, this paper proposes a wireless real-time environmental monitoring system based on Lora communication technology, including data collection nodes, Lora gateways, etc., and introduces their functions in detail. Finally, the feasibility is verified by testing.

1 Introduction

Tobacco is an important source of economic income for the country. The tobacco industry chain is very long and tobacco leaves are the basis of the tobacco industry. The tobacco leaves must go through a series of production processes before they can be put into the market. After the tobacco leaves are picked, they must be processed by primary roasting, redrying, storage and mellowing before they can be provided for cigarette companies. Therefore, the storage period is long, generally 1-3 years [1]. And the storage method is after packing, the packages will be stacked in order. Therefore, the storage area is large and the surrounding environment is complicated. In order to ensure the quality of the final tobacco products, manufacturers need to strictly control the stability of the storage environment of tobacco leaves.

The storage environment is different from conventional warehouses. Generally, goods are stored on shelves and it is suitable for wired monitoring systems. However, the stacking method of the tobacco packages is flexible and these packages are flammable items. The laying of the line must be cautious. Therefore, the monitoring system of the wireless transmission way should be considered.

With the research of the Internet of Things technology and the promotion of its application, new developments have been brought to the development of the storage environment monitoring system. The application of the Internet of Things technology in the monitoring system is mainly based on sensor technology, wireless communication technology, computer technology, network technology, etc., relying on temperature and humidity sensors, CO2 sensors, phosphine sensors and other equipment to detect environmental temperature and humidity, CO2 concentration, and phosphating The physical

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parameter environment such as hydrogen concentration realizes real-time monitoring of the internal environment of the tobacco leaf warehouse to ensure that the tobacco leaves are stored in a stable environment and are naturally alcoholized.

2 Feasibility analysis of LoRa communication technology applied in tobacco leaf storage

Lora technology was first proposed by Semtech in 2013 and it works in the Sub-GHz ISM unlicensed frequency band, including 433MHz, 470MHz, 868MHz, 915MHz [3], etc. It is a new kind of wireless communication standard for long-distance, high-capacity, and low-power consumption. [4]

The tobacco leaf warehouse is a large closed space with serious obstruction to communication signals. The mobility of personnel is low, and there are few human interference factors. The main environmental factors are the natural conditions such as temperature, humidity, and light intensity inside the warehouse. For some special warehouses, the concentration factor of the toxic gas phosphine which helps the alcoholization of tobacco leaves should be taken into consideration. [5] There are already mature sensors to detect these factors, but after obtaining the specific data, they need to be transmitted to the terminal device in a wired or wireless manner to realize the centralization and visualization of the data.

Especially for the environment of tobacco leaf warehouse, it is necessary to reduce the number of wires as much as possible. So compared with wired communication, wireless communication has more advantages in warehouse environment monitoring, and wireless sensor networks are widely used in various fields. [6-7]

NB-IoT, Lora, WiFi, Bluetooth, and Zigbee are all commonly used wireless transmission schemes. The characteristics of these schemes are compared as shown in the table 1. [8]

Although the storage area of tobacco leaves is large, it can be basically covered by WiFi. However, as a water-containing material, when the electromagnetic wave passes through, the tobacco leaves will cause a large attenuation of the power. The higher the frequency is, the faster the signal power attenuates [2]. With the lowest working frequency of 433MHz and the advantages of low power consumption, Lora is the best communication solution for the tobacco storage monitoring system.

3 The system design

3.1 The analysis of demand

Intelligentization is the trend of the current era. It is mainly divided into two aspects: intelligent service and intelligent management. Intelligent service refers to the intelligentization of original traditional services, such as self-service ordering in the restaurant, self-service book return in the library, etc., and intelligent management refers to the intelligent and mobile management and monitoring of the area [8], which mainly relies on the Internet of Things technology. The design of the Lora tobacco storage monitoring system is based on the latter, which connects users with the environment in the warehouse through sensor equipment and wireless Internet of Things to achieve the purpose of intelligent monitoring of the warehouse.

National standards stipulate that the moisture content of tobacco leaves during storage should be maintained between 15% and 19%. The moisture content of tobacco leaves is easily affected by external climate conditions, and the moisture content will have an impact on the chemical changes of the tobacco leaves during storage, and ultimately affect the color, aroma and taste of the final products. Moreover, the purchasing season of tobacco leaves is often the rainy season, and tobacco leaves are highly hygroscopic. Therefore, the most important monitoring factor is the humidity of the surrounding environment.

Table. 1. Comparison of different communication schemes.

	NB-IoT	Lora	Zigbee	WiFi	Bluetooth
Networking method	Cellular network	Lora gateway	Zigbee gateway	Wireless router	Bluetooth mesh
Transmission distance	> 10km	> 10km	10-100m	50m	10m
Nodes capacity	200000	500-5000	200-500	50	60000
Frequency band	Operator frequency band	433,868,915 MHz	2.4GHz	2.4,5GHz	2.4GHz

Tobacco leaves are stacked in different regions by distinguishing different types. When stacking, they are stacked one by one. Under the condition that the stacks are neat and stable, the stacking height is generally: no more than 4 packs of premium cigarettes, no more than 5 packs of medium cigarettes, and no more than 6 packs of other grades. This height is generally close to the ceiling, so the overall environment in the warehouse has a large space, and there are many cigarette packs to be monitored, but at the same time there are many obstructions.

Therefore, the Lora wireless network uses the nodes with temperature and humidity sensors, and the node is fixed inside the cigarette packet, which can effectively find whether the temperature and humidity of the surrounding environment of the tobacco leaf is too high or too low, so that the tobacco factory employees can find the problem in time and respond to them.

3.2 The structure design of the monitoring system

The Lora tobacco storage monitoring system is mainly composed of two parts: Lora node and Lora gateway. The overall system frame diagram is shown in Figure 1. The monitoring node is composed of sensors, MCU, and Lora modules, which are responsible for detecting relevant data. The gateway includes MCU and lora modules, which collects the data from nodes and upload them to the server. The structure of the system is shown in the Figure 1.

A large number of LoRa nodes are inserted into the cigarette pack in the form of cross bars, the temperature and humidity inside the cigarette pack. These nodes detect the data required by the temperature and humidity sensor, and the collected data is uploaded to the LoRa gateway through the LoRa module. All nodes are battery-powered, no external power supply is required. And it is convenient to add or reduce the number of nodes and deployment is convenient. The nodes cannot interfere or communicate directly with each other.

The LoRa gateway manages all LoRa nodes. It collects the data of all LoRa nodes, and packs the data and uploads it to the cloud server. The LoRa gateway provides Ethernet, Wi-Fi and Bluetooth communication modes. According to the environment of the tobacco leaf warehouse, Wi-Fi communication connected to the server can be selected. At the same time, due to the large node capacity of the LoRa network, only one LoRa gateway can manage all LoRa nodes in the entire warehouse.

Cigarette factory employees can view the data uploaded by the LoRa gateway in real time through smart phones, and can clearly know the temperature and humidity information of a specific cigarette pack by giving a specific address to each node. The system adopts a distributed network structure with little coupling between layers, which is convenient for management and maintenance.

3.3 The communication between nodes and the gateway

The Lora module of the node works in class a mode. After the microcomputer detecting the data through the temperature and humidity sensor regularly, it wakes up the Lora module and sends the data to the gateway, and then enters the waiting state. The gateway stays in the receiving state. After receiving the data uploaded by the node, it will give an ACK to the node. The node will enter the sleep mode after receiving the ACK from the gateway during the waiting period, if the node does not receive the ACK, it will send the data again. If the ACK is still not received, the node will stop sending and enter the sleep mode. This retransmission mechanism can reduce data loss caused by channel congestion.

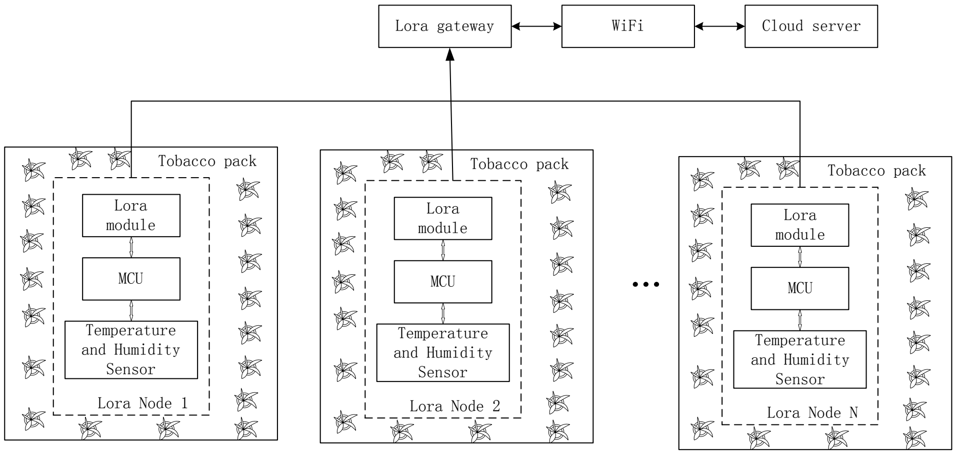

Fig. 1. The structure of the system.

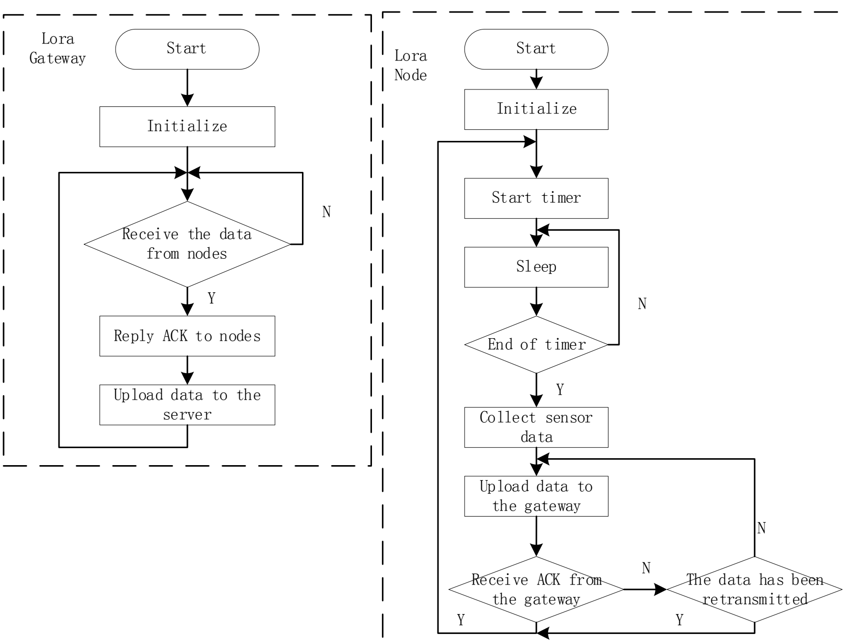

Fig. 2. The workflow of the system.

3.3 The communication between nodes and the gateway

The Lora module of the node works in class a mode. After the microcomputer detecting the data through the temperature and humidity sensor regularly, it wakes up the Lora module and sends the data to the gateway, and then enters the waiting state. The gateway stays in the receiving state. After receiving the data uploaded by the node, it will give an ACK to the node. The node will enter the sleep mode after receiving the ACK from the gateway during the waiting period, if the node does not receive the ACK, it will send the data again. If the ACK is still not received, the node will stop sending and enter the sleep mode. This retransmission mechanism can reduce data loss caused by channel congestion.

4 Conclusion

This article firstly introduces the current status of tobacco leaf and its storage and the development of Internet of Things technology. Secondly, the feasibility of the LoRa technical solution in the environmental monitoring of tobacco leaf storage and the functional requirements of the system are analyzed in detail. Finally, combined with the characteristics of LoRa technology, a LoRa-based intelligent tobacco storage monitoring system is proposed and a detailed plan is given, and field tests prove that the system is feasible.

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