Design of Intelligent Garbage Bin Supervision System

Based on Internet of Things Technology

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Abstract. Using STM32 microcontroller to build an intelligent garbage bin system, utilizing temperature and humidity measurement modules and ultrasonic distance measurement modules. Real time detection of the remaining capacity and internal temperature of the trash can, and alarm for objects that have not burned out their cigarette butts; Using LoRa wireless communication technology to upload collected data to the server, and monitoring the status of the garbage bin in real-time through the PC. This garbage bin provides convenience for garbage bin dispensers while improving the efficiency of garbage disposal.

Keywords: LoRa; Intelligent system; Internet of Things

1 INTRODUCTION

So far, domestic cities still use traditional trash cans. The status information of the garbage bin cannot be updated in a timely manner, and environmental sanitation personnel cannot handle it in a timely manner, resulting in low garbage collection efficiency. Starting from facilitating real-time monitoring of the usage status of garbage cans by garbage management personnel, this article utilizes remote wireless communication technology to develop and design an intelligent garbage bin system that can automatically open and close the lid, monitor whether the garbage is full, locate the position of the garbage bin, and integrate high temperature and remote communication.

2 DESIGN SYSTEM STRUCTURE

This design uses an STM32 microcontroller as the control core of the system, consisting of multiple sensors[1]. It uses human infrared sensors to sense human proximity, and then sends the information to the MCU, which controls the rotation of the servo to open the trash can; The ultrasonic ranging module can achieve real-time detection of the distance between the garbage bin lid and the top of the garbage; It can use a temperature and humidity detection module to conduct real-time detection of this garbage bin. When the temperature and humidity data in the garbage bin exceeds the threshold,

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an alarm function will be triggered[2]; By utilizing the GPS module, it is possible to accurately locate the garbage bin; The LoRa communication module uploads the data collected by various sensors in the trash can to the gateway for analysis and processing[3]; The WiFi module is used to connect with the PC upper computer and achieve data exchange. The overall design block diagram is shown in Figure 1.

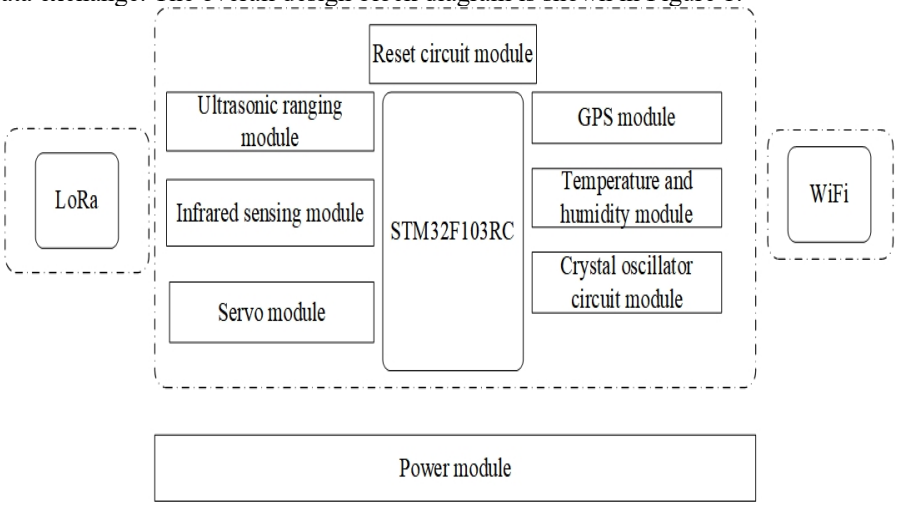

Fig. 1. Overall design scheme

3 SYSTEM COMMUNICATION PROTOCOL DESIGN

3.1 Terminal node main program

Before issuing a network access request, the LORa terminal node will first perform CAD channel detection on it. When the LoRa communication channel of the gateway node is occupied, the terminal node will perform a period of backoff on it, and then send it again to the competitive channel until it sends a response signal[4].

To avoid situations where no response signal is always received in the network, this design also uses a timeout retransmission mechanism[5]. Before the network access request is issued, the system will give a short interval to the terminal node to reduce the impact of network access on other terminal nodes. After the network access request is issued, if there is no response from the gateway within the set time, it will enter the network access again, and the number of network access times can be set[6]. When the number of network access times reaches the set maximum value, it will be considered as a network access failure, To prevent terminal nodes from falling into a dead cycle. The main program flow of the terminal node is shown in Figure 2.

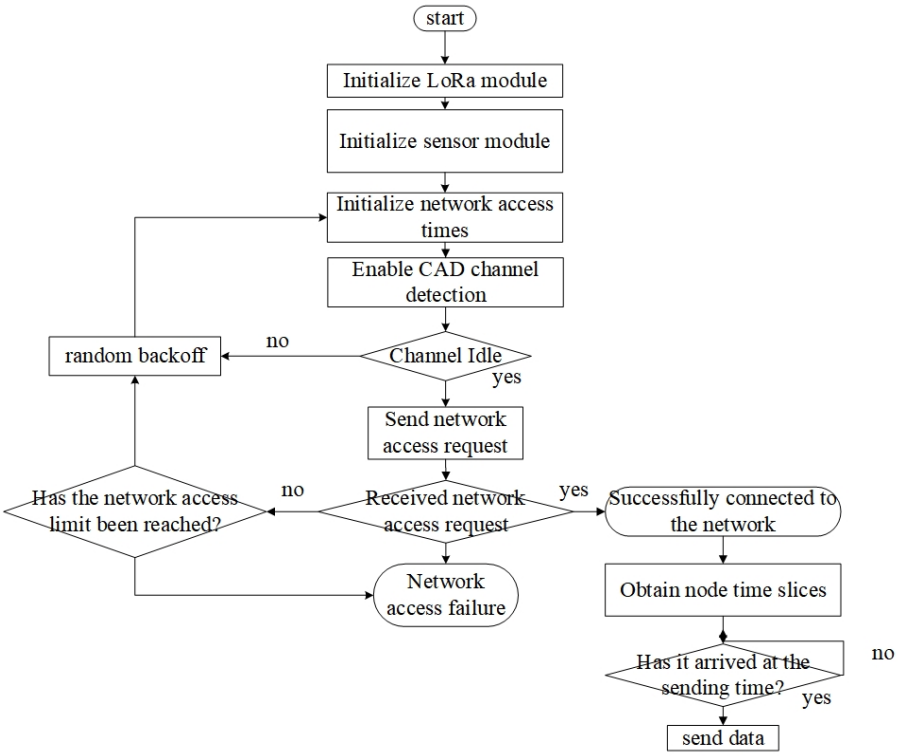

Fig. 2. Main program flow of terminal node

3.2 Gateway node main program

After the initialization of each module in the gateway node is completed, it starts to receive and analyze the network access request data packet sent by the terminal node. Based on the device identifier in the network access data packet, it observes the terminal node[7]. If it is found that the terminal has had network access operations before, it will add an access number to the terminal and send a response message to allow network access; If this terminal node has not been connected to the network before and is a new node, it is necessary to inquire about the number of terminal nodes in the gateway[8].

If the upper limit is not reached, it will be allowed to access the network by adding one to the number of terminal nodes; If the upper limit is reached, a reply of network access failure will be sent. After the terminal node is connected to the network, the gateway will enter normal working mode[9]. It will receive the data uploaded by the terminal node and transmit it to the upper computer through WiFi. The gateway needs to enable the timer function. When the set time is reached, the gateway will send a time correction data packet to the terminal[10]. The main program flow of the gateway node is shown in Figure 3.

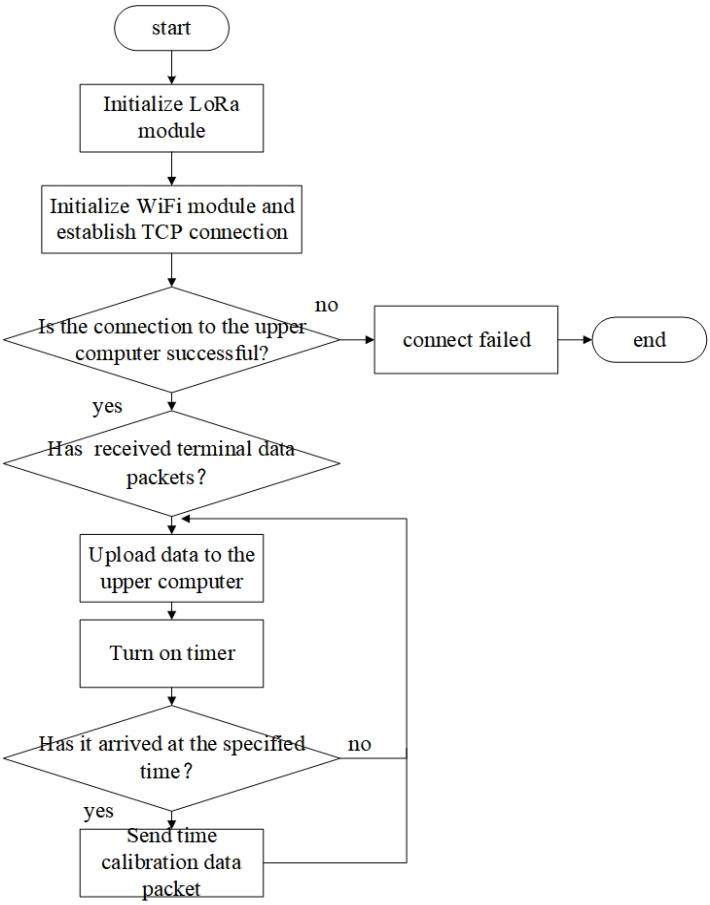

Fig. 3. Main program flow of gateway node

4 SYSTEM TESTING

Download the program successfully debugged to the hardware system and run it, test whether all functions of the system are normal, the success rate of wireless communication data transmission and signal strength, to measure the reliability of the system and the real-time performance of data transmission.

The success rate of data transmission and signal strength were tested in both open and obstructed areas. The test results are shown in Table 1, indicating that the data transmission of this system is reliable. The upper computer display is shown in Figure 4.

Table 1. LoRa communication distance test

Communication distance /m	Open areas/dBm	Communication success rate	Obstacled areas /dBm	Communication success rate
200	-39	99.8%	-43	99.8%
400	-40	99.8%	-46	99.8%
600	-41	99.8%	-47	99.8%
800	-46	99.8%	-49	99.8%
1000	-47	99.8%	-51	99.8%
1200	-50	99.8%	-53	99.8%
1400	-51	99.8%	-55	99.8%
1600	-54	99.8%	-57	99.8%
1800	-55	99.8%	-57	99.8%

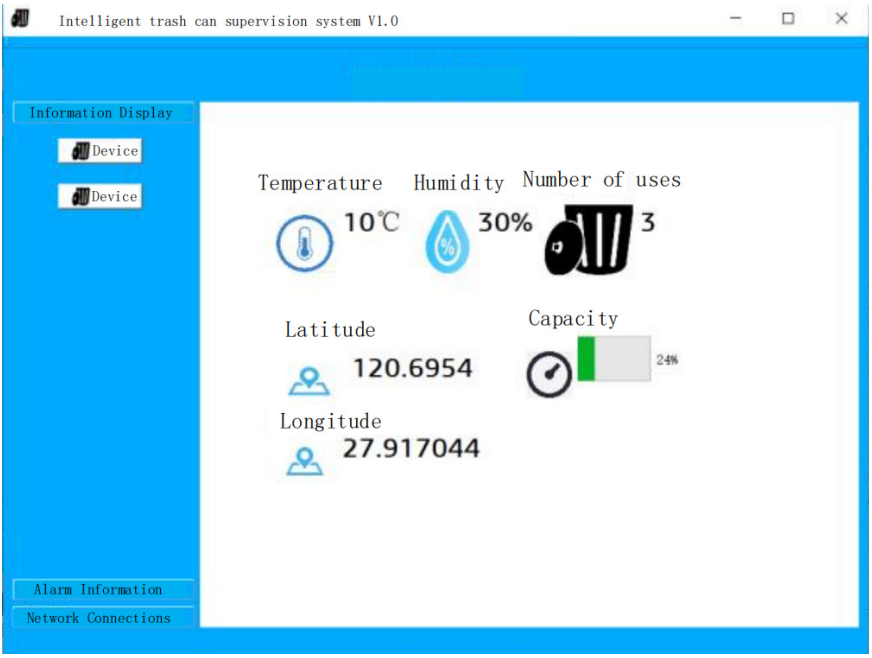

Fig. 4. Information display interface test

5 CONCLUSION

By comparing the advantages and disadvantages of LoRa and other wireless transmission methods, the intelligent garbage bin supervision system designed in this article based on LoRa technology has lower development costs, stable system operation, stable and reliable data transmission, convenient networking, easy maintenance, and good development and practical value.

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