ISSN 2706-6827 Vol. 2, Issue 6: 24-31, DOI: 10.25236/IJFS.2020.020604

Design of Data Acquisition and Control System Based on MQTT

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Abstract. *The designed data collection system could collect the data by each IoT node device through the MQTT protocol, display the data through the web client and remotely control the switch of the device. When the network is unavailable, the Bluetooth client could display the data and control the function of the device switch. Among the IoT node devices. In the wireless network environment, the devices upload data to the MQTT server with the WiFi module. Without a wireless network, the data would send to devices hrough the LoRa module to implement data and instructions.*

Keywords: *MQTT; LoRa Data Acquisition; the Remote Control*

1. Introduction

With the rapid popularity of IoT terminals, the ability to quickly and stably collect data from a large number of IoT terminals has become crucial. The MQTT protocol is a client-server message transmission protocol, designed for application scenarios with poor network conditions and lack of hardware resources. [1] So it is very suitable as the main communication protocol for remote data collection and control of IoT devices.

In the limited network conditions of the Internet of Things terminal, the data collected by the scattered nodes are forwarded through LoRa, summarized to the nodes with WiFi network. Then forwarded and summarized to the server through the MQTT protocol. [2] The data can be conveniently viewed and remotely controlled on the web side. equipment. At the same time, it also provides a Bluetooth client as another backup solution when the network is not available.

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2. Design Scheme of the Whole System

In the system, the IoT devices transmit data and receive instructions through LoRa without a wireless network. The interact with the peripheral modules could be drive through the CKS F051 development board. The IoT devices with the wireless network environment are in addition to directly interacting with those driven by themselves. In addition to the peripheral module interaction, the LoRa module also indirectly communicates data with the peripheral modules in the non-network area. The data in the network area is exchanged with the Android Bluetooth module driven by the CKS F103 development board, and the data and instructions are exchanged with the MQTT server through the ESP32 WiFi module. [3] Finally, the web client uses the MQTT server to collect data and display the function of sending instructions to control the switch of the remote device. The overall design block of this system is shown as in Figure 1.

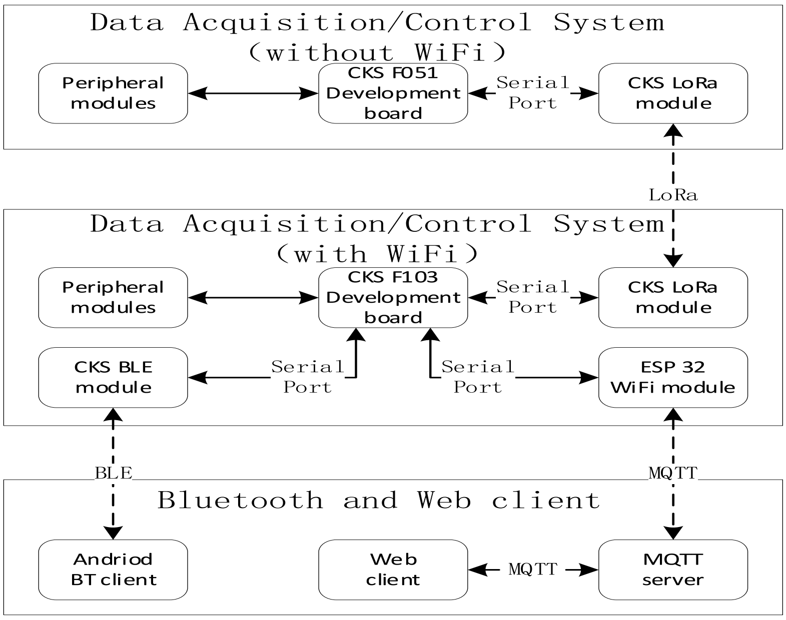

Figure. 1 Overall design scheme of the system

3. Design Scheme of Each Module

3.1 Design of Data Acquisition/Control System in Non-Network Area

In the example implemented in this paper, the peripheral module is replaced by the temperature and humidity module DHT11. Therefore, the specific function of this subsystem is to receive temperature and humidity acquisition instructions

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through LoRa to collect temperature and humidity data, and send the data to LoRa node in the netted region through LoRa module. [4-6]

The LoRa module is a self-made module using CKS LoRa chip. The schematic diagram and PCB layout of the module are shown in Figure 2 and Figure 3 respectively. The function of the module is to convert the LoRa chip native SPI communication interface into serial port communication that supports AT protocol, which is convenient for debugging in the development process.

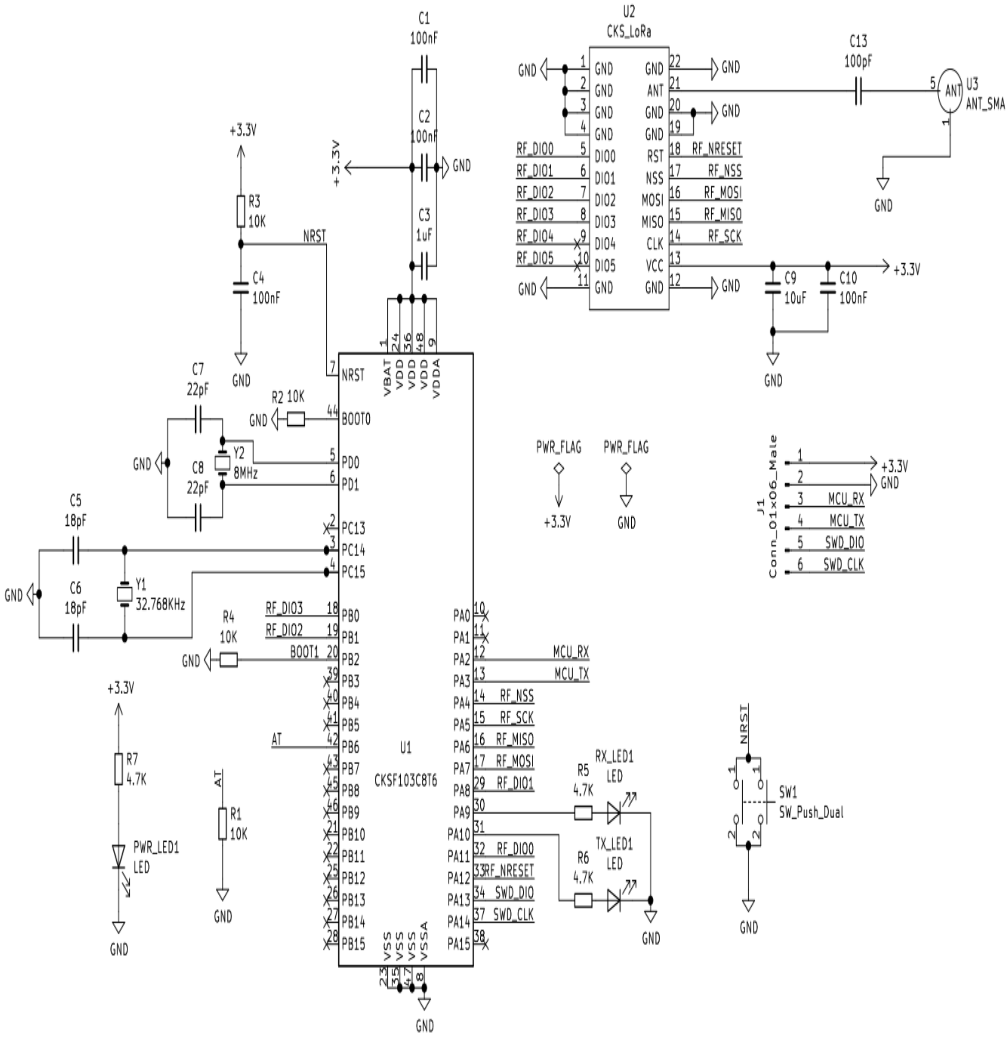

Figure. 2 Schematic diagram of LoRa module

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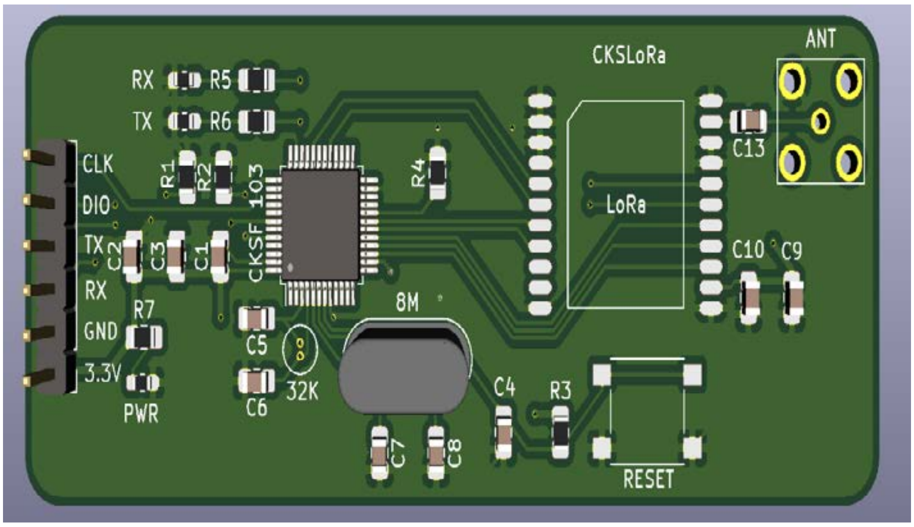

Figure. 3 LoRa MODULE PCB layout

3.2 Design of Data Acquisition/Control System in Networked Area

In the example implemented in this article, the peripheral module is replaced with a relay to simulate a remote device whose switch state is controlled. Therefore, the function of this subsystem is specifically to transmit and receive data with nodes in the non-network area through the LoRa module, exchange data with the MQTT server through the ESP32 WiFi module, and control the relays controlled by the development board CKS F103. [7]The Android mobile phone Bluetooth client could send and receive data and instructions through the CKS BLE Bluetooth module and peripherals driven by the development board.

The flow of the ESP32 WiFi module connecting to MQTT server is achieved by publishing information to a specified topic. The instruction reception is achieved by subscribing to a specified topic message, and specific data is obtained through a callback function.

The ESP32 MQTT gateway data flow diagram is shown in Figure 4. Receive events through MQTT to trigger the serial port sending action to realize cloud command forwarding to the microcontroller. The MQTT data sending action is triggered by the serial port interrupt, and the collected data is forwarded to their specific subscription topic, so that the data collected by the single-chip microcomputer is forwarded to the cloud.[8]

Figure. 4 Data flow diagram for the ESP32 MQTT gateway

3.3 MQTT Service Construction

The MQTT service is built using "EMQ X Broker", which is based on the Apache Version 2.0 open source protocol and can be used freely.

3.4 Web Client Design

The web client interface is designed using HTML5, and the real-time data interaction function with the MQTT server is designed using JavaScript combined with the MQTT.js library. Realize the functions of remote Internet of Things node temperature and humidity query and relay switch control. The flow chart of the web client program is shown in Figure 5.

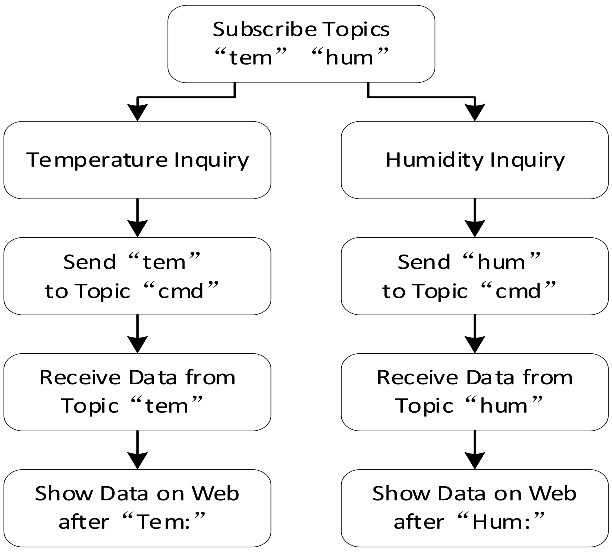

Figure. 5 Web client program flow chart

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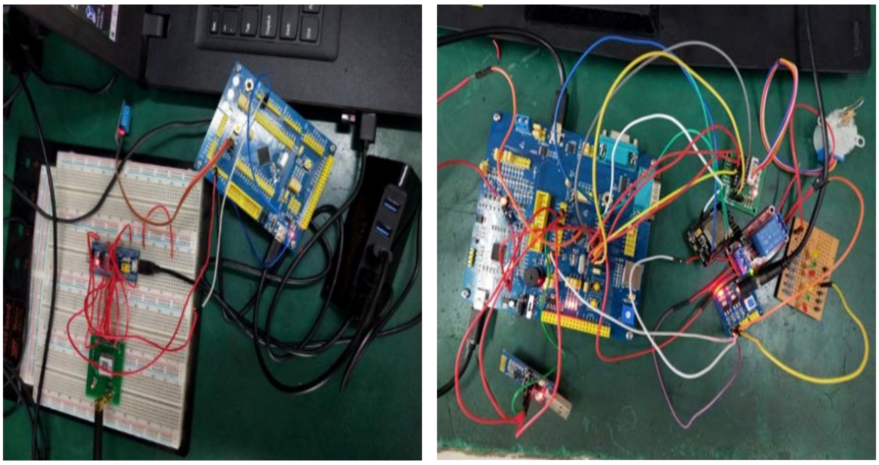
4. Test Results

4.1 The Data Acquisition/Control System



(a) Test board in non-net area *(b) Test area in net area*

Figure. 6 The test area of the data acquisition and control system

Figure 6(a) shows the test area of the remote data collection in the non-network area, where the CKS F051 development board is connected to the temperature and humidity monitoring module DHT11. The acquired temperature and humidity data is sent out through the LoRa module.

Figure 6(b) shows the test area of the data collection terminal in the networked area, where the CKS F103 development board is connected to the relay module and the stepping motor module to simulate electrical switches and curtain lifting. The switch board communicates with the remote network-free area through the LoRa module and sends the data to the MQTT server through the ESP 32.

4.2 The Temperature and Humidity Test Results on the Web Page

The designed system is tested and the actual test data is displayed on the web page as shown in Figure 7.

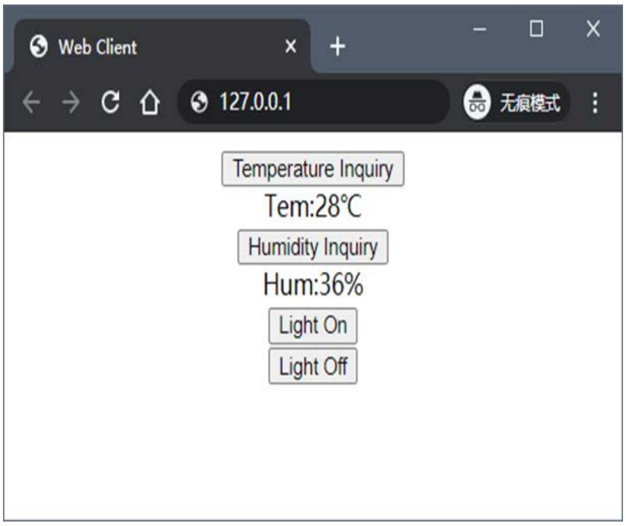


Figure. 7 Temperature and humidity test results on the web page

The web page has excellent cross-platform features and can run adaptively on PC, mobile phones and the tablets. The collected temperature and humidity data would send to the user through the web page in time. The system structure is clear and easy to implement, and the data is reliable.

4. Conclusion

The test results show that the remote data acquisition and control system designed in this paper can correctly display the collected temperature and humidity data through the web terminal and control the on-off state of the remote relay, achieving the design goal.

Acknowledgements

This work was supported by the Xi'an University of Posts and Telecommunications (Number: JGB201907), and the project of Xi'an Science and Technology Bureau (Number: GXYD17.20).

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