The Design of Data Acquisition and Management Based on the STM32 and WiFi

Jian WANG*, Chu-ting LIN, Jia-xing XIE and Jin-shun FENG

Electronic College of Engineering, South China Agricultural University, Guangzhou, PR China

*Corresponding author

Keywords: Data acquisition, STM32, WiFi, MySQL.

Abstract. A data acquisition and management design is presented in the paper, which is mainly composed of microcomputer, PC, WiFi router, WiFi module and MySQL database. The WiFi module with microcomputer is set to TCP server in the Station (STA) mode, while the PC is set to TCP client, and the GUI program of windows TCP/IP data transmission is written by Qt language. After STM32 microcomputer collecting the temperature and humidity data from the sensor DHT11, the data are sent to PC by means of WiFi module ESP8266, and then PC stores the data in the cloud MySQL database via Ethernet.

Introduction

The Data acquisition and management design is of great importance nowadays, it is widely used in the robots, livestock houses, automobiles, wearable devices etc., and the embedded microprocessor can operate sensors to obtain data easily due to the mobile and smart features. The traditional SCADA (Supervisory Control and Data Acquisition) and various sensor data acquisition using embedded microprocessor provided much useful information [1]. A near-infrared portable tissue ox meter with detection module using STM32 microprocessor is adopted [2]. With the development of the internet of things (IoT), more wireless data transmission ways appear: such as ZigBee, 4G and WiFi technology, the WiFi technology conforms to the IEEE802.11 specification, which can connect the computers with other devices by means of TCP/IP protocol, and it is becoming more popular due to the low cost comparing with 4G. Recording WiFi signal strength from access points (AP) along with the positions at which they were recorded to match those to new measurements for indoor positioning was proposed [3]. In [4] the smart phone as a central monitoring device for the bicycles and the WIFI network as a communication channel between the smart phone and the sensors were proposed. A microcontroller ATmega328 and WiFi module ESP8266 were used in the built system, where some WiFi routers were configured to form a WiFi mesh network, and the WiFi node throughput in the outermost area were measured [5]. Both the real time humidity and illumination environment monitoring system and the smart campus system adopted the WiFi technology [6,7]. Similarly, a WiFi-based greenhouse environment remote monitoring system was proposed in [8]. Those obtained data need to be stored for further processing and analyzing, and the database is the most widely used data management. The authors run a number of query experiments to evaluate the MySQL with NoSQL databases to show that which database system for surveillance in wireless multimedia sensor networks was efficient and scalable[9].

System Framework

The system framework is composed of sensor module, microcomputer unit, WiFi module and router, and PC, the sensor data can be sent by WiFi module to PC via WiFi router, and PC receives data and stores data to the cloud MySQL database through Ethernet as shown in figure 1.
System Hardware

The system hardware mainly includes microcontroller STM32F103RCT6, WiFi module ESP8266, WiFi router, sensor DHT11 and PC. STM32F103RCT6 is a high performance 32-bit microcontroller of the ST semiconductor company, which is based on the Arm Cortex architecture. ESP8266 is a complete and self-contained wireless data solution supporting the 802.11 b/g/n, it works in the way of the serial port wireless, namely, the COM-WiFi, which means that the ESP8266 module has RxD, TxD pins similar to that of the serial port, and the general AT instruction is adopted in the ESP8266. It has Station (STA), AP and STA+AP three work mode. In this paper the ESP8266 STA mode is adopted, in which TCP server, TCP client and UDP three work configurations can be set up, we choose ESP8266 to work in the TCP server configuration, and PC is set to the TCP client.

System Software

Obviously, the data transmission between WiFi module and PC is the key issue, and the WiFi communication essence lies in TCP/IP protocol, It includes two parts program: one is about the sensor DHT11, STM32 and WiFi module, the other is about the WiFi module with PC via Ethernet, the state flow of the system is showed in figure 2. There are some operations: Firstly, PC client and ESP8266 server should be in the identical local network through WiFi router; Secondly, the WiFi SSID, password, IP address and port number etc. are coded in the program.

STM32 Software Program

The STM32 part program is written by C language in the MDK-Keil5 development environment, in the present network provided by WiFi router, the WiFi SSID is Ele310, IP address is 192.168.169.158, and Port number is chosen as 8086. The program is composed of several steps as follows, and the ESP8266 configuration is shown in figure 3.

**Step 1** STM32 Timer initialization, serial port initialization, the Baud rate of serial port is set to 115200, then open the STM32 interruption.

**Step 2** ESP8266 STA work mode setup

**Step 3** DHT11 sensor initialization

**Step 4** STM32 communication with ESP8266
PC Client Software Program

Client/Server model is commonly used model in Web, where the client usually calls on the server based on the TCP/IP protocol, the server corresponds to the asking by monitoring the relative port. Windows socket is an open Web program interface; it can realize the TCP/IP protocol between the Client/Server. Qt is a multiplatform C++ application framework; it is attractive not only because of its superior quality and high-level technical support, but also because it comes with the source code. The application of GUI (Graphical User Interface) based on Linux Qt was discussed [10]. We use Qt Creator 4.9.0(Community) as the development environment. In Qt TCP/IP program the QTcpServer object monitors whether a client calls on by means of the function like follows:

Tcpserver->Listen(QHostAddress::Any, 8086), in which 8086 is an assigned port number.

Measure and Discuss

Single ESP8266 Module Test

ESP8266 module has RxD and TXD pins as mentioned above, it satisfy the serial port communication demand in fact, so we use serial port debugging program called Serial Port Assistant to test a single ESP8266 using AT commands. A USB-TTL module with RXD and TXD pins connects to ESP8266 like figure 4.
In figure 5(a), the TCP server and port number of STA mode of the ESP8266 is set up through the command: AT+CIPSERVER=1,8080, while in figure 5(b), the PC client calls on the ESP8266 server by means of port 8080 and IP address 192.168.43.215. When the PC client connects to the ESP8266 successfully, the data 009911 transferred by PC client can be received by the ESP8266 correctly. Figure 5(b) is also the Qt GUI of the PC client.

DHT Data Acquisition

Again the ESP8266 TCP server manner is chosen. Timer interruption TIM3 and TIM7 are employed in STM32, TIM3 interruption is adopted for DHT11 temperature and humidity data acquisition, and TIM7 interruption is adopted for ESP8266. The microcomputer board with WiFi module is shown in figure 6. Three DHT11 sensors are deployed in different place in the test; the received data showed in Qt GUI of PC client in figure 7 are Hex format at first, then they are changed to the decimal format when storing in the MySQL in Alibaba Cloud as showed in figure 8.
Summary

A data acquisition and management based on microcomputer, PC, WiFi module and MySQL database is presented and validated in the paper. It is low cost and flexible data acquisition design method.

Acknowledgement

This research was financially supported by the Agricultural and Rural Department of Guang Dong Province (Grant numbers: 2019KJ129) Foundation.

References

[1] Papić Milorad, Bundalo Zlatko, Bundalo Dušanka, et al., Microcomputer based embedded SCADA and RFID systems implemented on LINUX platform, Microprocessors and Microsystems. 63 (2018)116-127.

[2] Fu Yu, Jian Liu, System design for wearable blood oxygen saturation and pulse measurement device, Procedia Manufacturing. 3(2015)1187-1194.

[3] Nan Zhu, Hongbo Zhao, Wenquan Feng, Zulin Wang, A novel particle filter approach for indoor positioning by fusing WiFi and inertial sensors, Chinese Journal of Aeronautics. 28(2015) 1725-1734.

[4] YeongKyun Lee, Jongpil Jeong, Design and Implementation of Monitoring System Architecture for Smart Bicycle Platform, Procedia Computer Science. 134 (2018) 464–469.

[5] Rifki Muhendra, Aditya Rinaldi, Maman Budiman, Khairurrrijal, Development of WiFi mesh infrastructure for internet of things applications, Procedia Engineering. 170(2017) 332-337.

[6] Rui Zhang, Bo Yan, Hongfei Guo, et al., A new environmental monitoring system based on WiFi technology, Procedia CIRP.83(2019)394-397.

[7] Luo Li, Data acquisition and analysis of smart campus based on wireless sensor, Wireless Pers Commun. 102 (2018)2897-2911.

[8] Yuhan Zhang, Jinhai Wang, Intelligent home system based on WIFI, Communications in Computer and Information Science. 236(2011)319-327.

[9] Cihan Küçükkeçeci, Adnan Yazıcı, Big Data Model Simulation on a graph database for surveillance in wireless multimedia sensor networks, Big Data Research. 11(2018)33-43.

[10] Ming Zhao, Yuming Shen, The Application of Qt in liquid level detection, in: L. Jiang (Ed.), International Conference on ICCE 2011, AISC 112, 2011, pp. 81–86.