

Research on Heterogeneous Network Communication of Liquor Solid Fermentation Pit Intelligent Temperature Monitoring System

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Abstract

In this paper, an intelligent temperature monitoring system for liquor solid pit tank based on heterogeneous network technology is studied. The system includes a wireless Bluetooth temperature measuring rod, sink node, relay node, base station, PC host computer and mobile terminal. There are three temperature sensors on the rod of the wireless Bluetooth temperature measuring rod inserted into the cellar pool. The single-chip microcomputer system exposed outside the cellar pool is responsible for collecting the sensor data and sorting it to send it to the sink node through the Bluetooth module; the sink node is provided with a Bluetooth module and 433M wireless module, Bluetooth module is responsible for receiving the temperature data of the surrounding 6 cellar pool, and the sink node main control chip is compressed and sent to the relay node through the 433M wireless module; The relay node processes the data from each sink node and sends it to the base station; The base station transmits the temperature data of the cellar pool to the PC host computer for storage and interface display through serial ports; the mobile terminal accesses the data of the wireless temperature measuring rod nearby through Bluetooth pairing communication.

Keywords

Wireless Sensor Network, liquor solid pit, transmission reliability, heterogeneous network.

1. Introduction

As an important indicator in the fermentation environment of liquor, temperature often requires periodic monitoring. At present, there are three main ways to collect the temperature of the liquor cellar pool: One is the traditional manual plugging thermometer collection method. This method not only affects the fermentation environment in the cellar pool, but also has low measurement accuracy and read values. There are many shortcomings such as subjective factors; the second is to make wired measurements by wiring around the cellar, mainly fixing the thermometers at different locations in the cellar, and transmitting the measured values of the thermometer back to the middle through the cable Controller or PC. In this way, a large number of cables need to be densely distributed around the cellar, occupying the cellar space, destroying the fermentation environment, the cost of the system is relatively high, and the layout of the multi-channel cable also makes the system less safe; The third is the wireless collection method, which collects the temperature through ZigBee technology and transfers it back to the convergent node. This method does not take into account the impact of solid state fermentation on the node. At the same time, the centralized collection method is easy to cause network signal conflicts and data loss [1- 2].

The first method of frequent insertion and removal of thermometers not only wastes manpower and material resources, but also mainly causes damage to the closed cellar environment and affects the fermentation effect; the second method cannot perform real-time detection, which is not conducive to the upgrade and update of modern technology; The third method fails to consider the topology of the wireless network, which can easily cause data loss. Therefore, based on the Internet of Things technology [3-4], an intelligent temperature measurement system is designed to monitor the temperature in the cellar in real time, and the data is transmitted back to the PC host computer through the layered cluster heterogeneous network technology. It is of great significance to improve measurement accuracy, maintain signal stability and network security.

2. Intelligent Temperature Monitoring System

The schematic diagram of the communication operation of the intelligent temperature monitoring system for liquor solid cellar based on heterogeneous network technology designed in this paper is shown in Figure. 1, including wireless Bluetooth temperature measuring rod, convergence node, relay, base station, PC host computer, mobile terminal, wireless The Bluetooth temperature measuring rod evenly collects the temperature in the upper, middle and lower parts of the cellar pool and sends it to the sink node through the Bluetooth module. The sink node sends the collected data to the relay node through the 433M wireless module. The relay node collects and processes its coverage area The data of the node is aggregated and sent to the base station. The base station is connected to the PC host computer and sends the data through the serial port. The PC host computer stores and displays the online data of each cell in the interface. The mobile terminal accesses the wireless Bluetooth temperature measurement rod data via Bluetooth.

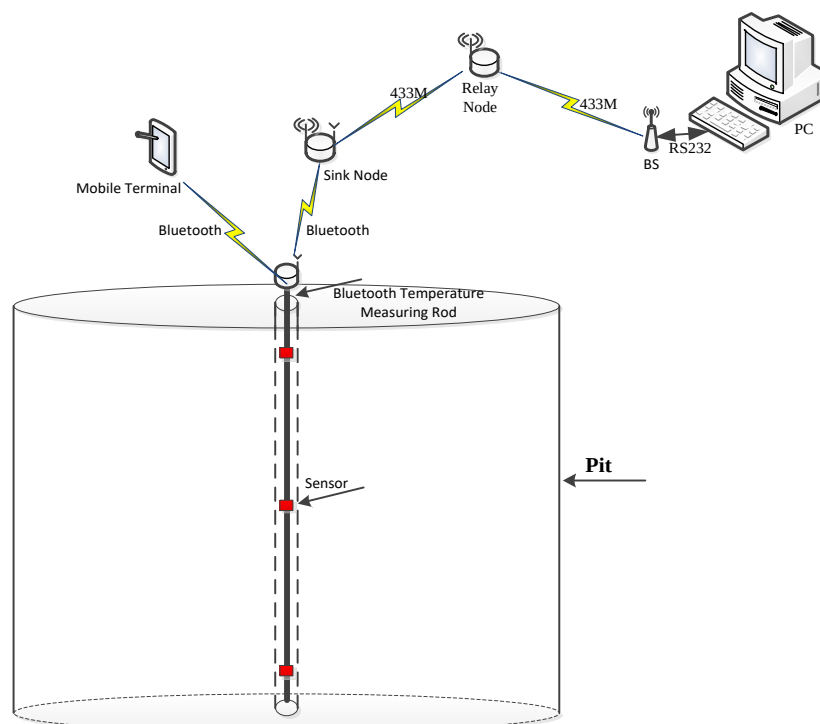


Figure 1. System communication operation diagram

Each cellar is arranged with a Bluetooth temperature measuring rod, each sink node is simultaneously wirelessly connected to six Bluetooth temperature rods, and each Bluetooth

temperature stick is only wirelessly connected to one sink node. The Bluetooth temperature measuring rod includes a rod body and a single-chip microcomputer temperature measurement system (as shown in Figure. 2), and the rod body is vertically arranged in the cellar pool; the single-chip microcomputer temperature measurement system includes three temperature sensors, and the three temperature sensors are respectively installed on the upper, middle and The lower section is used to detect the temperature data of the upper, middle and lower height positions in the cellar; the single-chip temperature measurement system is installed on the top of the rod body in addition to the temperature sensor, which is convenient for the maintenance and upgrade of the single-chip temperature measurement system.

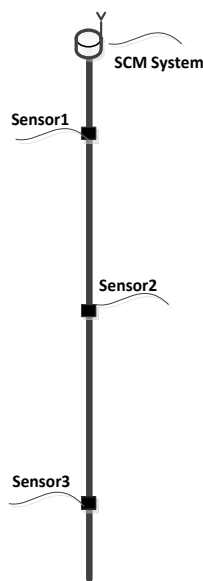


Figure 2. Bluetooth temperature measuring rod

3. Heterogeneous Network Communication

The communication structure of the intelligent temperature monitoring system for liquor solid cellar based on heterogeneous network technology designed in this paper is shown in Figure 3. In addition to the temperature measuring rod inserted into the cellar of the single-chip Bluetooth temperature measuring rod, it also includes a single-chip microcomputer, an LCD display, a Bluetooth module and an alarm circuit. The MCU periodically collects the data of the three temperature sensors, the LCD display screen is used to display the three temperature data, the alarm circuit is used to warn of abnormal temperature data, and the Bluetooth module is used to send the temperature data processed by the MCU to the sink node.

The convergence node includes a Bluetooth module, a single-chip computer, and a 433M wireless module that are sequentially connected to the communication; the relay node includes a single-chip computer and a 433M wireless module, and the single-chip computer and the 433M wireless module are in communication connection. Among them, the Bluetooth module of the aggregation node receives the data from the Bluetooth temperature measuring rods of the six nearby cellars. The single-chip computer of the aggregation node processes the data and sends it to the superior relay node through the 433M wireless module. The relay node collects and processes its coverage area The data of the aggregation node is sent to the base station through the 433M wireless module. The base station sends the data to the PC host computer through the RS232 serial port. The PC host computer database stores and displays the temperature data of each cell in the interface.

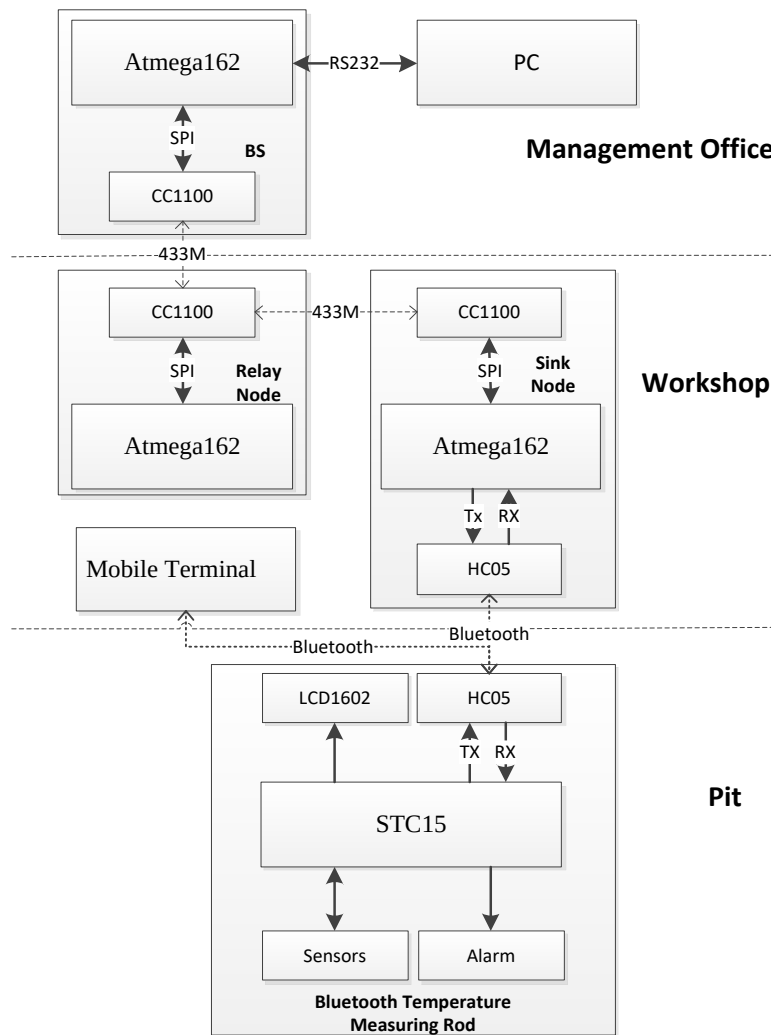


Figure 3. System communication structure diagram

The circuit design of the wireless Bluetooth temperature measuring rod is shown in Figure 4, in which the single-chip system uses an 8-bit STC15F2K60S2 microcontroller as the main control chip; the waterproof temperature sensor DS18B20 is evenly distributed in the upper, middle and lower three positions of the temperature measuring rod, and the DS18B20 and STC15F2K60S2 pass One signal line is connected for bidirectional communication. Three DS18B20s are connected in parallel to the three pins of STC15F2K60S2. No peripheral components are required during use; RW of LCD1602 is a read/write selection pin, which is connected to STC15F2K60S2. I/O, when RW is low level, write command or data to LCD1602, when RW is high level, read status or data from LCD1602, D0-D7 pin is connected to any 8 of P0-P3 of STC15F2K60S2 I/O port parallel input/output data; Bluetooth module chooses low-power HC-05 model, HC-05 communication distance is about 10m, can effectively cover the communication of 6 cellars, HC-05 module RXD (receiver) and single chip The TXD (transmitting end) is connected to receive data, and the TXD is connected to the RXD of the single-chip microcomputer to send data. The program design alarms when the temperature difference between the temperature measurement points is large or abnormal, and the single-chip computer controls the connection of the PNP transistor when the temperature is abnormal. The base pin output low level causes the speaker branch to be energized to issue a sound alarm. The speaker circuit is connected in series with a 10K potentiometer to adjust the sound loudness of the alarm. At the same time, the abnormal value is uploaded through the

heterogeneous network to facilitate the management personnel in time Understand and eliminate anomalies.

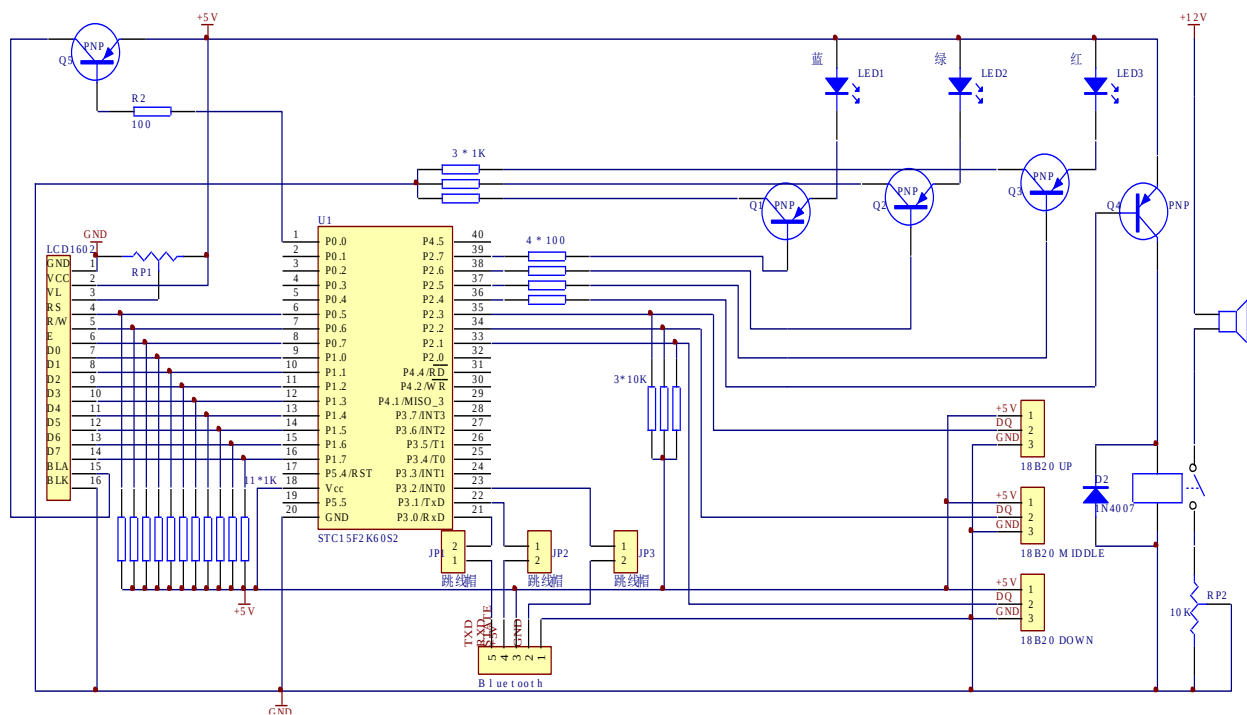


Figure 4. Circuit diagram of Bluetooth thermometer

The main steps of the wireless Bluetooth temperature measuring rod are as follows:

Step 1: Initialize, after power on, first configure the STC15F2K60S2 MCU and each module accordingly, in which all I/O ports are configured in quasi-bidirectional port mode, the display mode of LCD1602 is 5x7 dot matrix, 8-bit data interface mode and Hide the cursor, the timer T1 is used as the serial port baud rate generator, set the serial port 1 use mode 1 as the communication mode;

Step 2: The wireless Bluetooth temperature measuring rod is paired with the sink node or mobile terminal via Bluetooth;

Step 3: Data collection, collecting the temperature of the liquor cellar pool;

Step 4: LCD display, after obtaining temperature data, display the data through the LCD1602 LCD screen;

Step 5: Data transmission, the data is sent to the sink node or mobile terminal through the wireless Bluetooth module;

Step 6: Alarm detection, if abnormal temperature occurs, start the sound and light alarm system in time.

As shown in Figure 4, the communication between the Bluetooth temperature measuring rod and the sink node and the mobile terminal is completed through Bluetooth pairing connection. The present invention adopts a command response working mode to set up a Bluetooth master and slave for one-to-one pairing, sink node, The mobile terminal searches for other Bluetooth modules for the host and actively establishes the connection. The wireless Bluetooth temperature measuring rod receives the connections of other hosts for the slave. After power-on, the master and slave modules are automatically paired, and are connected to the serial ports of the respective microcontrollers to achieve transparent data transmission. The MCU models of the aggregation node, relay node and base station are ATMEAL AVR MEGA162, and the Bluetooth module models are HC-05. ATMEAL AVR MEGA162 is a dual serial port, 1 SPI interface;

433M wireless modules all use CC1100 as a radio frequency communication chip, 433MHZ frequency is less than 2.4G, longer wavelength, strong barrier ability, suitable for complex terrain plant applications, CC1100 maximum emission The power is 10dbm, and the effective communication distance is within 100m, which is very suitable for plant communication needs. As shown in Figure 5, the convergence node includes a Bluetooth module, a single-chip system, a 433M wireless module, the relay node and the base station include a single-chip system, a 433M wireless module, in which the single-chip system uses ATMEL AVR MEGA162 single-chip microcomputer as the main control chip, the MCU is dual Serial port, 1 SPI interface; 433M wireless modules all use CC1100 as a wireless radio frequency communication chip. The frequency of 433MHZ is less than 2.4G, the wavelength is long, and the obstacle penetration ability is strong. It is suitable for plant applications with complex terrain. The maximum transmit power of CC1100 is 10dbm, effective The communication distance is within 100m, which is very suitable for the communication needs of the plant; as shown in Figure 5, after the ATmega162 MCU at the sending end is initialized, when the MCU receives the temperature signal of the Bluetooth module, this event activates the MCU system and starts the SPI interface to send out through CC1100 Data, the receiving end CC1100 is configured to listen to the state, when the listening is correct, it starts to receive data, and then the ATmega162 microcontroller processes the data; the sink node, the relay node, and the base station complete the data transmission through the wireless communication of CC1100 in turn, and finally the base station passes RS232 level conversion to upload data to PC host computer.

The PC upper computer saves and processes these data through the database and displays and queries through the software interface. In view of the amount of data, the Access small database is used to store the temperature data collected by the wireless Bluetooth temperature measuring rod, including the address and temperature of each device; the input and output are designed in C# language the software interface has the functions of data statistics, storage, display, upload, etc. The user can query by date and node number, can download the floor plan of the plant, locate the exact position of the node, and can draw the temperature change curve of a node according to the collected data records.

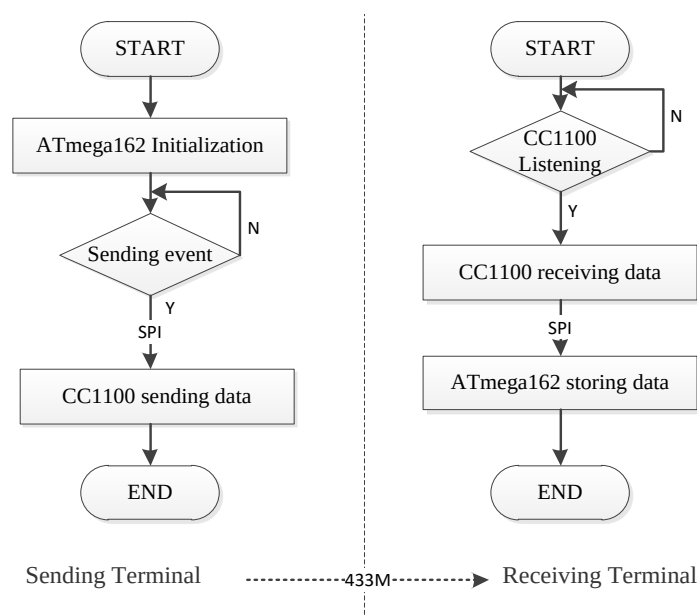


Figure 5. 433M sending / receiving procedure flow chart

The topological structure of the heterogeneous network of the system is shown in Figure 6. Based on this system, the temperature monitoring steps are as follows:

Step 1: Each cellar is equipped with a wireless Bluetooth temperature measuring rod. The temperature rod periodically collects the upper, middle and lower three temperatures in the cellar and sends it to the sink node via Bluetooth communication;

Step 2: Each sink node is responsible for collecting the temperature data of 6 cellars in the area covered by its own Bluetooth module, and the sink node single-chip system processes the compressed data and sends it to the relay node responsible for its own area through 433M wireless communication technology;

Step 3: In order to avoid repeated reception or signal conflict, each relay node only receives the data of the aggregation node of its own fixed address. The single chip system processes the compressed data and sends it to the base station through 433M wireless communication technology;

Step 4: In order to avoid multi-source signal conflict, the base station only receives the data of the relay node. The received data is uploaded to the PC host computer through RS232 level conversion. The host computer saves and processes these data through the database and displays and queries through the software interface;

Step 5: The worker can hold the mobile terminal with a Bluetooth module to carry out the workshop, and establish a connection with the nearby wireless Bluetooth temperature measuring rod to receive temperature data from it.

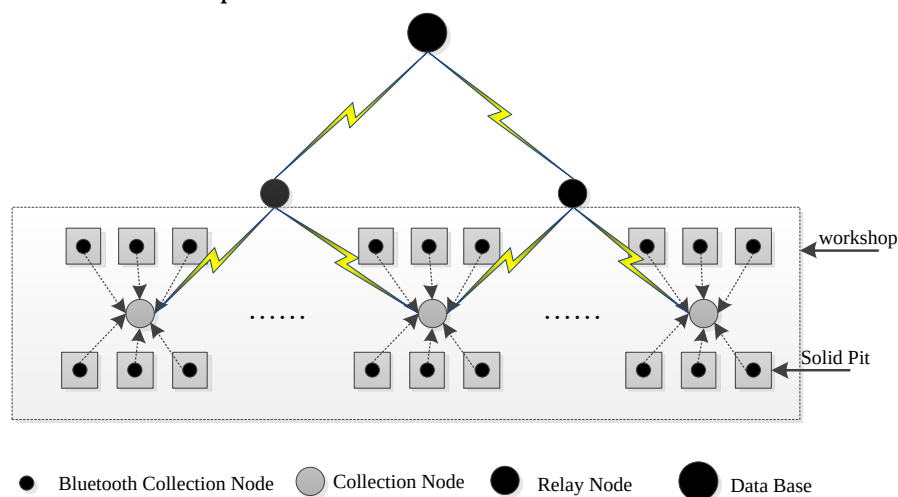


Figure 6. System network topology

4. Conclusion

The intelligent temperature monitoring system of liquor solid cellar based on heterogeneous network technology has a complete structure and complete functions. First, the temperature measurement rod based on Bluetooth technology can achieve uniform collection and online monitoring of cellar pool temperature; secondly, it combines Bluetooth technology and 433M wireless technology to build a layer cluster Heterogeneous heterogeneous network topology realizes the reasonable transmission and management of data. At the same time, the use of Bluetooth technology communication can realize the nearest sampling and query of the mobile terminal to the temperature of the cellar pool. The intelligent monitoring system based on heterogeneous network technology frees manpower, improves measurement accuracy, and ensures stable data transmission.

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