The Design of Greenhouse Environment Monitoring System Based on ZigBee

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Abstract. The internet is widely used in daily life, of course, also be applied in agriculture. This paper is focus on the technology of ZigBee and serial communication. The ZigBee communication module transfers the data from greenhouse to the monitoring system. Growers can get the data timely, and according to the received data to control greenhouse environment. The monitor computer program is based on VB.NET. ZigBee module gets the data from sensor, through serial ports the information is transferred to the monitor computer. The monitoring software stores the data and displays it on the user interface. If the data beyond the threshold value, the system will give an alarm sounds.

Introduction

Greenhouse environment monitoring system detects greenhouse temperature, humidity and other environmental parameters, reducing workload of plant personnel. Records the data on time, convenient growers to control greenhouse environment, facilitate to the growth of crops. At present, the signal propagation mode in most of the greenhouse control systems are wire transmission, a large number of wiring is inevitable. It has many disadvantages, such as high cost, routing is complex, maintaining is difficult. However, the wireless transmission method can effectively solve the above problems.

The system designed in this paper, the data acquisition node is consists of single-chip computer, temperature sensor and humidity sensor, applies radio frequency technology for data transmission. The wireless node is to collect information and monitor computer displays it to the system interface.

ZigBee Technology Introduction

ZigBee is a low-power, cheap and short-range wireless network communication technology, it is used in almost all industries of low rate and short-range wireless communication, such as home furnishing, traffic, and building etc. Significant features of it are the low rate, low power, low cost, self configuration and flexible network topology structure. Due to in non working mode, the ZigBee node is in a dormant state. Because the ZigBee protocol stack is much simpler than others, reduces requirements of the controller, so we can use single-chip computer and a small amount of memory, to reduce the cost greatly. In the communication distance, it through the network coordinator setting network automatically, using the CSMA-CA methods for channel access; and the node device is free to join and leave, is a self-organizing network configuration.

System Structure Design

The system is composed of terminal node, coordinator (also known as the ZigBee gateway) and database management system. As shown in Fig 1, the terminal node is consist of temperature sensor and humidity sensor, collects data in real-time, the data through the C51 single-chip computer uploaded to the ZigBee wireless network. Each ZigBee module also has relay function, so as to avoid too far distance to transfer. The module is responsible for wireless transmission. Database management system applies VB.NET develop human machine interface. The terminal node is to collect and send data, database management system is to analysis and storage data. The coordinator

is responsible for collecting information through RS232 transmit to the host computer, and the system is responsible for realizing real-time display data, and to realize data storage, query, delete and other functions.
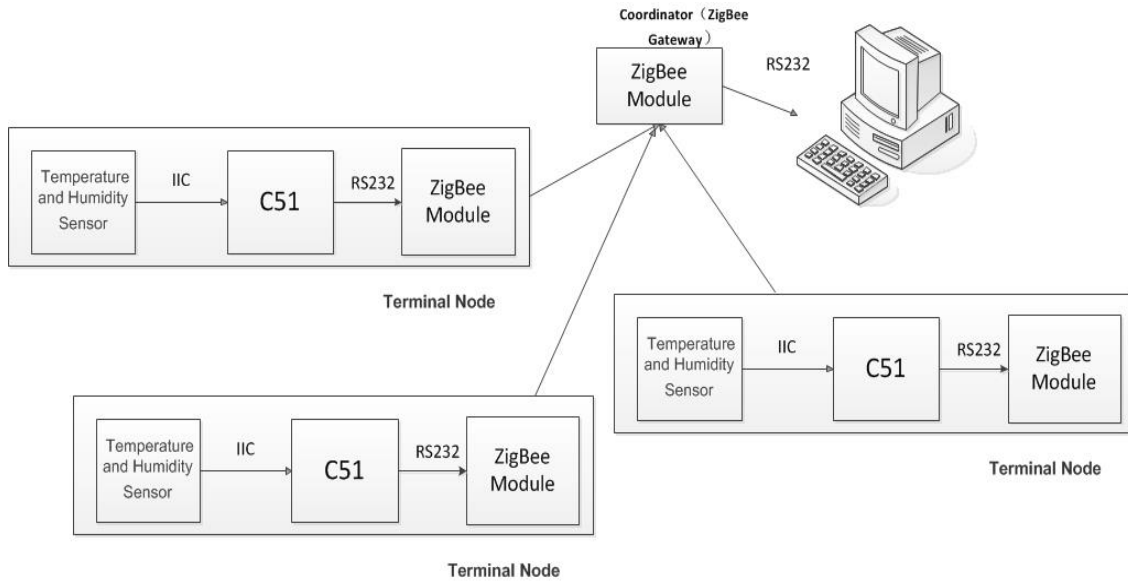
Fig.1 Structure diagram of system

System Hardware Designing

Environmental monitoring system hardware device is composed of terminal node and coordinator, as shown in fig 2. coordinator, it mainly includes microcontroller, RF sending-receiving unit, wireless node and power module and interface unit. From the system hardware, we should mainly consider the accuracy of the temperature and humidity, the detecting range and economic aspects. In this paper, the ZigBee module includes the integrated temperature and humidity sensor and CC2530.

The terminal node includes the temperature sensor and the humidity sensor, MCU and ZigBee module. The terminal nodes are placed in the greenhouse, the temperature sensor and the humidity sensor gets the information. Through the IIC bus MCU transfers the data to ZigBee network, then the coordinator transfer the information to database management system through the RS232 serial port. When distance the terminal node to coordinator is too long to transfer information directly, the data can be transfer to other terminal node, and then transfer to the coordinator.
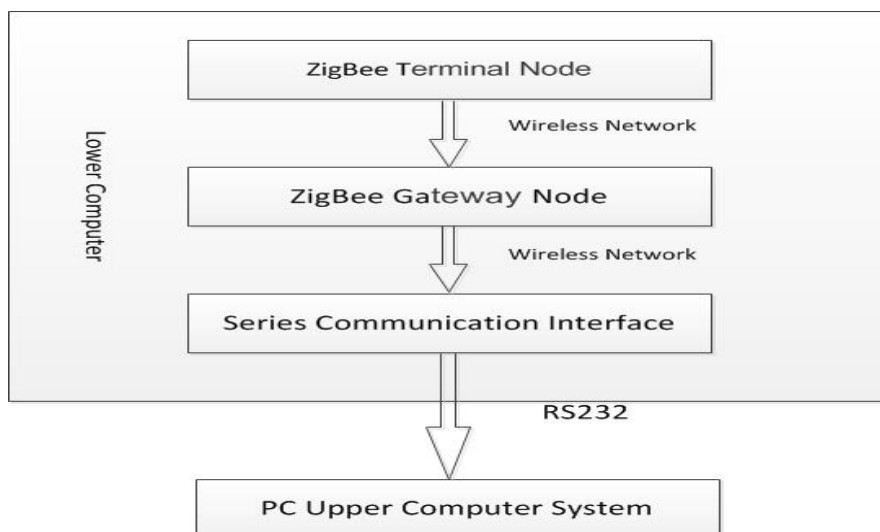
Fig.2 Structure diagram of lower computer system

System Software Design

The monitoring software is developed in Microsoft Visual Studio 2008 environment, the system transfers the data which is collected by terminal node to access database. Growers can through computer monitoring software query the history data, through monitoring interface monitor the data changes in real time, and can set the alarm threshold and the matching parameters etc.

Data Receiving Module

To transfers the data to database management system. The software is programmed In Microsoft Visual 2008, generally, we uses communication control of Microsoft Communication Control (MSComm).

Step follows:

(1) open the serial port connection (2) determine whether the terminal node parameters are correctly chosen (3) set the serial parameters according to the machine parameters (4) establish serial port communication events (5) receive data information.

Section code follows:

```
Private Sub SerialPort1_DataReceived(ByVal sender As System.Object, ByVal e As System.IO.Ports.SerialDataReceivedEventArgs) Handles SerialPort1.DataReceived
          'introduce SerialPort class, receive data HOneData（the humidity of first node）three group of six data
   Dim byteToRead As Int16 = SerialPort1.BytesToRead( )
          If byte To Read = 21 Then
               Dim ch(byte To Read) As Byte
               Dim bytesRead As Int16 = 0
               bytesRead = SerialPort1.Read(ch, 0, byteToRead)   'store the received data
   If ch(0) = 170 And ch(1) = 85 Then    ' judge whether the length of data is effective
               HOneData = CLng("&H" & Hex(ch(2) & ch(3))) / 10
               …………' transform hexadecimal into decimal（front），decimal point moves
single bit to the left(divided by 10）.
```

Data Processing Module

When the computer receives the data, the data be decomposed into three parts, the node number, values of temperature and humidity data, then the data will be transform hexadecimal data into decimal data, at last save to the database. Flow chart of data processing module is as shown in fig 4.
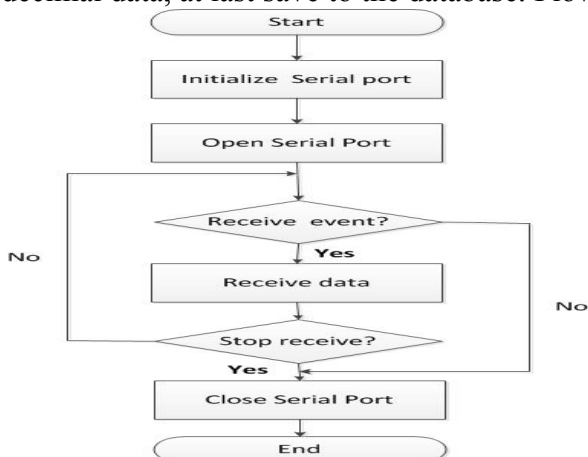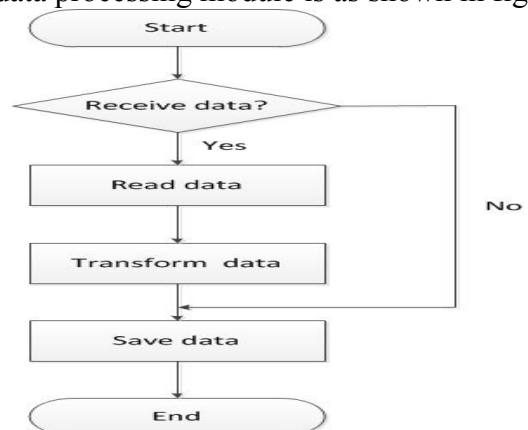
Fig.3 Data receiver module

Fig.4 Data processing module

Section code follows：

```
Imports System.Data.OleDb 'apply access control
Public LHGconn As New OleDb.OleDbConnection("provider=microsoft.jet.oledb.4.0;" & "data
source=" & My.Application.Info.DirectoryPath & "\NewData.mdb;") 'open database，relative path
      Public Sub LHconnopen( )
           Try
                If LHGconn.State < > ConnectionState.Closed Then LHGconn.Close( )
                LHGconn.Open( )
                Call RAlarm( )'database connection，alarm if error
```

Data Display Module

The data display module is the most important module in the system, GDI+ which is provided by.NET Framework converts the data to a picture, and displays it to growers. The system interface has two axes which are used to display the temperature and humidity data, through mathematical calculation to determine the coordinate value of the data on the axis. Connect adjacent coordinate points together to form a real time display curve. Use the Bitmap class to package GDI+ bitmap. Bitmap is used for processing image which is defined by the pixel data. The Graphics.FromImage can create a new Graphics from specified Image, at last using the PictureBox control to display the graphics and images.

Conclusion

The system detects temperature and humidity data based on ZigBee, it has many advantages, such as reliable, simple, flexible, low cost etc. The system can collect real-time data and transfer it to the user, the user can timely grasp the greenhouse environment, so as to adjust and control the environment, and there are values of application.

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