The Design of Network Coordinator Between ZigBee and GPRS For Remote Monitoring Applications

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***Abstract*—Aiming at the design defects of traditional wireless network node, a kind of design scheme of wireless network coordinator based on ZigBee and GPRS technology are proposed. The system uses LPC 2119 as the core and µC/OS-II as operating system. It realizes the establishment and management of ZigBee network, the data communications between ZigBee network and GPRS network. The system can be used for the need of remote monitoring occasions.**

\Key Words—Wireless network, Coordinator, ZigBee, GPRS, Embedded systems.

I. INTRODUCTION

Because the traditional wired network has the problems of expensive installation and maintenance cost and low reliability and so on, wireless networks have been more and more popular for people. ZigBee is kind of wireless Communication which oriented to short distance, low cost, low power, while, GPRS is a remote communication mode. The combination of the two becomes a trend of wireless network to realize information and network of the monitor object [1]. This paper presents design scheme of wireless network coordinator that combine ZigBee with GPRS technology, the design and complete of the scheme can meet the large scale remote monitoring requirement, and can be widely used in industry, agriculture, military and other large scale remote monitoring field.

II. THE SYSTEM HARDWARE DESIGN

This system mainly completes the data interaction of ZigBee network and GPRS network, ZigBee network building, node adding and deleting and the network maintenance work. ZigBee network node sends the data collected at scene to the ZigBee network's center node, ZigBee network center node connected to the Microcontroller via the Serial Peripheral interface. The Microcontroller processes the data and connected with the GPRS module by UART. GPRS module is connected to the Internet to realize long distance transmission of data. Therefore the system is also the gateway. The system is mainly composed by the Microcontroller. ZigBee module, GPRS module, external Flash, man-made machine interaction module, a clock circuit and reset circuit. The overall system diagram as shown in figure1

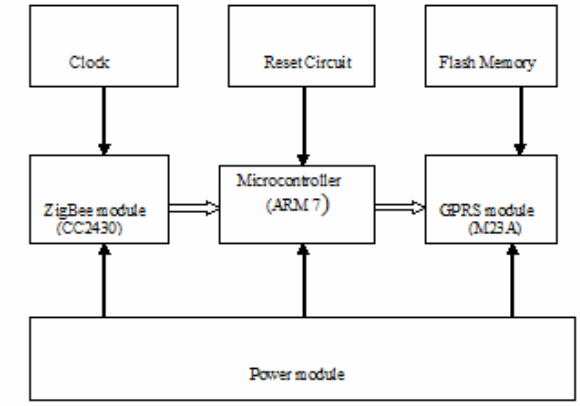

Figure 1: Diagram of the System

A. Microcontroller Unit

The Microcontroller module uses Philip's LPC 2119, which is based on a real-time simulation and tracking of 16/32 bits ARM7?TDMI-S CPU with 128 KB Microcontroller, and has an embedded high

speed Flash memory, 128 bits memory interface and a unique accelerated structure make the 32 bits code run at the maximum rate of operation. The processor's rich internal resources, strong processing ability and low power consumption is particularly suitable for this system's requirements for power consumption, cost, capability of data processing, it is the right choice to the system. Microcontroller LPC 2119 is intermediate layer of GPRS module and ZigBee module, which connected to M23A GPRS module through the serial port and ZigBee module CC2420 via the SPI interface. As the data interface layer of the GPRS data and ZigBee data, it achieves the two network data conversion through the software programming.

B. *The ZigBee Module*

The ZigBee module CC2420 is the first matches the 2.4 GHz IEEE 802.15.4 standard RF transceiver, introduced by Chipcon. The device include many additional features, and is the first RF devices for ZigBee product. Wireless communication devices developed by this chip supports data transmission rate of 250 kbps and can realize fast networking from multi-point to multi-point. The function of CC2420 is realizing the building of ZigBee wireless network, receiving data from the terminal nodes and sending command to the terminal node. LPC 2119 uses interruption to connect to CC2420 and communicates to it through SPI interface. The connection relationship of CC2420 and LPC2119shown in below figure 2.

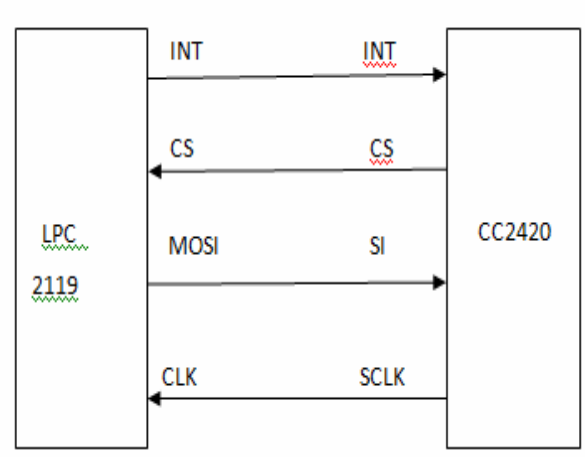

Figure 2: The connection relationship of CC2420 and LPC 2119

C) *The GPRS Module*

The function of GPRS module is to send data to the remote monitoring center of the staff's mobile phone and transfer monitoring center orders. We choose GPRS module M23A in this system, it is the GSM/GPRS GSM communication module launched by BenQ company, which integrates the complete RF circuit and GSM processor, and it is suitable for development wireless application products based on GSM/GPRS. GPRS communication circuit M23A module as the center which embedded TCP/IP protocol stack, and consists by the M23A module related peripheral circuits. The circuit portion includes M23A module power supply circuit, starting circuit, communication interface circuit module and SIM card interface circuit.

D) *Power Module*

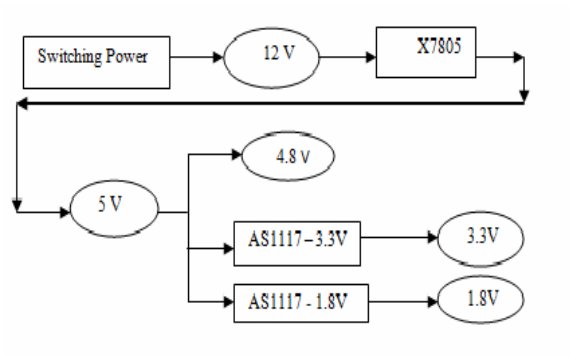

Figure 3: Diagram of power conversion relationship

In this system, a lot of chips have defferent operating voltages, LPC 2119 CPU working voltage is 1.8V, IO working voltage is 3.3V, ZigBee module CC2420 working voltage is 4,2V. So, the design of the power part is the key. Power supply module transfers relations as shown in figure 3.

E) *Peripheral Circuit*

In 2.4 GHz band, the rate of ZigBee network is 250 kbps, while the actual rate of M@#A module is much lower than 250 kbps. Therefore, the most likely the speed of bottleneck of the whole system exists in the GPRS uplink channel. Considering the ZigBee networks's data capacity is small within the scope of certain time, external 8 MB Flash memory of the system works as data cache, can effectively alleviate the data transmission bottleneck, and provides operation space for other application and μC/OS-II

Operating system. Clock circuit using 11.0592 MHz external crystal oscillator circuit, reset circuit use keys to reset, a man-machine interaction module selection uses Liquid Crystal Display and Key circuit.

II. The System Software Design

A)The Overall Software Design of the System

The software design of this system uses C language for the development of language and embedded μC/OS-II for the operating platform. The μC/OS-II is a free, completely open source, can be transplanted, curable, cutting out preemptive multitasking real time operating system. As with other operating system,The μC/OS-II begins from the main() function to carryout to complete the initialization of an operating system, task creation, and starting system. The network coordinator software design using hierarchical design ideas, different function is divided into different modules, each module uses API way together. The network coordinator software frameworks as shown in below figure 4.

In this system, the driver programs are: LCD driver, keyboard driver, memory driver program, UART driver, RF driver and so on. The underlying driver provides interface to the upper program. The network coordinator task, ZigBee communication task and GPRS communication task. Different tasks have different priority. The GPRS communication task has the highest priority, followed by ZigBee Communication task, Key task and display task. When high priority task is in execution, it will send a message to the message mailbox, enter the wait state and give up on the use of CPU, the low priority task received the message that high priority sends to it, it will start it's tasks. Now we put emphasis on ZigBee Communication module and GPRS module.

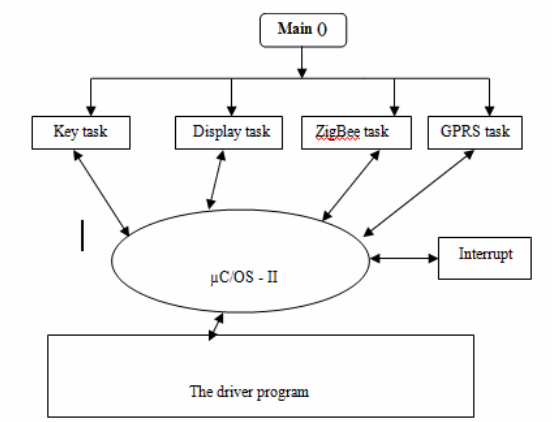

Figure 4: Software design diagram

B. The ZigBee Module Software Design

According to OSI model of ZigBee agreement, the module is divided into three layers: the driver layer, protocol layer and application layer [2]. The driver layer provides the hardware control and corresponding interface, protocol layer includes 802.15.4 protocol based on physical layer, data link layer and network layer. Application layer calls the service provided by protocol layer, and completes the system operation and the other communication module. The drive layer finishes establishment and management of ZigBee network. Establishment and management process of the network is as follows:

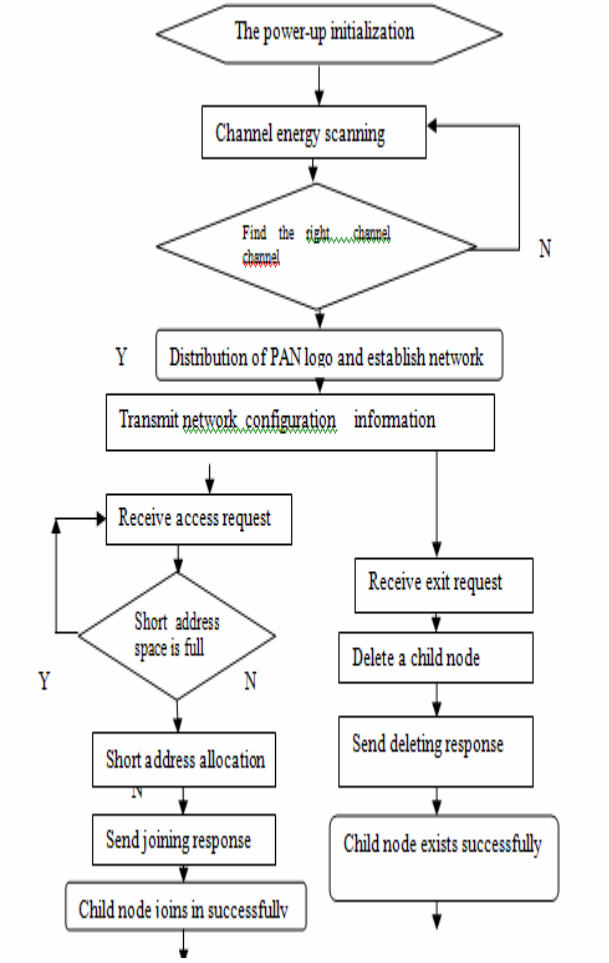

Figure 5: The building and management of network

The device of establishment ZigBee network must have the ability of ZigBee coordination. Therefore, it must be FFD device, and the device is not joined in other network. Coordinate establishes a new network through a network request primitive. When network construction started, the network layer management entity (NLME) first requests the MAC layer for channel energy scanning, scanning result is sent to the network layer management entity. Network layer management entity sorts the received energy, and selects the best channel to establish network. If you have found the right channel, network layer management entity assigned a unique PAN identifier for the new network, until now, a new network has set up [3]. The network coordinator device is a father device, then to be joining node is a child-equipment. Parent device establishes network, sets its own address as 0X0000, and transfers network configuration information by way of broadcasting. Child node searches idle state of channel when applying to join in the network, transmits a beacon frame. When receiving several beacon frames with link quality signal parameters, the child node chooses the better link quality node and sends access request to coordinator. After the coordinator permitting, it will assign a short address within the network to the node. When a node levels a network, it will send a request frame to father device node, the parent node receives the request, removes the node from the network and sends a response frame to node. Specific flow diagram as shown in figure 5.

C. GPRS Module Software Design

The M23A GSM / GPRS module has embedded TCP / IP protocol on the basis of the GPRS module. The user only need to call the corresponding AT command to set the module and the module itself will complete the GPRS network and Internet interconnect, then realize data transmission. M23A GSM / GPRS module has a set of standard AT command set, before we use GPRS module, we initialize the GPRS module and establish network connection through the AT command. After M23A GSM / GPRS module powers on, it is always in two kinds of pattern: command mode and online data transmission mode. When the module is in command mode, instructions can be directly sent to module through the serial port. Set parameter in command mode in order to enter the online data transmission mode. Online data transfer mode is no longer receiving AT command (in addition to the return command mode + + +), it can only transmit the data, and the input character will be sent as the data. The following is the operation of M23A GSM / GPRS module with AT command to establish a connection to the UDP process:

1) Enable all AT instruction function through the AT+CFUN = 1 command.
2) Make the M23A module sign in the internet through the AT+COPS = 0 command.
3) Activate the PCO string through the AT%CGPCO = 1, PAP,",", 1 command.
4) Set the access point of the network for China Mobile network through the AT+CGDCONT = 1," IP"," CMNET" command.
5) Set UDP server address and port number through the AT $DESTINFO =" 10.181.170.1", 25001, 0 command.
6) Establish a connection and enter the data transmission mode through the ATD * 97 # command.

When this 6 operation steps are successful, M23A GSM / GPRS module can be transparent data transmission through the GPRS network, any of the operation step's failure should repeat to send the corresponding commands until the operation success.

IV. THE ENDING

The system provides a design of the wireless network coordinator which combines ZigBee technology with GPRS technology. Using ZigBee technology to network speed, low cost, small power consumption and the characteristics of GPRS long distance communication characteristics, combining the two to achieve communication of long distance and short distance communication complement each other, thus achieving data long distance transmission. The design and completion this system can meet requirements of large-scale monitoring, and realize demands of intelligent and network of large scale monitoring object. The system has broad application prospects.

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