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Design and research of a universal & portable WSCN node configure instrument based on WinCE platform

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ABSTRACT

Wireless sensor and controller network node is an important component in Internet of Things as well as its design plays an important role in Internet of product development. To achieve and configure the signal strength, address, product information of WSCN node in the process of development, production, installation and maintenance is indispensable. In view of obtaining WSCN node basic information and configure instrument are rare, based on in-depth analysis of WSCN node's signal strength, address configuration, product attributes and other technologies, use of embedded software and hardware components of the design ideology, a scheme and implementation method about touchable and portable WSCN node configure instrument based on WinCE platform is advanced. Freescale's ARM Cortex-M0+ core KW01-Zigbee chip, which is officially released in 2014, work as the core of WSCN node's communication and the software framework is built on MQXLite-RTOS followed by the basic principles of embedded software engineering, which make the system have good portability and reusability. Action shows, the system is a new WSCN node configure instrument because of its steady communication ability, accurate and reliable data, good controllability, convenient use, which will be a good reference for the other instrument's development.

KEYWORDS

WSCN; WinCE; Universal; Portable; Configure instrument.

INTRODUCTION

WSCN (Wireless Sensor & Controller Network) is a wireless network configured with a large number of stationary or moving sensors in a self-organization and multi-hop network to cooperatively sense, collect, process and transfer information within the geographic area covered by network and eventually sends this information to the observer.

The United States has made various research projects on WSCN in 1988, 2001 and 2003, subsequently other research institutions in other countries also join WSCN research program[1]. Our country's research is synchronized with these countries, mainly in WSCN work of Tsinghua University, Shenyang Institute of Automation Chinese Academy of Sciences, Harbin Institute of Technology, Heilongjiang University[2].

Monitoring area is usually deployed a large number of sensor nodes in order to improve the portability of the system, abstracting WSCN node technologies in common for multi-level research. Each node has WSCN MAC address and the IP address corresponding to the MAC address, RSSI (Received Signal Strength Indication, a wireless communication strength), the chip temperature measurement and router setting. Inspect and configure these parameters, greatly improve the efficiency of the system's development.

Meanwhile, the current testing equipment is mainly a desktop computer or laptop. When performing field tests, needing come with the computer, power outlets, communication nodes, connect computers with communication nodes and run the application program. These series of steps consume time, which make the test inconvenient. In response to these problems, proposing a research program, that is a general portable configure instrument[3] on WSCN & WinCE[4]. The WSCN-UPCT-I-type instrument can be configured to monitor the operational status of equipment for real-time queries, fault detection and intelligent control. When accused of equipment failure, locates the cause of the failure, then reports to the testers. Testers can maintain the device according to the fault information. The product is suitable for the fields of industrial control, medical instrumentation, smart home, aircraft control[5] and in-car systems[6]. In a word, the instrument is applicable, which will have good prospects.

THE OVERALL DESIGN CONCEPT

The entire system is made up of monitor section and be-monitored section. Monitor section has a handheld device and a WSCN node, the other one contains a WSCN node and .The two WSCN nodes are separately named PC node and TEST node. The two nodes communicate through RF module following KW01-zigbee protocol. Completion of a serial interrupt reception, the serial interrupt de-framing, RF data transmission, RF interrupt reception, to achieve energy test, temperature test, CSMA/CA send, in order to achieve intelligent monitoring and configuration. System structure's shown in Figure 1.

We adopt Freescale Company's KDS as the bottom software's develop environment, handheld terminal section choose Visual Studio 2008 C#.

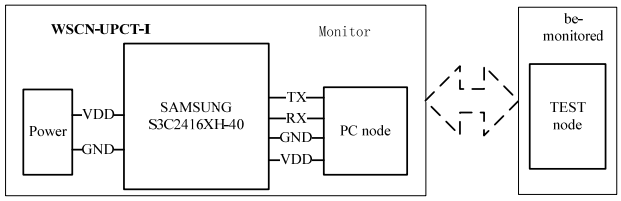

Figure 1 : System structure

SYSTEM HARDWARE ARCHITECTURE AND UNDERLYING DRIVE DESIGN

Adopt Freescale's KW01 as WSCN communication node, which has low power, high receive sensitivity and anti-jamming ability[7]. The software framework is built on MQXLite-RTOS, which is lightweight operating system. Operating system is responsible for the underlying hardware operation, the application calls the API interface provided by the operating system to obtain data collection via WSCN's RF module, then configure instrument run the application when powered in order to achieve human-computer interaction.

Hardware

Using the ARM Cortex-M0 + architecture Kinetis L series 8*8 mm 56-pin LGA package MKW01Z128 chips as KW01-Zigbee development board.KW01-Zigbee development kit hardware's shown in Figure 2. KW01 integrated in ARM Cortex M0+ kernel Kinetis KL26 microcontroller and a wireless front-end transceiver SX1231 chip with below 1GHz ISM frequency band, which has -40 centigrade degrees to 85 centigrade degrees working environment temperature as well as general software solutions and related routing protocol. So it can be used as WSCN node.

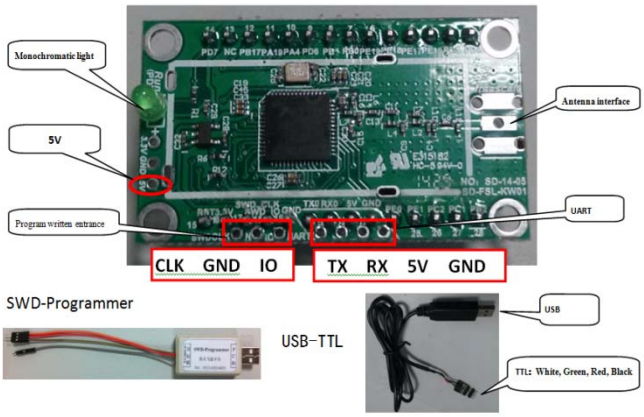

Figure 2: KW01-Zigbee development kit hardware

The monitoring system adopts SAMSUNG S3C2416XH -40 low power comsumption processor, which has a working frequence of 400MHZ when it is in the highest state, at the same time. The system is loaded with 64MB DRR and 256MB NAND Flash, with which the system can fully satisfy with the hardware requirement of WinCE OS.

The underlying drivers portable component design

In order to improve the portability of the program, we use component-based programming ideas to name the component, such as for "RF" module, we use the "rf" to name this module. Each component contains a header file (*.h) and source files (*.c)[8].

Among them, the header file contains only the external interface function declarations, which represents the user's guide of the component, and the source file contains the external interface functions, and source code. The bottom software of the system's shown in TABLE 1 and TABLE 2.

TABLE 1: The bottom of the drive member Package

Component	Source/header files
gpio	gpio.c gpio.h
rf	rf.c rf.h
……	……

TABLE 2: The bottom of the drive member Package

Files	Description
gpio.c	Each function source code
gpio.h	The basic function of a function declaration: 1.void gpio_init (uint_8 port, uint_8 dir, uint_8 state): Initialize port pins as designated gpio pins 2.void gpio_set (uint_8 port, uint_8 pin, uint_8 state): Set pin state 3.uint_8 gpio_get (uint_8 port, uint_8 pin): Get the designated pin status 4.void gpio_reverse (uint_8 port, uint_8 pin): Reverse designated pin output status 5.void gpio_pull (uint_8 port, uint_8 pin, uint_8 pullselect): Make the specified pin is pulled high or pull-down
rf.c	Each function source code
rf.h	The basic function of a function declaration: 1. isr_uart0_re ():UART0 receive interrupt handler. Receive serial data, call CreateFrame () to frame, then set of serial receive event bits Event_Uart0_Re, start de-framing task 2. task_uart0_re (): UART0 data de-framing. Judge serial receive event bits Event_Uart0_Re, analyse serial receive data frames

	3. task_rf_send(): RF send task. Judge RF send event bits Event_RF_Send, call RF_SendData () forwarding the received test packets 4. gpio_CD_ISR():RF Interrupt handle. Entry into the receiving RF interrupt, set corresponding receive events Event_RF_Recv, start RF to accept the task task_rf_Recv() receive task 5.task_rf_Recv():Judge RF receive event bits Event_RF_ Recv, call RF_ReceiveFrame() to receive Test Node loopback
……	……

WSCN NODE DESIGN

WSCN node has an IP address, MAC address, RSSI, chip temperature, RF temperature, hardware/software version number and other system parameters, which can be divided into two types, these are settable system parameters and unsettable system parameters. System parameter settings is shown in Figure 3.

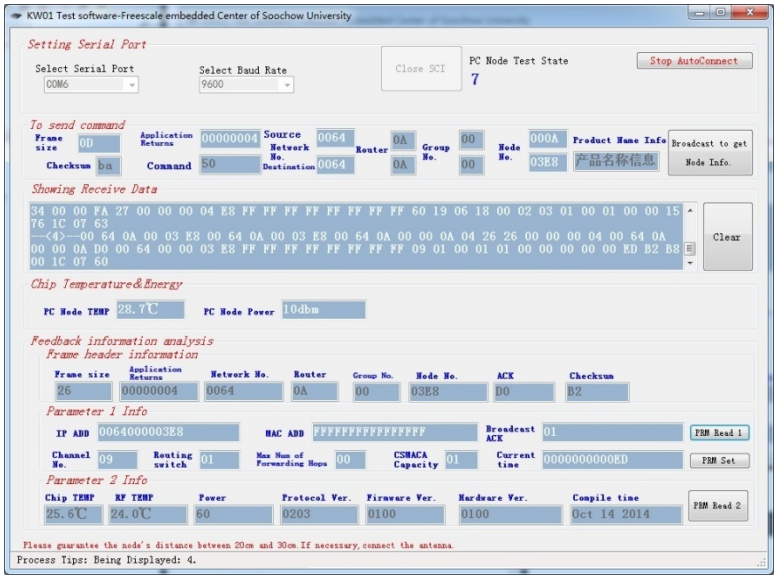

Figure 3: System parameter settings

RF component of KW01 is used to achieve 433M frequency wireless transceiver functions, which complies with 802.15.4 protocol, provides interface to complete the initialization, the transmit data, receive data, the energy test, temperature test, CSMACA transmission and so on. PC testing software sends test packets of 60 bytes to PC node via the serial port, PC node receives the packets and forwarding them to the TEST node via serial port. Test node receives the packets by RF, samples the local node's chip temperature, and the energy value, then put them in transmitted data's first three bytes. Then writes to the flash, in order to test the Flash read and write functions. Forwarding the 60 bytes of data to the PC node, PC node samples the local node's chip temperature, and the energy value ,then put them in transmitted data's first three bytes. Finally, PC testing software will receive the data packets and the configure instrument will display.

TERMINAL DESIGN

KW01-zigbee module protocol

KW01-zigbee module stack complies with and extends the 802.15.4 protocol, the specific implementation is divided into the physical layer, MAC layer, NET layer, application layer.

The physical layer only receives or transmits physical data, in order to complete Rf's initialization, the transmit data, receive data, the energy test, temperature test, CSMA/CA test; MAC layer is used to packet and parsing the data, and set various parameters, including the MAC address, IP address, Node number, routing mode, CSMA/CA mode and broadcast mode; NET layer encapsulate protocol stack for parsing NET data, read and set various parameters, including net layer initialization, net data processing, net response processing, net data transmission, parameter read, parameter settings, etc; Application layer is used for implementing specific projects related to application processing.

Each node in the network has a fixed node number and address. The packet format is an important part of the communication protocol, the communication protocol packet frame format's shown in TABLE 3. Frame size contains the length of the field itself from the beginning to the end all the checksum byte length (maximum length of 100 datas), checksum is accumulation of the single-byte. Here, we use CRC to check, which is a data transmission error detection mode.

TABLE 3: Communication protocol packet frame format

Cotent	Byte
Frame size	1Byte
Application return	4Bytes
Network address	2Bytes
Address fields	4Bytes(1byte route. 1byte group no., 2bytes address)
Command	1Byte
Command content	NBytes
Checksum	1Byte

The commands can be defined by users to control the monitored device on application layer. When replacing the monitored device, you need to reload the device information, which will increase the workload of the developers. Here, we define a common framework in ZigBee, a package of all system commands, and in the end of the underlying code, as well as define the corresponding commands in the header file (includes.h), to make synchronous updates. Some commands are listed in TABLE 4.

TABLE 4: Some system commands

System command	Command meaning	Acknowledge
0x00	Switch lights	Terminal controller returns the current state of the light switch after correctly received, otherwise returns an error response frame
0x01	Switch lights setting	After the terminal controller receives, return acknowledge according to the received response frame
0x02	Power Query	Terminal controller returns the current lamp power (percentage) if received correctly, otherwise returns an error response frame
0x03	Power Adjustment	After the terminal controller receives, return acknowledge according to the received response frame
0x06	Query protocol, software, hardware version information	Terminal controller returns version information after the response frame is correctly received, otherwise returns an error response frame
0x0A	Terminal controller reset command	After the terminal controller receives, return acknowledge according to the received response frame
0x0B	AD value query	Terminal controller returns the AD value of specified channel (response frame A8) after correctly received, otherwise returns an error response frame
0x0F	Zigbee module reset time setting	After the terminal controller receives, return acknowledge according to the received response frame
0x10	Set switch lights by MAC address	After receipt of the terminal controller, the corresponding operation, does not return the response frame
……	……	……

Portability

The configure instrument's input power voltage is 9V ~ 28V DC power, here we provide a voltage of 12V.

Series three 3.7V lithium battery, then add a polymer protective plate protection circuit, constitute a complete power module. Specific circuits shown in Figure 4. The output in Figure 4, should also be charged the end, you need pay attention to the polarity when connecting the battery.

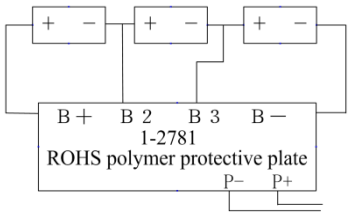

Figure 4: Power circuit diagram

Monitoring functions achieve

Here we maintain a mapping table file, the file contains the MAC address and device type. Load the file into the program map table when the configure instrument start up. When communicates with surveillance equipment, first scans the surrounding equipment, and connect with one of the established connection. Then queries the device MAC address exists in the mapping table, and if not, manually select the device type, registered and added to the map and files by different logic judgement. This part of the flow chart shown in Figure 5.

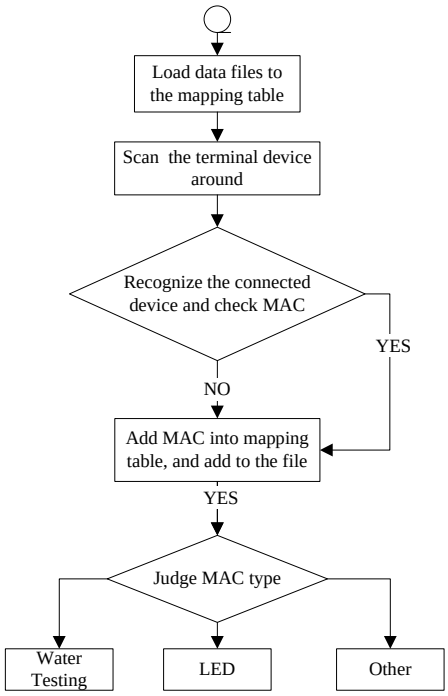

Figure 5: Monitoring equipment flowchart

Auto-Run application

After completing the development of application, compile and deploy, then download it by synchronic software or copy it by U disk to the Configuration Device's flash, which can support permanent storage, instead to the RAM, for the latter will lose data when power down. Add the application to the mapping and modify the registry to make the application auto-run[9]. User applications will run on the device with WinCE operating system[10] when powered. The Configuration instrument has been successfully applied in the Road Lamp Control System of Suzhou Huaxiang Information Technology Co.Ltd. The result of the experiment shows that the Configure instrument communicates stably, manipulates conveniently, and low-cost, which can be used in many fields.

CONCLUSIONS

This paper presents a WSCN node configuration scheme based on WinCE, which communication by KW01.Final results show that the scheme is feasible, and has been proven in practice, and can be a good reference for the other instrument's development. This configure instrument has good appearance, beautiful interface, low-over, green energy and strong communication functions, which will have good market in many fields. In the future, we will do some work about memory optimization to make it better used in various fields.

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