Applied Mechanics and Materials Vols. 71-78 (2011) pp 2276-2279
Online available since 2011/Jul/27 at www.scientific.net

doi:10.4028/www.scientific.net/AMM.71-78.2276

A ZigBee-Based Indoor Intelligent Lighting System Research and Design

Chaoze Lu[1,a] , Xiang Yang[1,b] ,Wei Pan[2,c]

[1]School of Information Science & Engineering, Guilin University of Technology, Jiangan Road No.12 Guilin, 541004, China

[2]School of Mechanical and Control Engineering, Guilin University of Technology, Jiangan Road No.12 Guilin, 541004, China

[a]luchaoze@126.com,[b]yangx@glite.edu.cn,[c]243546041@qq.com

Keywords: ZigBee; Intelligent Lighting System;Wireless Sensor Network

Abstract. The traditional lighting control system has many defects such as poor energy-saving effect , comfort , management and control technique. What's more troublesome wiring is also a problem. This paper is based on the ZigBee wireless technology and designed a low-power dissipation intelligent node control hardware platform.Which used the MSP430F2619 for processor of TI company, CC2430 RF(Radio Frequency) chip and silicon controlled dimming circuit. It is designed with software that has different lighting modes according to the different environments.The design achieved the brightness autoregulation of light in different environment-s.Therefore create a comfortable household environment.

Introduction

With the quality of life improvement, the traditional lighting system can hardly satisfy human needs.This is a new kind of indoor intelligent lighting system which is designed according to humans demand and the drawback of the traditional lighting system.The design adopts the ZigBee wireless sensor technology which has many advantages such as low rate,low-power dissipation,close range and cheap consumption. The system can effectively solve the problems.For example,lights are long time turned on even if with no people.

System Overall Design Project

This intelligent lighting system is consisted with PC terminal,coordinator nodes,routing nodes and terminal nodes.As shown in Fig 1.The platform of system is based on wireless sensor network which is with mixed star type and mesh topology structure. Subsystem in every room adopts the the star topology structure network.It includes a routing node and several terminal nodes.The routing and coordinator nodes between rooms adopts the Network topology structure network .Coordinator nodes can be connected with PC and supervise the entire network operating conditions. The network topology structure and the working state of nodes can be displayed on PC terminal interface. The coordinator nodes can also send demands to routing nodes and preset corresponding room's lighting mode. All the nodes' wireless communication adopt the ZigBee protocol.It works at the free application frequency of ISM. ZigBee works in the 868MHz of Europe,915MHz of America and universal 2.4GHz. Besides ,the bus capacity is subnet with 254 nodes and major network with 65000 nodes. Above parameters show that ZigBee can fully satisfy the demands of this intelligent lighting control system whatever in the aspects of price or capacity.

Design of hardware

Choice of Micro controller .MSP430 serial microprocessor(MCU) is made by Texas Instrument(TI) company and it is a 16-bit mixed signal processor base on RISC. MSP430F2619 is a new latest product of TI compared to previous products, CPU clock of it is increased to 16MHz.The standby current is reduced to 1uA.The sleep mode is increased to 5 different kinds so we can adjust it

flexibly.The response to wake up the sleep mode is reduced to 1us.It has lower power dissipation.The Flase capacity is increased to 116KB so the external storage memory is not needed.What's more it improves the performance of the MCU.Take every performance into account,this system chooses MSP430F2619 as MCU.

Design of light adjusting circuit. The schematic of light adjusting circuit is shown as Fig.2.The daylight lamps are power supplied by Mains supply and the light-sensitive diodes and MCU are power supplied by battery.The circuit works as follows:The light-sensitive diode HP100CL03 change the light intensity into current value and with the load resistance current is changed into voltage value then be sent to A/D of MSP430F2619.The collected digital signal is compared with preset value in the register.If is smaller than threshold means that outside has weak light intensity.So daylight lamp should be increased .If not then reduced it.The control of Lamp brightness is achieved by alternating current zero examination .The PTA0 pin of MCU is to collect the digit of zero-crossing point.The PTA1 pin is used to control the three-ending bidirectional silicone switching to open.

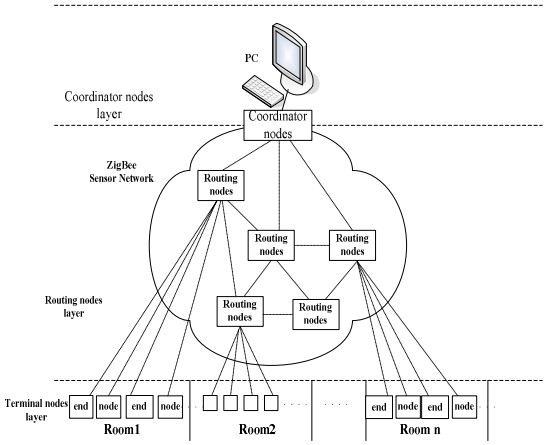

Fig .1 Hierarchy structure of system

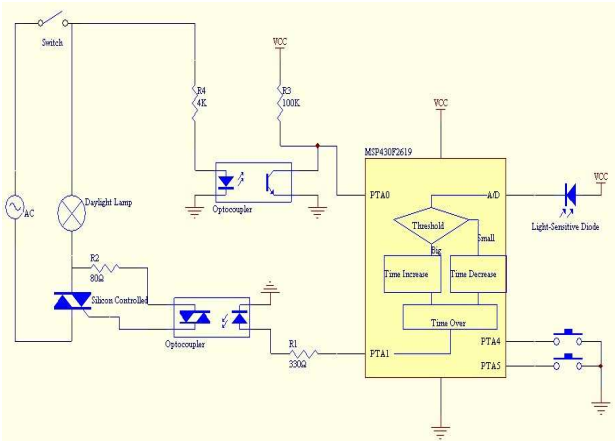

Fig.2 Schematic of light adjusting circuit

Choice of RF(Radio Frequency) chip. The CC2430 is a true RF(Radio Frequency) chip up to ZigBee standard with 2. 4 GHz.It insists on the framework of 2420 chip and adopts 0.18 um CMOS productive technology.The CC2430 combines the excellent performance of the leading CC2420.It includes RF transceiver with an industry-standard enhanced 8051 MCU, 32/64/128 KB flash memory, 8 KB RAM,A/D transistor,4 timer,AES128 security coprocessor,programmable watchdog and USART,32KHz Crystal Oscillator Sleep Timer,power on reset circuit,power off detecting circuit and 21 programmable I/O-pins.In the receive mode,the 2.4 GHz radio-frequency signal received from antenna amplified by low noise amplifier will be down-conversion to 2MHz intermediate-frequency signal.Then the signal will be processed by inputing to the system after its filtering and amplification and be changed into digital signal by A /D transistor.In the send mode,a mapping and modulation is completed according to the IEEE 802. 15. 4 standard. The modulated baseband signal were transformed by D/A transistor and then will be modulated by single sideband amplitude modulation into intermediate-frequency signal .After that the intermediate-frequency signal will be filtered by low-pass filtering and directly down-conversion to radio-frequency signal.Finally it will be transmitted by RF antenna after amplified.Compared to CC2420,CC2430 has lower sleeping current and higher receiving sensitivity. Therefore,The system chooses RF chip of CC2430.

Design of entire hardware platform. According to the selected hardware elements such as MSP430F2619 processor module,CC2430 RF communication module, lighting adjusting circuit module. The general structure of the node hardware platform is shown in Fig.3.Among which the sensor module is chosen by different environments' needs. Including IR infrared sensor, light acquisition sensor and so on.

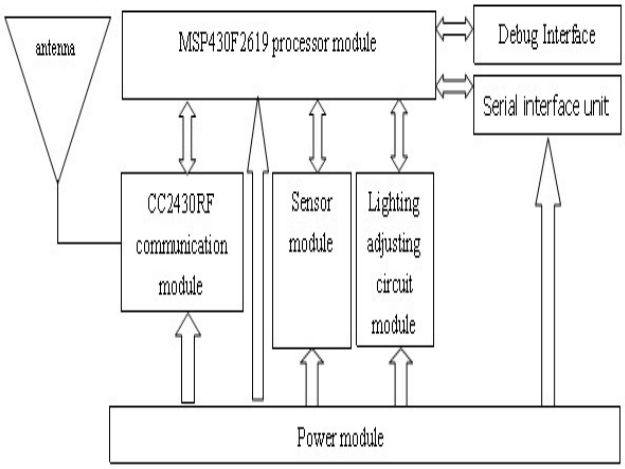

Fig.3 Hardware platform diagram

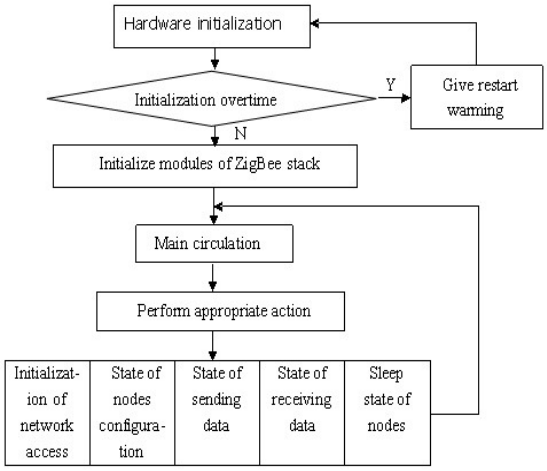

Fig.4 Software structure of network node

Design of software

Software design of network node. Terminal node involves access initialization,node configuration,Sending and receiving data,modes such as free, sleep and so on.The architecture of nodes' software design is shown in Fig.4.After power-on,the first thing is hardware initialization.All modules are initialized according to ZigBee.Specific module is worked according to the decision of main program circle.The realization of routing nodes software is as follows. System parameters will be initialized after its power-on.For example,setting parameters of wireless module,internal variables and state machine .Routing nodes are mainly to transmit digits.When there's no transmission,it turns to sleep state.It sets the corresponding lighting modes according to the home environmental information collected by terminal nodes.Meanwhile they are also responsible for communicating with coordinator nodes which are interact to data centre on PC.They work as an coordinator in WSN.After the power-on initialization,coordinator will create a network and other node are permitted to add in.Then detect wireless signals circularly.If receiving access applications of nodes,the nodes will be allowed to access the net and give each network address.If Upload data are received,it will be transmitted to data centre.When the commands from data center are received,it will perform an appropriate action after analysis.

Design of system communication control. Fig.5 is the flow chart of system communication control.After the system start,terminal nodes and routing nodes will transmit with a fixed period its IP and work state information to coordinator.Terminal nodes transmit to Upper routing nodes directly and the routing nodes will transmit to coordinator nodes by the way of multiple hops.Protocol nodes send the relevant information that received terminal nodes and routing nodes to PC by serial bus RS232 and the PC displays the system states.Such as some nodes are at the state of lack voltage or some communication failures happen.If PC shows that system is OK,each subsystem will enter self-control mode.After that,routing nodes will judge the corresponding lighting mode according to the information such as number,position of people and light intensity indoors and so on.Then send to the terminal nodes that control the lights.This terminal nodes respond by such operates that turn on,trun off or adjust the light intensity.

Scenario system test

I set up a demonstration system that aimed at modern home as a simple example shown in Fig.6. In the aisle has a coordinator node and a routing node in the house. With number1, 2, 3, 4, 5, 6, 7, 8, 9 terminal nodes and three control nodes X, Y, Z.With a light A in front of door,light B near bed ,light C in living room, desk lamp D,two wall lamps a and b on the sofa and wall lamp c on TV.

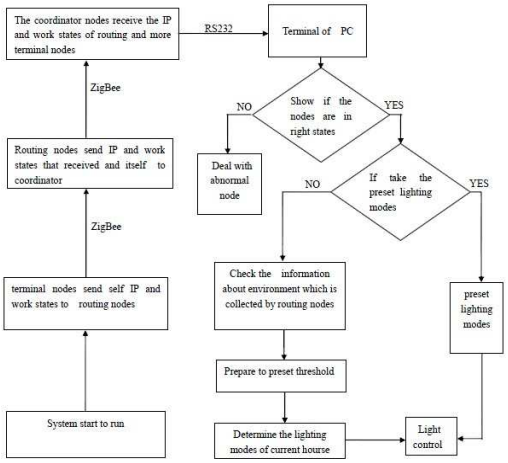

Fig.5 Flow chart of system communication control

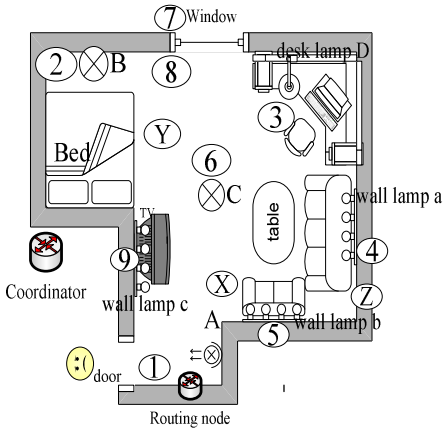

Fig.6 Design of Scenario

Conclusion

This paper introduces a kind of based on ZigBee indoor intelligent lighting control system. Compared the traditional lighting control system, it has a lot of advantages.Its wiring is concise , lighting control intellectualization.According to demand oneself can adjust the brightness of the light. It has considerable energy saving effect, extend the life of lamps and lanterns, scene change flexible, favorable to improve the environment of comfort. Therefore, based on ZigBee indoor intelligent lighting control system has good development prospect, will produce certain economic value and society value and can for building the saving-type society to make an important contribution.

References

[1]Liang Zhang.Based on ZigBee technology intelligent household environment monitoring system[D].Wuhan University of Science and Technology Vol.8(2009), p.41-42.in Chinese.

[2] O. D. Incel, L. van Hoesel, P. Jansen, and P. Havinga.Mc-lmac: A multi-channel mac protocol for wireless sensor networks. Ad Hoc Netw Vol.9(2011),p.73–94.

[3]Xu Yong etc.Based on ZigBee technology intelligent lighting system design. Research and Development Vol.1(2010),p.42-45.in Chinese.

[4] Xiaoyong Zhou,CAI Jian Ping etc.Research and implentation of novel intelligent indoor light control system.Application Research of Computers Vol.8(2009), p.2997 -2981.in Chinese.

[5]Sha Man.Design of embedded wireless smart home gateway based on ARM9. Journal Computer Application Vol.9(2010), p.23-24.in Chinese.

[6]Jing Fan, Shitang Yin, Qiong Wu, Fei Gao, "Study on refined deployment of wireless mesh sensor network",Pr International Conference on Wireless Communications, Networking and Mobile Computing, Print ISBN:978-1-4244- 3708-5, September 2010,p.1-5,doi:10.1109/ WICOM.2010. 5601354(IEEE Xplore).

[7]Information on http://focus.ti.com.cn/cn/tihome/docs/homepage.tsp

[8]Information on http://www.feibit.com/bbs/forumdisplay.php?fid=18

Frontiers of Green Building, Materials and Civil Engineering
10.4028/www.scientific.net/AMM.71-78

A ZigBee-Based Indoor Intelligent Lighting System Research and Design
10.4028/www.scientific.net/AMM.71-78.2276