

Microcontroller_based smart house

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Abstract

Home automation system is one of the essential necessities in modern life to have a secure house when you leave the house, it also used to control and monitor home devices automatically. The purpose of this paper is to design and develop an efficient wireless ZigBee-based home automation and security system. The system consists of a number of microcontroller-based Printed Circuit Boards (PCBs) that could be distributed across a building for perform a specific task which are connected to the master microcontroller-based PCB. Each PCB should be linked to the master PCB through wireless network system (ZigBee module).

Keywords: Smart house, ZigBee, Microcontroller, and “Arduino” (C based) programming

Introduction:

Developments of technology and improvements in microcontroller systems make life simpler and more secure. In our daily life, automation systems are improving rapidly. Home automated system plays the main role in requirements of modern life and could be preferred by many householders over manual system.

Home automation security system is one of the appliances that have been benefited from an advancement of electronic technology. There are many types and designs of home automation systems, which can be achieved in the world; they control many of electrical devices such as lights, heaters, doors, blinds, etc.

Different communication systems can be used to connect all parts in a smart home system. The aim of this connection is to control and monitor all subsystems together. In this paper a ZigBee based system prototype has been invented as a home security system.

The system consists of four modules, these modules are as follows: Security/ Alarm system, temperature controller, light controller and automated blinds controller.

Review Other Systems

The concept of “smart home” has been proposed for many years, which started from very simple system to microcontroller based wireless home automation system.

The term of “Smart House” was used in an official way by the American Association of House Builders in 1984. (Harper 2003, 1). Smart house is one of the real possibilities in modern world.

(Han, Sch. of Comput. Sci. & Eng. and Lim 2010) Suggested a new smart home Energy Management System (SHEMS) based on ZigBee and IEEE802.15.4, which was named as a zigbee sensor network. In this system, a new routing protocol Disjoint Multi Path based Routing (DMPR) was developed in order to improve the performance of our ZigBee sensor networks

(Malhi, et al. 2010) designed and developed a smart noninvasive wearable physiological parameters monitoring device. The system could be used to examining the physiological parameters, such as temperature and heart rate of a human being. This system includes an electronic device that is worn on the wrist and finger by an at-risk person.

(Byun, et al. 2012) implemented a smart house that based on self-adjusting system. The system has been applied in real test bed and conducted an experiment, which made the system's energy consumption been reduced.

In this paper, we propose and implement a Microcontroller based smart house using zigbee wireless protocol. The efficiency of the system is increased in both the reduction power consumption and robust security.

System Architecture and Design

The Architecture system consists of three main parts, which are the hardware, software and communication system that explain them below

1. System hardware:

System hardware is all the physical items that are used to build the project such as Microcontroller, sensors, and actuators. All hardware components should be checked to make sure they perform as required. There are three main devices. First one is **Microcontroller (ATmega328P)**: that is a basic computing device. All computers should have several things in common include; CPU, RAM, and I/O devices. The reasons of using microcontroller are because they are small and low cost, portable (which are "embedded" inside some other device)(Brain n.d.)

The second group is **Inputs - Sensors**: The main inputs that are included in such systems are: Light Dependent Resistors (LDRs), Thermistors, Potentiometer, Motion sensor, and Tactile switches Keypad. The last group is **Outputs – Actuators**: The main outputs that are included in such systems are: Light Emitting Diode (LED), Liquid Crystal Display (LCD), and DC motor or Direct Current Motor,

Hardware Design:

The project consists of four sub-systems. All of them are connecting to the master node through wireless ZigBee protocol in star topology.

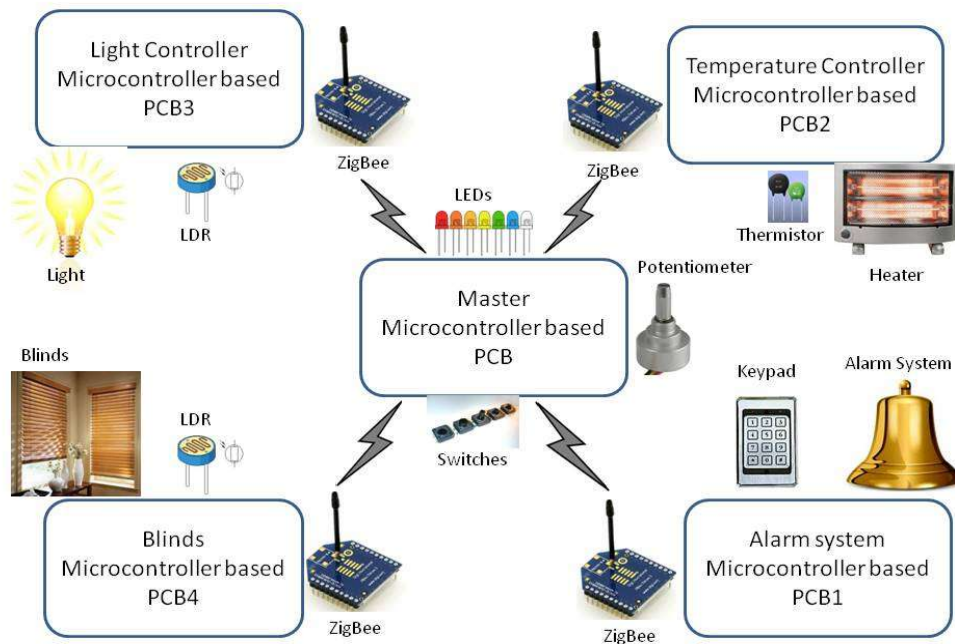


Figure (1) hardware design

2. System Software

System software is the program run within the system hardware and used to test the program hardware structure. This system implemented by using the following software. The first software is **X-CTU**: MaxStream publicizes the X-CTU software for configuring and testing MaxStream radio modems includes XBee (ZigBee). The second software is **Arduino Software**: The Arduino language is a modified of the C++ programming language, but it uses built-in libraries to simplify complex coding jobs to make it easier for users(John-David Warren 2011). The third one is **LabVIEW**: which is stands for Laboratory Virtual Instrument Engineering Workbench, is a graphical programming platform, which is used to develop projects from design to test and from small to large systems(LabVIEW System Design Software 2013).

3. Communication module

ZigBee is a wireless networking standard for home automation and personal network, which uses for transferring low data rates if it is compared to other wireless protocols(Gislason 2008). ZigBee is a short range, low complexity, low power consumption, low data rate, cost-effective and two way wireless communications features (Zhang, et al. 2012).

Experimental result:

The designed and implemented system works properly and each node (sub-system) does a specific task. The task of each sub-system illustrates briefly with its final circuit board.

Master node: This node displays current date and time that is managed by RTC (Real Time Clock). Master node also monitors all other nodes, which accesses them through wireless ZigBee and tactile switches have been used to change the menu to go through the other nodes.

Security (alarm system) node

This node has been designed and implemented to execute the alarm system. A keypad is attached to this node that is used for entering security code to set/reset the alarm system.

This sub-system measures and displays the temperature of the room. It also controls turning on/off heater and fan depending on temperature level in the area. A potentiometer has been attached to the board to set the SetPoints (Minimum and Maximum temperature).

2.1.1. Lighting and Blinds controller

This node of the system controls rolling up/down the blinds and turning on/off the lights. The sub-system has been designed and implemented to roll up the blinds and turn off the light in the mornings and roll down the blinds and turn on the lights in the evenings. A motion sensor also has been attached to the board to turn off the lights in unnecessary times.

Result

The project is designed and developed a number of PCB boards connected to sensors and actuator in a house, these boards include;

- Master PCB, which manages and monitors all other PCBs.
- PCB1 is responsible for security system.
- PCB2 is responsible for temperature system.
- PCB3 is responsible for lights system and blinds system.

Each board has been designed and implemented, and they all do their tasks as desihned. They connect to master PCB through wireless network (ZigBee). Now the XBees (ZigBee)s are attached to the system to perform wireless communication which operates in specific area that is up to 15 m inside building and 50 m outside building.

This system has been applied in one house for a week, and we noticed that the power consumption decreased from 200 to 150 kilowatt. In terms of the security system, it is armed to be ready for setting alarm system once an unauthorized person wants to open doors or enter the house without using correct code.

Conclusion

The project was designing and developing a wireless ZigBee-based home automation and security system. The system includes a number of microcontroller-based Printed Circuit Boards (PCBs) that have been distributed cross a building for doing specific task.

The project has proved to provide to decrease power consumption and made a secure house. There are many studies on smart house but we have gained some experience from practical use that the system will work properly over 50 m outdoor and 15 m indoor, which, traveling data between nodes can be blocked due to walls, closed doors and windows, and other objects that transmit and/or receive radio waves.

The system has been programmed in “Arduino Language” (AVR C programming) using Arduino compiler and integrated with LabVIEW as user interface.

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