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Research paper

Design and Implementation Smart Home Alarm System with Zigbee transceiver

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Abstract

The smart house system is a significant area for the Internet of Things (IoT) with appropriate demands that structure for the smart home usages. The proposal for the smart home system (HCS) via IoT built in XBee is presented in this paper. The system design uses XBee wireless technique communications, which is able to send and receive the transmission data between the central controller unit and various house sensor nodes to reading and sending Temperature, Gas Sensing and IR Security information. The tested results illustration the wireless monitoring usage for the ability is recognized. The control proposed system design is simple and achievable, which can be used for smart house remote monitoring extensively.
Keywords: *House Control System (HCS), Wireless Sensor Network (WSN), ZigBee, Arduino.*

1. Introduction

When electrical energy and information technology were introduced into households at the end of the 20th century. The use of electrical household devices has increased rapidly. It created the need to automatize and control the living environment, and this is where the term "Smart House" originates from. A "Smart House" is commonly defined as an "automatic networking technology for integrating the equipment with appliances which the complete house be able for observed with controlled centrally such as a single device. Even though the idea of a smart house existed before, system implementation was possible only after appropriate technical solutions were offered. With the appearance of a microcontroller, cheap processor production and personal computers, the smart home system has become cheaper and more accessible. Today, it is possible to have a low-price, fast and simple home control system HCS.

In order to achieve this level of complex automation, the HCS should be modular and robust. When upgrading or downgrading the system (depending on the end-user needs) with various types of sensors, switches, valves, motors, etc., the HCS has to be stable, adaptable and responsive. To achieve a stable, adaptable and responsive system, future work should be focused on expanding hardware support and running stability tests for various elements and operational conditions. Considering HCS software, extra functionalities should be implemented to expand and simplify the user's interaction with the system. It can be accomplished with the implementation of speech and face recognition software, probabilistic behavior recognition methods and creating a simple, efficient and enjoyable user interface. The primary goal of the HCS was to ensure a more comfortable and easier way of life. In a short period of time, the primary goal of the HCS was expanded to optimize energy consumption and increase environmental safety. Today, the smart home system unifies devices managing lighting, windows, doors, heating, air conditioning, security and surveillance, various multimedia devices.

2. Related Works

In this section, some considered changed techniques using Arduino and ZigBee technology System with their features are presented. Fang Chen, Linlin Qin [1] presented the ZigBee with temperature with humidity sensors was usage like sensor node, a fan and the wet curtain formed as two controller nodes which are respectively connected with the ZigBee module.

Jun-Long Pan and Chia-Ju [2] presented Smart Home Monitor & Supervisor (SHMS), using ZigBee techniques, the sensors with actuators that attached via a ZigBee technique system. The design is a simple smart socket, that works remote control by ZigBee.

Nazrul Nayan and Ili A.M. Ikhsan [3] presented design and improvement of ZigBee technique, that functions as a communication channel for hardware and sensors in a home automation

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method for smart houses. An (LCD) is used to show the system output on a receiver.

Hiro Gabriel Ferreira, Edna Dias [4] presented prototypical built from standard technology for allowing occasion sense with controlling for electrical equipment's, then extant with advanced developing, over the RESTful or UPnP techniques to enable expansion is easy for uses which be able to efficiently improving the life through an apparent interface by regular public.

3. System Implementation

In this paper, a design with the implementation of the device to a proposed structure is presented. The structure scheme has two parts: hardware with software. The hardware part has components of the design (Arduino Uno, ZigBee, LM35 Temperature, MQ-2 Gas, and Infrared Radiation (IR) Sensor) and software part is the programing language in this paper using Arduino C that written and saved in the Arduino Uno (the code) with procedures which run and control hardware.

3.1. Arduino

Most hardware modules for design are based on Arduino that suggested for microcontroller, form scheme, the device contains one principal microcontroller. Arduino Uno is constructed on the ATmega328 microcontroller as shown in Fig. 1. [5].
Arduino has 14 digital input/output pins (6 pins can be used as PWM), 6 analog inputs, 16 MHz quartz crystal, USB connection, power jack and ICSP header with a reset switch [6].
Arduino software is set of commands using the code in language Arduino C program then tell hardware procedures that do then can to do it. Arduino program, that characterized from Arduino integrated development environment (IDE), that using for progress with for estimating the designed system [6].

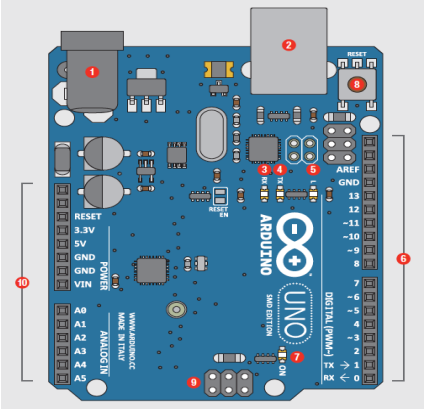


Fig. 1: Arduino UNO

3.2. XBee

The operation of widespread is currently wireless transmission methods, such as Wi-Fi, WiMAX, LTE, etc., based on the use of radio frequency channels and ZigBee [7].
XBee technology is the exposed global standard manufactured for IEEE 802.15.4 MAC/PHY. It describes a network layer over 802.15.4 that supporting progressive net routing abilities [8].
And using the AES method for the encryption, The AES method is a symmetric-key secret message that is in cooperation with the transmitter and the receiver to employ a solitary key for encrypting and decrypting. The data block length is unchanging to be 128 bits, although, the length is possible to be 128, 192 or 256 bits. Additionally, the AES is an iterative procedure, every iteration is known as a round and the overall number of rounds is 10, 12 or 14 if key length is 128, 192 or 256 in that order. The 128-bit data block is split into 16 bytes. These bytes are configured to a 4×4 array called the state and the entire inner processes of the AES algorithm are carried out on the state (Karthigaikumar and Rasheed, 2011) [9].
Many wireless sensor networks have utilized ZigBee as the communication technology among its sensor nodes, especially the networks that are using grid topology such as [10], [11].
ZigBee interacts member circuit with sensor techniques to the innovative category for wireless, small, little power network techniques, that using several techniques for their advantages, like a low (complexity with power consumption, with cost), great (efficiency with reliability) with the network coverage zone that very much wide [8].
ZigBee confused with XBee mostly. These modules are distinct from each other, ZigBee is a communication protocol, when XBee supports ZigBee.
The XBee module can be used as a medium for interaction and a communication module between microcontrollers and serves as a wireless network for data transfer. Two types of XBee devices are used in home automation: XBee S1 and XBee S2[6].

Table 1: Comparison of characteristics of Bluetooth, WLAN and ZigBee [3].

Characteristics	Bluetooth	WLAN	ZigBee
Protocol (IEEE)	802.15.1	802.11b/g	802.15.4
Range (meters)	10	50-100	10-100
Data rate (bits/s)	1 M	11 & 54 M	20, 40 & 250 k
Battery lifetime (days)	7	0.5-5	>100
Operating frequency (Hz)	2.4 G	2.4 G & 5 G	868 M, 902 -926 M & 2.4 G
Complexity	High	High	Low
Power consumption (mW)	198	1050	72
Security	64 &128 kbits	IEEE802. 11i (WPA2)	128 bit AES & application layer security
Application	Wireless communication	Internet, website & e-mail	Control & Monitoring

3.3. LM35 Temperature Sensor

LM35 series is an accurate integrated circuit temperature devices. The sensor does not require any external adjustment or else extra for delivering usual precisions from ±1⁄4°C in a room with ±3⁄4°C, within complete range from −55 to +150°C [12].

3.4. MQ-2 Gas Sensor

MQ-2 gas sensor can detect some gases. Sensitive material for SnO2, then for fresh airborne have a lower conductivity. The sensor takes high sensitivity for LPG, Propane with Hydrogen, which can be useful for Methane and additional flammable steam. The sensor has most features that low cost with appropriate to different application [13].

3.5. Infrared Radiation (IR) sensor

The wavelength of the Infrared radiation among is around 750 nm to 1 mm, spanning five orders of scale. The longer wavelength

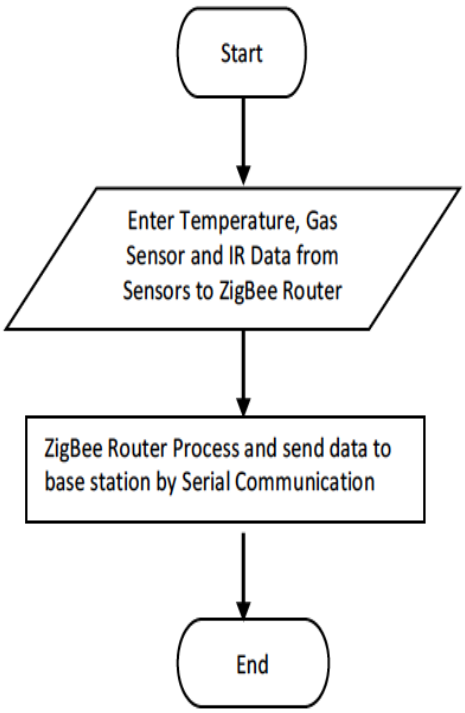
income that has the lower frequency. Object normally radiate infrared through the spectrum for wavelengths, then the single exact section from the spectrum is to attention because the sensor typically considered single to gather radiation inside the precise BW [14].

3.6. Software

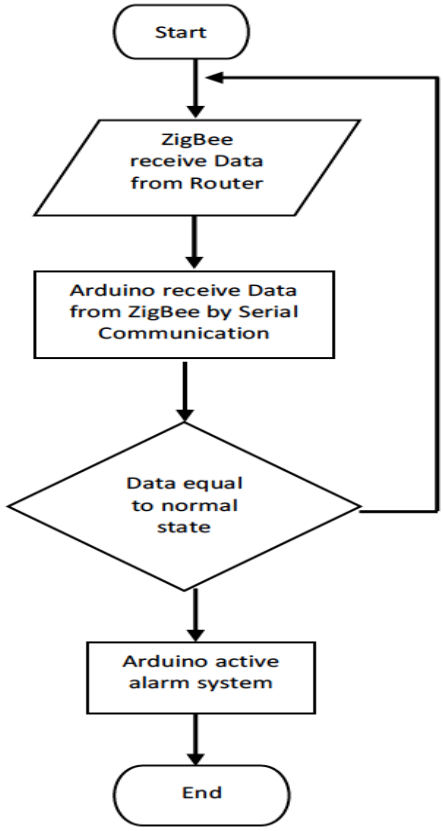
Arduino program is taken from Arduino (IDE), which is used for progress with for projected design. Whatever, diverse category libraries that are well-matched with the Arduino IDE using in the program code for the design as in LCD, keypad, I2 C protocol libraries.

4. Proposed design

After completing the program code for the system which is written in Arduino c Language and the flow chart of the system for both the Station (transmitter and receiver) shown in Fig.2, the base station of designed system has Arduino UNO and ZigBee technology. The ZigBee unit configures and controls the Base station performance like coordinator as shown in Fig 3.
The proposed system working steps has two stages (Transmitter stage and receiver stage). In transmitter stage, send Temperature, Gas Sensor and IR Data from Sensors by using ZigBee Router, and send data to base station by using Serial Communication. In receiver stage, ZigBee coordinator receives Data from ZigBee Router. Arduino receiving Data from ZigBee is by using Serial Communication. Then, if Data equal to normal conditions, Arduino can activate alarm system.



(a) Tx Section



(b) Rx Section

Fig. 2: The flowcharts for the proposed system



Fig. 3: Base station coordinator

We employ three types of sensors on the sensor node, the LM35, MQ-2- Gas sensor and IR sensor for generating and transmitting the data through ZigBee Transceiver and then tested the system. The results from the sensors perfectly are shown in Figs. 4-5.

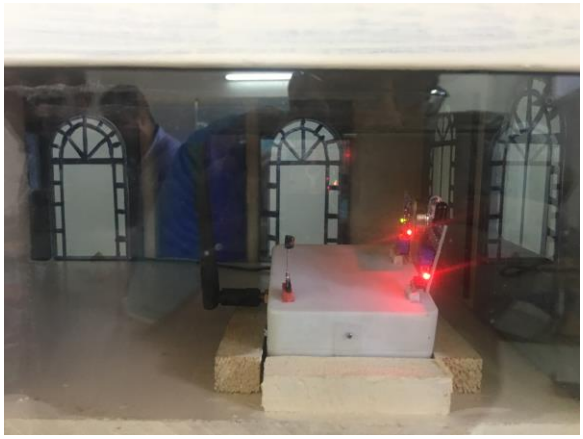


Fig. 4: **Sensor node Router**



Fig. 5: Full Prototype

5. Conclusion

In this paper, a design for low cost smart house system controller by using Arduino Uno microcontroller with ZigBee technique to monitor the base station for the alarm system plus the sensors node, system was designed as easy, low cost, and low power consumption system which gives the reliability with a self-effacing way of handling. The other advantage is providing gateway node for the Wireless Sensor Network. The system capability for additional detecting node is able to add application of exact scheming. Details from the system with the tested result have confirmed illustrations and usefulness for this system.

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