IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 6 Issue 3, March 2019
ISSN (Online) 2348 – 7968
www.ijiset.com

IoT based Classroom Automation using Zigbee

Rathy G. A [1] Associate Professor, EE&CE Department, NITTTR, Chennai, India

Email: rathysanju@gmail.com [1]

Sivasankar P. Assistant Professor, EE&CE Department, NITTTR, Chennai, India [2].
Email: siva_sankar123p@yahoo.com [2]

ABSTRACT

In today's world of automation, Internet of Things(IoT) is gaining a lot of importance and is becoming more popular day by day; The IoT, is a system of interrelated computing devices, mechanical and digital machines, objects or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. This paper focuses on designing Class Rooms Automation System (CRAS) by installing smart internet connected devices in the classroom. Zigbee and Cortex M3 are used to design and control the entire class room automation system.

Keywords: IoT, Zigbee, sensors, WiFi, classroom automation, IEEE 802.15.4, Cortex M3, CRAS, SAS

1.0 INTRODUCTION

In the digital era of technology, the involvement of machines and automation of process are done by human beings. IoT provides connectivity of devices in same network which are in sync with one another, allowing them to send and receive data

ZigBee is the most popular industry wireless mesh networking standard for connecting sensors, instrumentation and control systems. It is a specification for communication in a wireless personal area network (WPAN). ZigBee and IEEE 802.15.4 are low data rate wireless networking standards that can eliminate the costly and damage prone wiring in industrial control applications. Fig1. shows Example ZigBee network. Control equipment can be placed anywhere and still communicate with the rest of the system. It can also be moved, as the network does not look into the physical location of a sensor, pump or valve. The benefits of ZigBee technology applications include:

- Home and office automation
- Industrial automation
- Medical monitoring
- Low-power sensors
- HVAC control

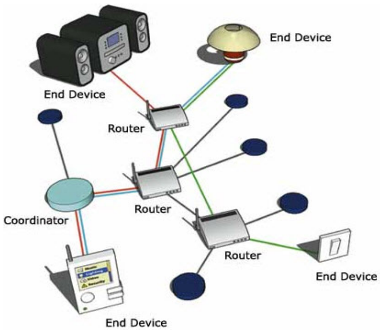


Fig1. Example ZigBee network

Nowadays as new smart sensors are available in the digital market, it simplifies the automation process. With the help of smart sensors, Zigbee and CortexM3 controller it is proposed to develop a classroom automation system which automates the Electrical appliances such as lights fans etc. to minimize the power consumption. Also cortex M3 and Zigbee are playing a vital role to recognize the entry of human beings and detect the movements of them to improve the safety of the laboratory.

2.0 LITERATURE REVIEW

Yasodharan (2018) has used IoT for energy efficient Environmental Conditions recognizing and supervising Classroom automation using Arduino. This gives a vast advantage on the smart Classroom systems using Internet of Things. This project helps teachers present in the classroom to allow them to control the classroom using android application in the Android smart phone.

Siddhai Naik(2017) has used a low cost and efficient Hybrid Smart Home Automation (HSHA) system for controlling as well as monitoring the loads. Wireless controlling and monitoring of loads is done using a smartphone via an android application. The android application has features such as password protection, availability of different modes of operation, real-time power monitoring and controlling the loads using switch or voice control.

Aishwarya Kumar(2016) a solar charged smart inverter that uses WiFi technology to inform the user of the battery voltage as well as the run time of the loads which the user chooses to run. This work uses MSP430F55291P microcontroller

Anisha Gupta(2015) design and implementation of an Ethernet-based intelligent automated system for conserving electrical energy using a INTEL GALILEO 2^{nd} generation development board, which can be used in large organizations like a University or an office. This work on automation, so that the electrical devices and switches can be remotely controlled and monitored without any human intervention. It uses the available infrastructure in a classroom that includes surveillance camera and Ethernet connectivity so as to minimize the cost criteria.

From the above various literature survey it is observed that automation is implemented for collecting the data and monitoring the system using different controllers. Now in this paper, the automation process is designed and implemented using the latest cortex M3 controller and Zigbee network for monitoring and controlling the electrical appliances connected with smart sensors. This will improve the safety aspects and minimize the power consumption of the automated classroom.

3.0 PROPOSED CLASSROOM AUTOMATION SYSTEM(CRAS)

The proposed classroom automation is aimed to improve the authenticated entry to classroom/laboratory by introducing RFID reader system. Similarly, the power consumption of the automated system will be improved using PIR sensor, RTD Temperature sensor. Zigbee and Cortex M3 controller are used to maintain room temperature at a particular set point defined by the administrator. Also Zigbee protocol standard integrated with cortex M3 will enable the administrator to control the electrical appliances of the classroom remotely. The layout of the classroom automation system is shown in Fig 2.

The system consists of four nodes connected in the mesh topology. These nodes are referred as routers. Each router has a ZIGBEE and WiFi which enable node to node communication. Cortex M3 controller monitors and controls the room parameters. RFID reader is installed at the door. A person entering has to swipe the RFID card so that door opens. A camera is also placed at the door to enable face recognition at the classroom entrance. PIR sensors and temperature sensors are installed to detect the motion and to read the temperature to reduce the power consumption.

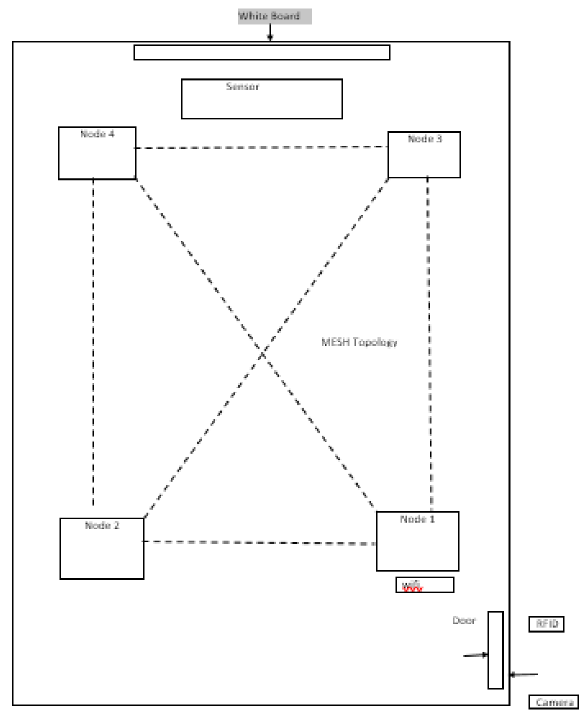


Fig 2. Layout of the system

4.0 DESIGNINING OF THE CRAS

The step by step design details of CRAS are explained below:

Step1: A person entering the classroom by swiping the RFID card. This is communicated through Wifi to the Router no 4 to update the database which is explained through flow chart shown in Fig 3.

Radio Frequency Identification (RFID) refers to a wireless system comprised of two components: tags and readers. The reader is a device that has one or more antennas that emit radio waves and receive signals back from the RFID tag. Tags, which use radio waves to communicate their identity and other information to nearby readers, can be passive or active. Passive RFID tags are powered by the reader and do not have a battery. Active RFID tags are powered by batteries.

RFID tags can also be integrated with electronic components, such as sensory material, Analog to Digital Converter (ADC), and Micro Controller Unit (MCU) to make an integrated sensor module. The RFID tag is used as a communication interface for data transmission. Passive RFID sensors harvest the RF energy from RF radiation to power the circuit and complete the sensing function, then save the data in the RFID chip to be accessed by RFID readers, which is described in and the passive sensing is of interest for data collection in remote sensing and RFID

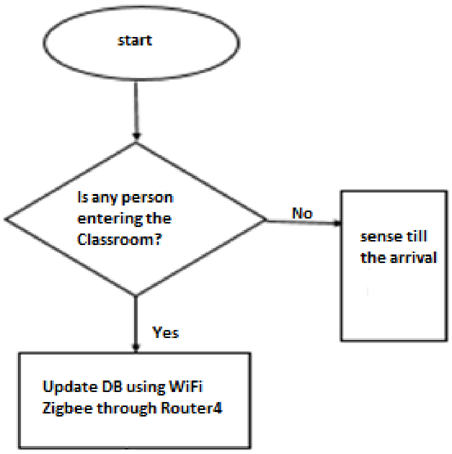


Fig 3. Flow chart to sense a person at the door

In this work RFID reader and tags are used to avoid unauthorized access to the classroom as well as the lab. This also helps to develop automated Student Attendance System (SAS).This SAS will record student entry time as well as the exit time which simplifies the role of teachers in maintaining the attendance. Whenever the student enters in to the classroom/lab it will immediately communicated to the administrator/teacher using Zigbee based WiFi router.

Step 2: A person leaving the classroom by swiping the RFID card. This is communicated through Wifi to the Router no 4 to update the database which is explained through flow chart shown in Fig 4.

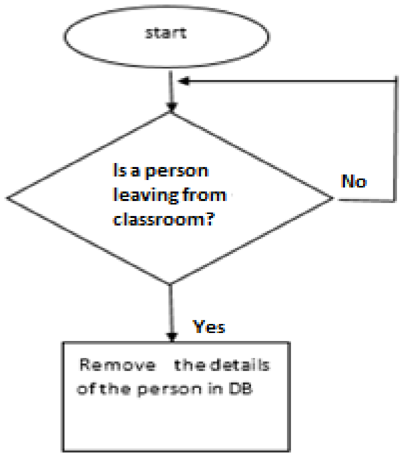


Fig 4. Person leaving the classroom

The communication between the routers are held with the help of Zigbee and WiFi. ZigBee is an open, global wireless standard developed to address the unique needs of low-cost, low-power wireless M2M networks. It is a specification to suit the high level communication Protocol. This Protocol is used to create PANS (Low Power digital radio). Low-Powered, Zigbee devices often transmit data over longer distances by passing data through intermediate devices to reach more distances creating a mesh network.

Mesh Networking (topology) is a type of network topology where each Node serves as rely for other node. Every Node is collaborating to propagate the data in the network. Message is propagated along a path by hopping from node to node until the destination is realized. To ensure all its paths availability a routing network must allow for connections and reconfiguration around broken or blocked paths using self-healing algorithm. It is reliable network since it is having more than one path between source and destination in the network. Zigbee has defined rates 25kbits/sec. Zigbee has three different device types such as Coordinator, Router and End devices. In the proposed work Zigbee network is implemented in mesh topology. Zigbee net works are called PANS. Each network is definned with unique PAN Identifier (PAN ID). This ID is Common among all devices of the same net work. Zigbee devices are pre configured with a PAN ID to Join or they can discover nearby network and select a PAN ID to Join. If multiple Zigbee networks are operating within the range of each other, each should have unique PAN ID. In a Zigbee Network, the coordinator must select a PAN ID and

Channel to start a network. After that it behaves essentially like router.The Coordinator & Router can allow other devices to join the net work, and can route data. After an end device joins a router or coordinator, it must be able to transmit or receive RF data through that router or coordinator only.

In this work, XBee Pro is used which is the heart of the classroom automation system. Xbee-Pro is a low power sensor network Wireless module. It provides reliable delivery of data between devices.The Operating frequency is 2.4 ghz It is used in Indoor application range whose range is 300 feet(90 m).The Outdoor application range is upto 1 mile(1600 m) . It transmits a power output is 60mw. RF Data rate is 250,000 Bps. Serial interface data rate is 1200 Bps to 250 KBps. It is 20 pin IC and operates at a supply voltage range is 2.8 v to 3.4 volt. Xbee-Pro supports IEEE 802.15.4 Standard of wireless communication. This standard was developed to provide a framework and the lower layers in the OSI model for low cost, low power wireless connectivity networks.

Step 3: Whenever PIR sensor detects the movement of the person it will switch on the lights. If no movement is sensed for more than 5 minutes it automatically switches off the light. Fig 5. Illustrates the flow diagram of motion detection

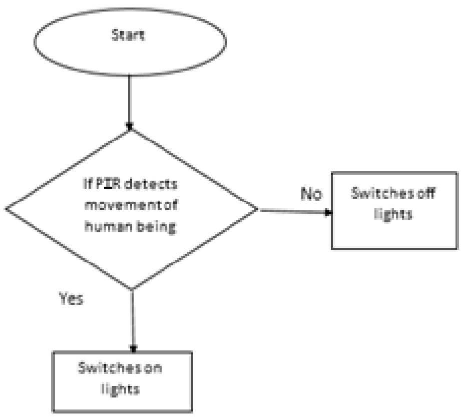


Fig 5. Flow chart for motion detection using PIR sensor

PIR sensor detects a human being moving around within approximately 10m from the sensor. This is an average value, as the actual detection range is between 5m and 12m. PIR are fundamentally made of a pyro electric sensor, which can detect levels of infrared radiation. The motion can be detected by checking for a high signal on a signal I/O pin. Once the sensor warms up the output will remain low until there is motion, at which time the output will swing high for a couple of seconds, then return low. If motion continues the output will cycle in this manner until the sensors line of sight of still again. The PIR sensor has two calibration parameters, time delay and sensitivity level. These two parameters will be useful to calibrate the required time delay and the accuracy to detect the motion. These can be adjusted according to the requirement.

Step 4: Whenever any student /teacher enters the classroom/lab, the respective data will be transmitted to the administrator system through routers. The information will update the attendance data base. The cortex M3 controller will sense the room temperature through RTD when any entry occurs inside the classroom

If the temperature of the room as detected by the temperature sensor is less than 28 ^{o}C the fans are switched off. If the temperature is more than 28 ^{o}C as detected by the RTD, the data is given to the cortex M3 controller which in turn gives the command to turn on the fan as shown in Fig.6. The cortex-M3 controller is a high performance 32-bit controller, which offers the significant benefits to the developers. The ARM architecture is a 'Harward architecture' which offers separate data and instruction buses for communicating with the ROM and RAM memories. It consist a 3-stage pipeline to fetch, decode and execute the instructions sequentially. The Cortex processor is a cost sensitive device which is used to reduce the processor area and has extensive improving interrupt handling and system debug capabilities.

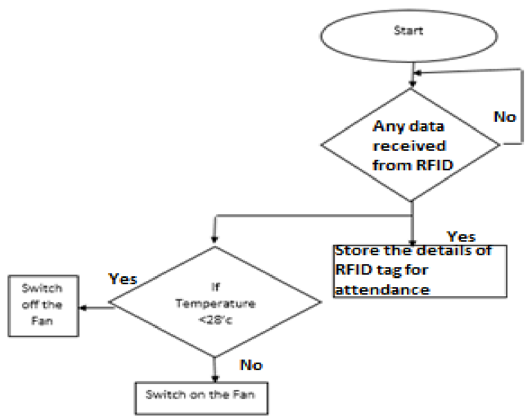
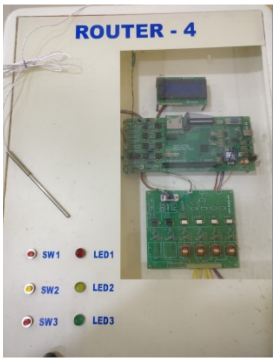


Fig 6. Flow chart for temperature control

5.0 Experimental setup of CRAS

An experimental set up was made with four nodes named as Router 1, Router 2, Router 3, Router 4. Communication between these nodes are done by the Xbee Pro



The Cortex M3 controller does the control of checking the temperature inside the classroom/ Laboratory, and turns on /off the fans. The fans are also turned on/ off by reading the temperature through RTD. The PIR sensor is used to detect the motion to switch on/off the lights. Zigbee and WiFi are enabling for the router communication.

After implementing the mesh topology using four Routers,the details of the students and teachers will be collected and stored in administrator system. The presence of a person and the room temperature will be continuously monitored and respective data will be updated in the data base. The available data in the database will be accessed remotely through IoT gateways. Similarly these electrical appliances can be controlled remotely anywhere in the world through the principles of IoT. In this way IoT based Classroom Automation using Zigbee is implemented to save energy and improve the security systems of any classroom.

Conclusion

The experimental setup "IoT based Classroom Automation using Zigbee" has been installed and the setup is working effectively. If no movement detected for more than 5 minutes CRAS switches off the lights. If the temperature goes beyond the setpoint controller will switch on the fans. RFID increases the security and updates theSAS. The IoT gateway and cloud will enable the remotecontrol of electrical appliances of the classroom.

REFERENCES

1. Yasodharan R et.al.(2018) IoT based Classroom Automation using Arduino" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-2 | Issue-2,February2018, URL: http://www.ijtsrd.com/papers/ijtsrd9404.pdf

2. Siddhai Naik et.al (2017) Improvisation of smart home automation using hybrid sources 7th International Conference on Power Systems (ICPS) Pune,IndiaISBN Information:Electronic ISBN: 978-1-5386-1789-2

3Anisha Gupta ; Punit Guta ; Jasmeet Chhabra(2015) published IoT based power efficient system design using automation for classrooms in the Third International Conference on Image Information Processing (ICIIP) INSPEC Accession Number: 15804818

4. Archana N. Shewale and Jyoti P. Bari, "Renewable Energy Based Home Automation System Using ZigBee", IJCTEE Volume 5, Issue 3, June 2015.

5. Alphy John, I.Bildass Santhosam, —Home Energy Management System Based On Zigbee‖, International Journal of Inventive Engineering and Sciences (IJIES) ISSN: 2319–9598, Volume-2, Issue-4, March 2014

6.M.G. Golzar, Co. AsanPardazan, H.R. Tajozzakerin, "A New Intelligent Remote Control System for Home Automation and Reduce Energy Consumption", Mathematical/Analytical Modelling and Computer Simulation (AMS), 2010.

7. A.Z. Alkar, Univ Hacettepe, J. Roach, D. Baysal, "IP based home automation system", Consumer Electronics IEEE Transactions, vol. 56, no. 4, November 2010.