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Indoor Monitoring and Home Automation using Sensenuts Wireless Sensor Network Platform

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Abstract—*Wireless sensor network (WSN) can be easily deployed in an indoor environment in comparison to a wired system. This paper presents the implementation of indoor monitoring and home automation system using a new WSN platform called Sensenuts. The developed system consists of pan-coordinator and coordinator nodes which communicate among themselves using 802.15.4 Zigbee. The system can be used to monitor the temperature and light of an indoor area, control the devices based on these readings and hence saving energy. The proposed system provides a low cost, flexible and intelligent system for home and offices.*

Keywords*: Wireless Sensor Networks, IEEE 802.15.4 Zigbee, RFD, FFD, Coordinator, Pan-coordinator.*

1. INTRODUCTION

Wireless Sensor Networks (WSN) is new area of research which is rapidly growing due to its advantages over wired system like low cost, scalability, and easy to reconFig. capabilities. There are various applications of WSN including environment monitoring [1], health monitoring, precision agriculture and vehicle monitoring etc. One of the attractive features of WSN is their autonomy [2]. When a node which is designated as FFD (fully functional device) is kept into a network starts receiving packets from the other neighbour nodes and also passes the packet towards sink node. If the node is designated as RFD (reduced function device) it starts forwarding its packets to its pan-coordinator, it can not receive the packets from other nodes.

Nowadays people want life where they can have automated and intelligent environment which provides them convenience, security and reduction in daily living cost by saving energy. Home automation can be defined as application of technologies in home where we can enhance the quality of life of residents by providing various services including monitoring of physical parameters like temperature, light intensity and controlling the devices based on the readings of temperature and light intensity using WSN. This system adds intelligence to human life and on the other hand saves energy consumption by home appliances and hence reduces the cost of living.

WSN uses 802.15.4 Zigbee technology [6] which is considered as mini version of Wi-Fi. 802.15.4 Zigbee works on 900-928 MHz and 2.4 GHz with a data transfer speed of 250 kbps. The maximum range of 802.15.4 Zigbee is 30 m – 100 m which is suitable for indoor monitoring and home automation system [3].

Sensenuts WSN platform used to implement the system described in this paper, Sensenuts is an emerging platform for WSN applications. It is feasible in various WSN applications due to its low cost, small size and low power consumption features. There are different modules in the Sensenuts platform that combines to make a node for a network. The nodes when combined in a network with a suitable topology for an application then the network is called WSN, which is the heart of implemented system.

2. ARCHITECTURE OF THE SYSTEM

Under WSN applications different topologies can be used for different applications, 802.15.4 Zigbee supports star, cluster and mesh topologies. For indoor monitoring and home automation system less number of nodes are required, so star topology is best suited for this system.

There are two types of nodes used in this system one is coordinator and other is pan-coordinator. Coordinator collects readings of temperature and light intensity from the sensors and sends it to sink node that is pan-coordinator node. Coordinators are deployed in different rooms or in different indoor areas at a distance which is in the range of pan-coordinator. The pan-coordinator is connected to the PC/Gateway which serves the readings to web page. Users connected to internet can observe the readings on their devices.

Fig. 1 shows the connection of coordinators to the pan-coordinator in star topology and describe the function of the system. The automation is done by providing the coordinators with functionality of controlling the electrical appliances using relay circuit. The relay circuit switches ON/OFF the appliances based on reading of the sensors.

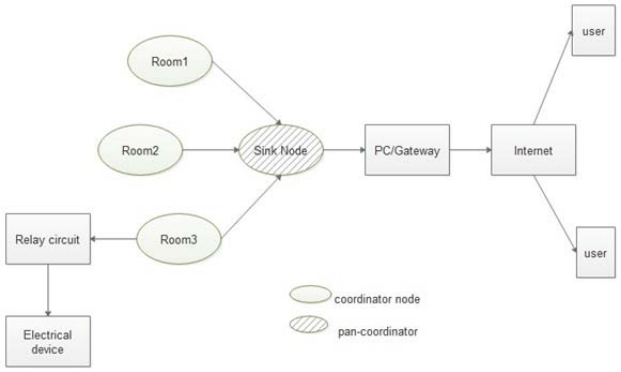

Fig. 1: Architecture of the System

Fig. 2 describes the working of the nodes. Coordinator nodes join a network which is set up by a pan-coordinator node. Coordinator nodes takes readings of temperature and light intensity at predefined intervals with the help of sensor attached, it forms a packet and broadcasts the packet. The pan-coordinator accepts the packets which are broadcasted by coordinator nodes in the network; it updates the reading of temperature in degree Celsius and light intensity in Lux in the GUI.

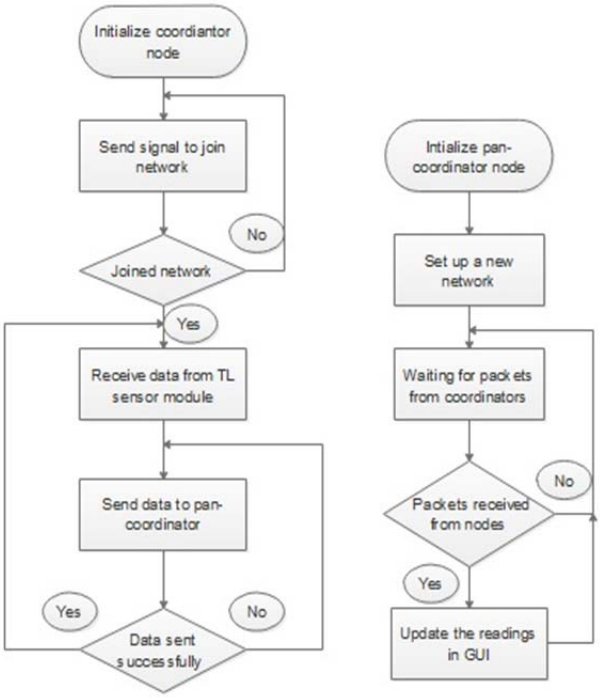

Fig. 2: Flow chart of Coordinator and Pan-coordinator

3. HARDWARE USED

In this paper Sensenuts WSN platform is used which has following modules [3].

3.1 Radio Module

It comprises of micro-controller and an integrated transceiver for processing, sending and receiving the data. The radio module can be programmed in order to define the function of node. Fig. 3 shows the radio module, it has following specifications:

- 32-bit RISC Jennic 5168 microcontroller
- 1-32 MHz clock speed
- 256KB flash, 32KB RAM, 4KB EEPROM
- 2.4 GHz IEEE 802.15.4 compliant transceiver
- 128-bit AES security processor
- Integrated PCB antenna
- Rx current 17mA, Tx current 15mA
- 2V to 3.6V battery operation

Fig. 3: Radio Module

3.2 Gateway Module

It programs the micro-controller and acts as an interface between the network and PC. Fig. 4 shows the gateway module. It has following specifications:

- USB to asynchronous serial data transfer interface
- USB protocol handled by the device(No USB specific programming required)
- Data Transfer rate 115200 baud
- 128 byte receive buffer and 256 byte transmit buffer

Fig. 4: Gateway Module

3.3 TL Sensor Module

It is used to measure temperature and light intensity. It is generally mounted over the radio module. Fig. 5 shows the TL sensor module, it has range and specifications as follows

- Temperature Sensor range -25 C to 80 C with 12 bit resolution 1uA shutdown current, maximum 10uA active current
- Light sensor range 3 to 64 k lux with 16 bit resolution, 0.3 uA shutdown current, Max 58uA active current, Excellent IR/UV rejection

Fig. 5. TL Sensor Module

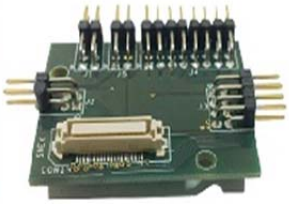

Fig. 6. Extender Module

3.4 Extender Module

This module actually consists of header pins which gives access to all the pins of the processor on the board. It is used to integrate third party sensors to the radio module. It can be also used for hardware debugging when there is a requirement of checking the voltage on some particular pin or view an output waveform from an output port on a DSO.

The combination of Radio module and TL sensor modules makes a coordinator node that can take the reading of temperature and light intensity in the area where it is placed and can send the readings to a pan-coordinator that is connected to PC through the gateway module. The Extender module can be mounted over the coordinators in order to provide them functionality of controlling the devices through relay.

4. SOFTWARE USED

Many software are used to implement this paper, the description of software used is as following

4.1 Eclipse Indigo C, C++

Eclipse is used to write the program for the radio modules in order to define their behaviour as coordinator or pan-coordinator in the network. The codes are written in C language as the OS of nodes supports this language.

4.2 Sensenuts GUI

Sensenuts GUI is used to visualize the readings of the different nodes collected by the pan-coordinator connected to the PC. In this GUI we can see the MAC address and the corresponding readings of the nodes. The GUI is also used to flash the bin file in Radio module, the bin file is generated by writing the code in Eclipse.

4.3 NetBeans IDE 8.1, JDK 7, Glass Fish Server

NetBeans is used to write the code in JSP which is advance version of java with web support. JDK is java development kit that provides the environment for JSP. The web page developed using these software is named as “Monitoring System”, which takes the reading from the nodes and displays the current reading on web page that can be seen on any java enabled device connected to internet. The Glass Fish Server is used to serve the page the page to internet.

5. VISUALIZATION OF READINGS

The readings of Temperature and light intensity in different rooms can be visualized using the Sensenuts GUI or Monitoring System web page if we want to observe it on local PC that is connected to the pan-coordinator. If the readings are needed at remote location we can visualize it on any authorized PC or cell phone that supports java and is connected to the internet on the Monitoring System webpage.

Fig. 7 shows the Sensenuts GUI showing the readings of temperature in degree Celsius and light in Lux on the PC which is connected directly to the pan-coordinator.

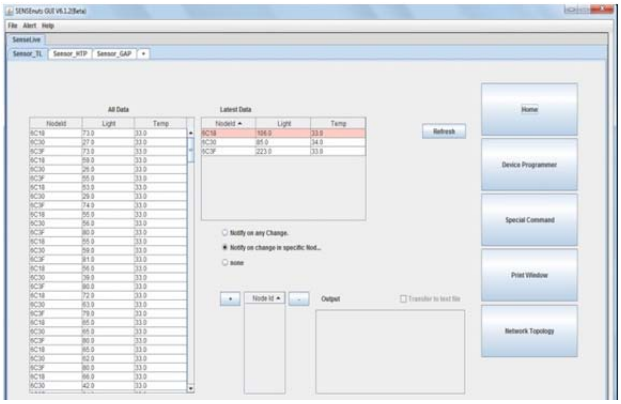

Fig. 7: Sensenuts GUI

Fig. 8 shows the readings parameters from different rooms along with the MAC address of the nodes placed in corresponding rooms. The readings can be observed on any authorized device connected to the internet on the given web page. The operation column on web page shows the animation of fan, based on the readings of temperature. The fan runs if the readings of temperature go above a certain fixed level (Threshold level).

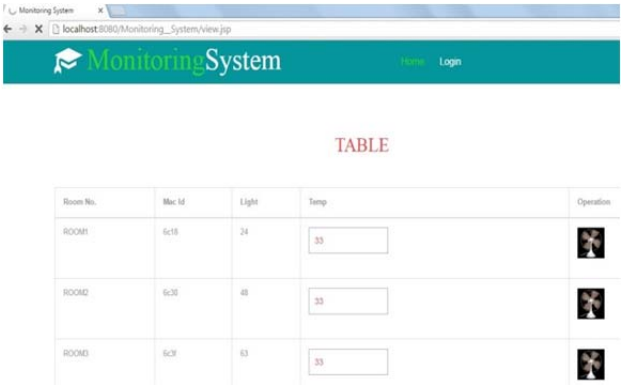

Fig. 8: Web page GUI

6. CONCLUSION

In this paper, a wireless sensor network was successfully built for monitoring temperature and light readings of 3 rooms. The readings were successfully displayed on PC connected to the sink node and to the remote user using internet. The coordinator nodes were programmed in such a way so that they can control the home appliances like fans and lights based on readings of temperature and light respectively. This system makes the home smart and cost effective by saving energy.

The system can be extended to outdoor areas like habitat monitoring, precision agriculture by increasing the number of nodes and changing the topology of the network which best suited to the application. The Sensenuts devices used in the system which are cost effective and energy effective can also find their use in Internet of Things (IoT) applications by the interconnecting the various WSN networks to internet.

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