Application of Wireless Sensor Network in Home Automation

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Abstract- *This paper is based on wireless sensor network for home automation using Wi-Fi and Zigbee to automate the home .In order to use low power and low cost for the solution of automating the home using Wi-Fi and Zigbee technology. A prototype automation system for monitoring and controlling in home with sensor nodes and controlling nodes has been developed and tested in home. The system consists of sensor nodes, actuators nodes, router nodes, and one coordinator node.WSN is very helpful to implement the home automation system. Inside the home we have lot of electronic equipment to make our job easy. Here in this paper we implement the home automation system to advance the manual monitoring.*

Index Term- Home Automation, Zigbee, Wi-Fi

1. INTRODUCTION

Home automation system is becoming more and more popular. People want to live in intelligent living spaces equipped with home automation systems, these systems not only provide them convenience, comport, security but also reduce their daily living cost by energy saving solutions .The demand for home automation products has been increased rapidly, which promise a potential market trend in near future. In Europe buildings are responsible for 40% of total energy consumption [1], which is more than the demand of industry or transportation. The total energy consumption has been rising since 1990 and the tendency shows that it will continue increasing if strong actions are not taken

A. Existing Home Automation Technologies

There are many definitions of home automation available in the literature. [1] Describes home automation as the introduction of technology within the home to enhance the quality of life of its occupants, through the provision of different services such as telehealth, multimedia entertainment and energy conservation. The traditional home automation systems use wired connection solutions. However the implementation of these systems requires cable installation at the same time with house building. This problem causes inconvenient for users, especially when their houses have been built, few of them accept wired solutions because the

installation of new cable system can destruct the original interior decoration. However, high speed data rate transmission means that much power will be consumed. However, high speed data rate transmission means that much power will be consumed. Home automation system requires low cost, low power consume, and do not require high speed data rate.

Wi-Fi is better suited for operating full-scale networks because it enables a faster connection, better range from the base station, and better security (if configured properly) than Bluetooth. Zigbee has often been regarded as a mini version of Wi-Fi. Keeping some features like range, power consumption apart, Zigbee and Wi-Fi are often used in similar applications in terms of household based wireless communication. These short range wireless technologies even share common ISM band of 2.4GHz, use same spread spectrum technique.

B. Features of the proposed System

This paper presents a novel, stand alone, low-cost and flexible Wi-Fi and Zigbee based home automation system. The architecture is designed to reduce the system's complexity and lower fiscal costs. Hence, the system endeavours not to incorporate complex and expensive components, such as a high end personal computer, where possible. The system is flexible and scalable, allowing additional home appliances designed by multiple vendors, to be securely and safely added to the home network with the minimum amount of effort. The system allows home owners to monitor and control connected devices in the home, through a variety of controls, including a Zigbee based remote control, and any Wi-Fi enabled device which supports Java. Additionally, users may remotely monitor and control their home devices using any Internet enabled device with Java support. A home gateway is implemented to facilitate interoperability between heterogeneous networks and provide a consistent interface, regardless of the accessing device. A virtual home pre-processes all communications before they are realised on the real home automation system.

There have been a lot of researches for controlling the electric appliances at home. They allow users to control and

Manage electric appliances in the home network. They used remote controllers, PCs, mobile phones, PDAs, voice, human

Movement and gesture to control appliances which connected

to the home network. Remote controllers were replaced with

Human hand gestures. It is focused on control friendliness especially for elderly or disabled people tried to use the same remote controller to control different kind of appliances using radio and infrared technologies allowed wireless handheld devices such as mobile phones and palm-size computers to be used as remote controls for applications on PCs and appliances within home. Universal control environments were proposed to browse multiple devices and select services/

C. *Difference between Wi-Fi and Zigbee*

1. IEEE Standard: Wi-Fi has been standardized under IEEE 802.11.x standard. There are several versions of the protocol where x gets replaced by a, b, g, n etc. which are different versions of Wi-Fi. Zigbee comes under 802.15.4 IEEE standard.

2. Caretaker Alliance: Wi-Fi is managed and its certification process is taken by Wi-Fi Alliance, an independent group constituted by several electronics and communication companies. On similar grounds, Zigbee also has a separate alliance that takes of Zigbee based product development and certification processes.

3. Development Timeline: The idea for Wi-Fi came out as an alternative to ease work of cashier machines in the year 1985. A community to standardize was established in the year 1990 which launched the standard in the year 1997.

On the other hand, idea was Zigbee was conceived in the year 1999, when it was found that for some long running applications, Wi-Fi and Bluetooth were not prepared. It was launched in the year 2004.

4. Operating Frequency: Wi-Fi is known to work at 2.4GHz, 5GHz, though there have been recent developments where Wi-Fi is working at 60GHz frequency. Zigbee works at 900-928 MHz and 2.4GHz. Besides that Zigbee protocol has a specific frequency of 868 MHz for European countries.

5.Channel Bandwidth: Zigbee protocol based communications have a channel bandwidth of 1MHz

while Wi-Fi channels have a bandwidth of 0.3, 0.6 or 2MHz.

6. Network Range: Zigbee is restricted to Wireless Personal Area Networks (WPAN), reaching 10-30meter in usual applications. Recently, there have been some applications which tend to reach 100m in terms of range. Wi-Fi serves up for PAN and WLAN area networks with an average range between 30 to 100 meters.

7. Data transfer speed: Wi-Fi networks, though faster than Zigbee in terms of data transfer, show variation in terms of speed. Wi-Fi networks defined under 802.11b standard have maximum data transfer speed of 11mbps while a and c versions have 54mbps of maximum data transfer speed. Maximum speed in Zigbee networks is only 250kbps, fairly low than the lowest Wi-Fi offers.

8. Bit Time: It can be defined as time taken to transmit one bit at a given data rate of transfer. Bit time in Zigbee is 4micro seconds while in Wi-Fi it is only 0.00185 micro seconds.

9. Power Consumption: Wi-Fi, though now having a low power version over the horizon, has not been known as a power efficient network. Wi-Fi based devices need a good battery back-up if one wants to use them for more than 10hours or so. On the other hand, Zigbee protocol has been designed for "assemble and forget" manner. These are extremely minimal in terms of power consumption and hence can go on for weeks and months. In general, Zigbee based networks consume 1/4th of the power consumed by Wi-Fi networks.

10. Network Elements: In a standard point to point network, two stations can be connected to each other. A Wi-Fi router is also needed in some places where one needs to connect multiple devices to each other and/or wants to connect to the internet.

In Zigbee, the network elements can be broadly classified into three types: Zigbee coordinator, Zigbee end router, Zigbee end device.

11. Network Size: A single Wi-Fi based network can have a network size of up to 2007 nodes whereas Zigbee based networks can have over 65,000 nodes in one such network.

12.Network   Security: Zigbee protocols use Advanced Encryption Security (AES) methods for encryption and CCB-CCM methods for network security. On the other hand, Wi-Fi based networks

use WEP, WPA and WPA2 protocols for network encryption and security, respectively.

13. Applications: Wi-Fi is a preferable choice for internet connection based network and now is also encouraged to interface various media/entertainment devices wirelessly. One can find Wi-Fi in data exchange between a computer and modem, streaming music and videos on a television through a Wi-Fi enabled computer or media device. Zigbee protocol has been precisely designed to exchange data and it is more prevalent in the wireless sensor based networks such as those in home automation systems or industrial machinery coordination systems

II.SYSTEM ARCHITECTURE

The controlling and monitoring network is designed using Wi-Fi wireless sensor network technology. Routers have the function of routing and receiving messages, the remain nodes carry out sensing and controlling functions. All communication between devices propagates through the coordinator and routers to the destination devices. The general node is composed of power supply module, a microcontroller, a Wi-Fi transceiver, an interface for in-system serial programming and some other extended interfaces.
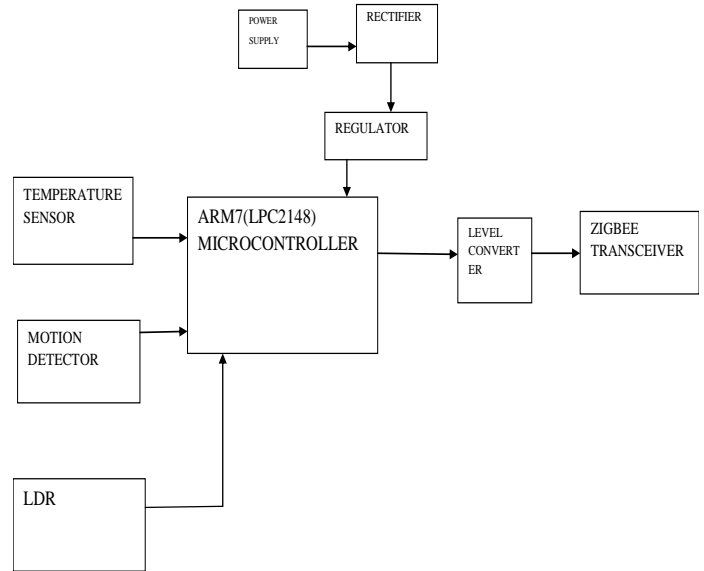
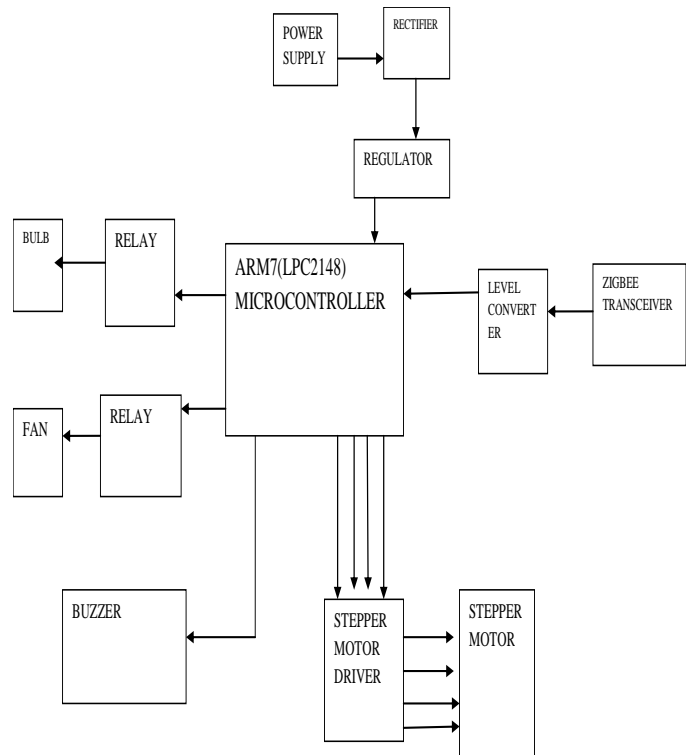**BLOCK DIAGRAM**

Fig 1: Zigbee Transceiver

Fig 2:Zigbee Reciever

III.SYSTEM IMPLEMENTATION

The implementation of the proposed system is show in fig Wireless Sensor Network (WSN) for home automation system consists of consists of two main parts: sensor network, controlling and monitoring. Control and Monitoring Network consist Wi-Fi router, actuators and Zigbee node. Wi-Fi router it communicates with microcontroller through serial communication port and it communicates with pc Wi-Fi network wirelessly. Actuator nodes consist of electrical appliance like light, fan etc .turning on and off of these appliances is done by internet by communicating with server Wi-Fi router and as well as user can get the status of all the appliances in the actuator node.
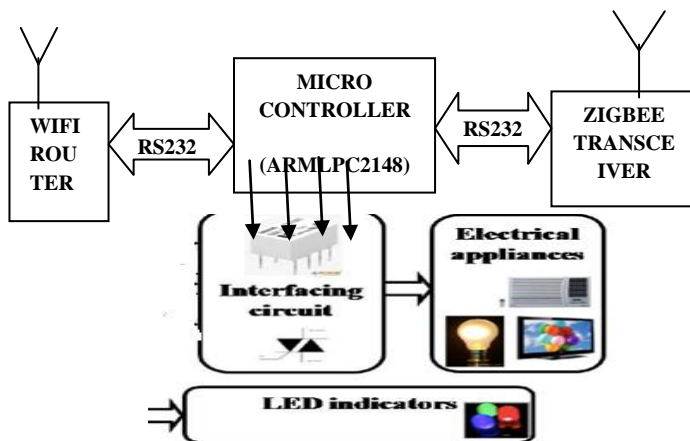

Fig.3:Control And Monitoring Network

Sensor Network consist of several sensor like temperature, humidity, motion sensor, smoke sensor and door status sensor and Zigbee node. The sensor nodes have the function to monitor the building security and environment conditions. All sensor nodes are designed using rechargeable battery power supply. To increase recycle time life of battery, energy saving mode is applied to control the operation of each node. Zigbee node communicates with Building control and monitoring network node to transmit the all sensor data.

A. Zigbee Home Automation Network

The Zigbee home automation network consists of a coordinator, routers and several end devices. The coordinator is responsible for starting the Zigbee network.. The Zigbee devices developed for the home network, as mentioned, includes a light switch, radiator valve, safety sensor and Zigbee remote control. A Zigbee end node has been integrated with these devices. As the devices are started, during their respective initialization stage, the node scans for available channels to identify the network it wishes to join.The node sends a request to the network coordinator to join the network. The request is sent to the coordinator directly or through a neighboring router on the desired network with which the node shares the best signal. On receipt of the request the coordinator judges whether the requesting device is permitted to connect to the home automation network. The standard implementation of most Zigbee networks prevents unauthorised devices joining the network by providing a short user defined period where device may join.

B. Wi-Fi Network

The homes Wi-Fi network was implemented through a standard Wireless (802.11b and 802.11g) ADSL Modem Router, with a 4 port switch. The modem provides two primary functions. Firstly, the modem provides the connection between the Internet and local Wi-Fi network; hence extending access to the Wi-Fi enabled home gateway to any location with Internet access. Secondly, any local Wi-Fi enabled device within range of the home's Wi-Fi network can directly access the home gateway. This provides a low cost communication method with the home network, reduced infrastructure costs where Wi-Fi devices are already in use. Moreover, home owners can monitor and control the home automation network, using familiar technology and devices.

Fig.4. WRT54GL v1.1

We have used Linksys WRT54GL v1.1. This router works as a server and communicates with the controlling laptop. The reason of using this particular router is that it is intended to be hacked by the company. It is an open source router which enables the use of many third party firmware and many hacks as well. WRT54GL Version 1.0 and version 1.1.
There are very minor differences between the version 1.0 and 1.1 WRT54GL routers .Wi-Fi router IP address is 192.168.1.1 and system IP address

192.168.1.0 to 192.168.1.24. we install a java run environment(JRE) programming i.e. Java 7 update 45 to run IP camera DCS931L .IP camera has a IP address of 192.168.1.109.IP camera is rotated in each angle by using stepper motor.

Serial port on router: The reason why we need a serial port is so that the router will be linked to the microcontroller and to communicate with microcontroller its needs a serial port as microcontrollers do serial communication. Microcontroller takes serial signal from the router and feeds it to the car circuit. Since the soldering in this mod is not very difficult, this is a good mode to attempt if you're just starting out in electronics and are looking to get some soldering experience. The electronics part is not too difficult, but the result can be very useful to control external electronics or just to have a serial console. There are mechanical case modifications that are required as well, which makes this mod a bit more tricky than just a soldering project

Fig 5:Serial Port On Router

C. Microcontroller

ARM was founded by formerly known as ACORN RISC Machine founded by ACORN COMPUTERS LTD in 1983-85, later named as Advanced Risc Machine in 1990. ARM is basically a general purpose 32 bit processor. ARM is incorporated with the 32 bit controllers manufactured by Philips with the banner name LPC series controllers. ARM family started with the series number from ARM 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13. The series till ARM 6 were basically 16 bit microcontrollers. ARM 7 was the first 32 bit controller given by ARM. The even

number of series was reserved for the company's R&D purpose and the odd version was released to the market for commercial purpose. ARM 10 is the only even series that was released to the market. We are using LPC2148 series controller

D. Home Automation Devices

Light Switch: A conventional light switch was integrated with a Zigbee microcontroller. In this prototype the user could access the light switch, detect the lights current state ("On" or "Off"), and adjust the state accordingly.

PIR Sensor: PIR sensor is an electronic device that generates an electric charge when exposed to infrared radiation. As the name implies this sensor is made of pyroelectric materials such as crystals. When the amount of infrared radiation that is striking to the crystal changes, the amount of charge also changes. This charge is sensed and converted to a voltage level via a FET transistor that is build inside the sensor. The sensor is sensitive over a wide spectrum. For the detection of human being PIR sensor is used if a person is detected a buzzer sound is appeared.
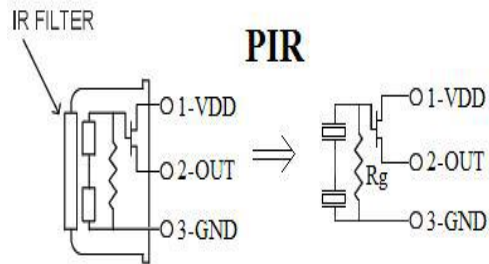

Fig.6. A PIR sensor and its equivalent circuit

Sensor Network Application:

Although computer-based instrumentation has existed for a long time, the density of instrumentation made possible by a shift to mass-produced intelligent sensors and the use of pervasive networking technology gives WSNs a new kind of
Scope that can be applied to a wide range of uses.

These can be roughly differentiated into
• monitoring space,
• monitoring things, and
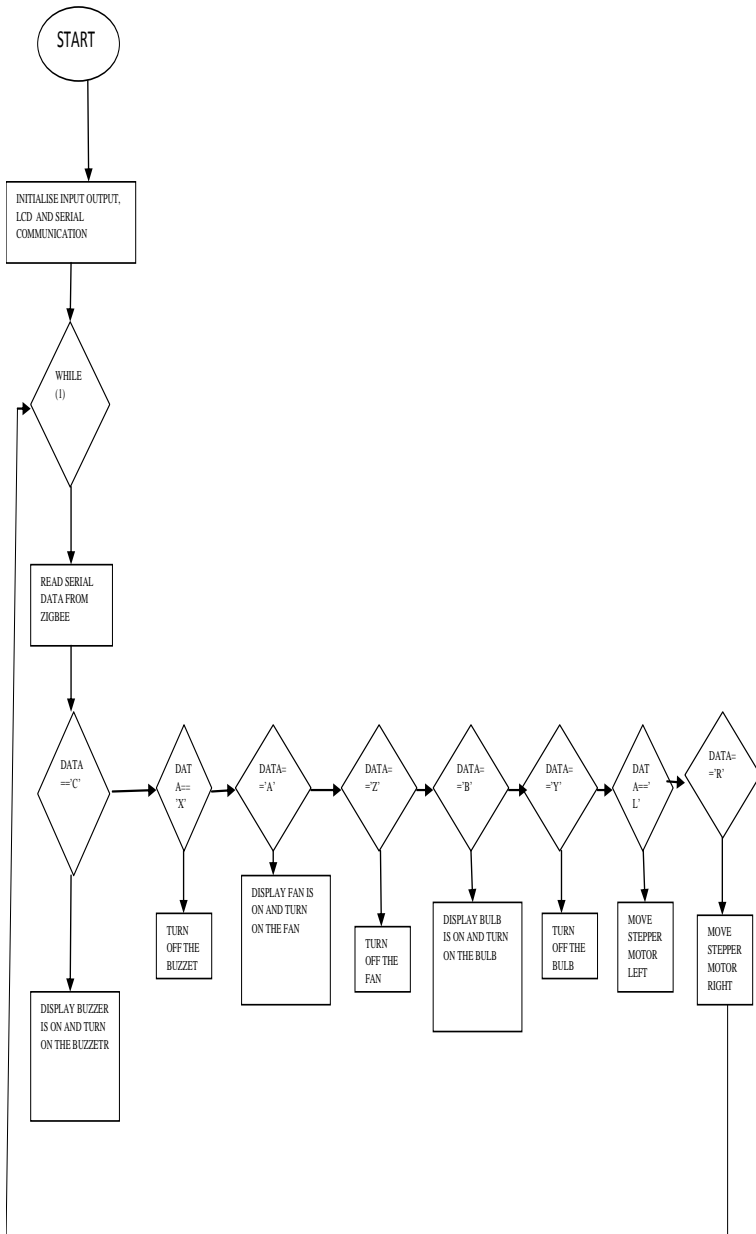• monitoring the interactions of things with each other and the encompassing space.

The first category includes environmental and habitat monitoring, precision agriculture, indoor climate control, surveillance, treaty verification, and intelligent alarms. The second includes structural monitoring, ecophysiology, condition-based equipment maintenance, medical diagnostics, and urban terrain mapping. The most dramatic applications involve monitoring complex interactions, including wildlife habitats, disaster management, emergency response, ubiquitous computing environments, asset tracking, healthcare, and manufacturing process flow.

IV.FLOW CHART

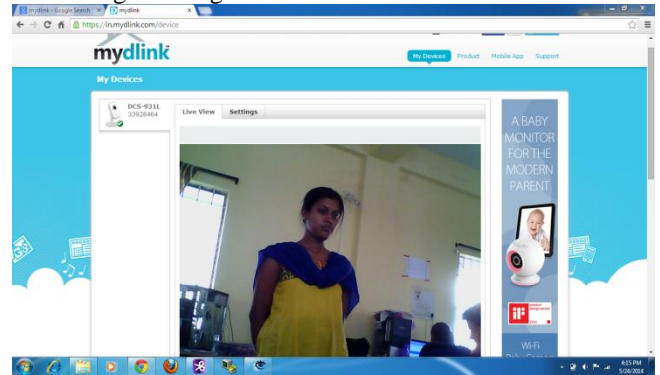The Zigbee transmitter can be controlled with the following steps:
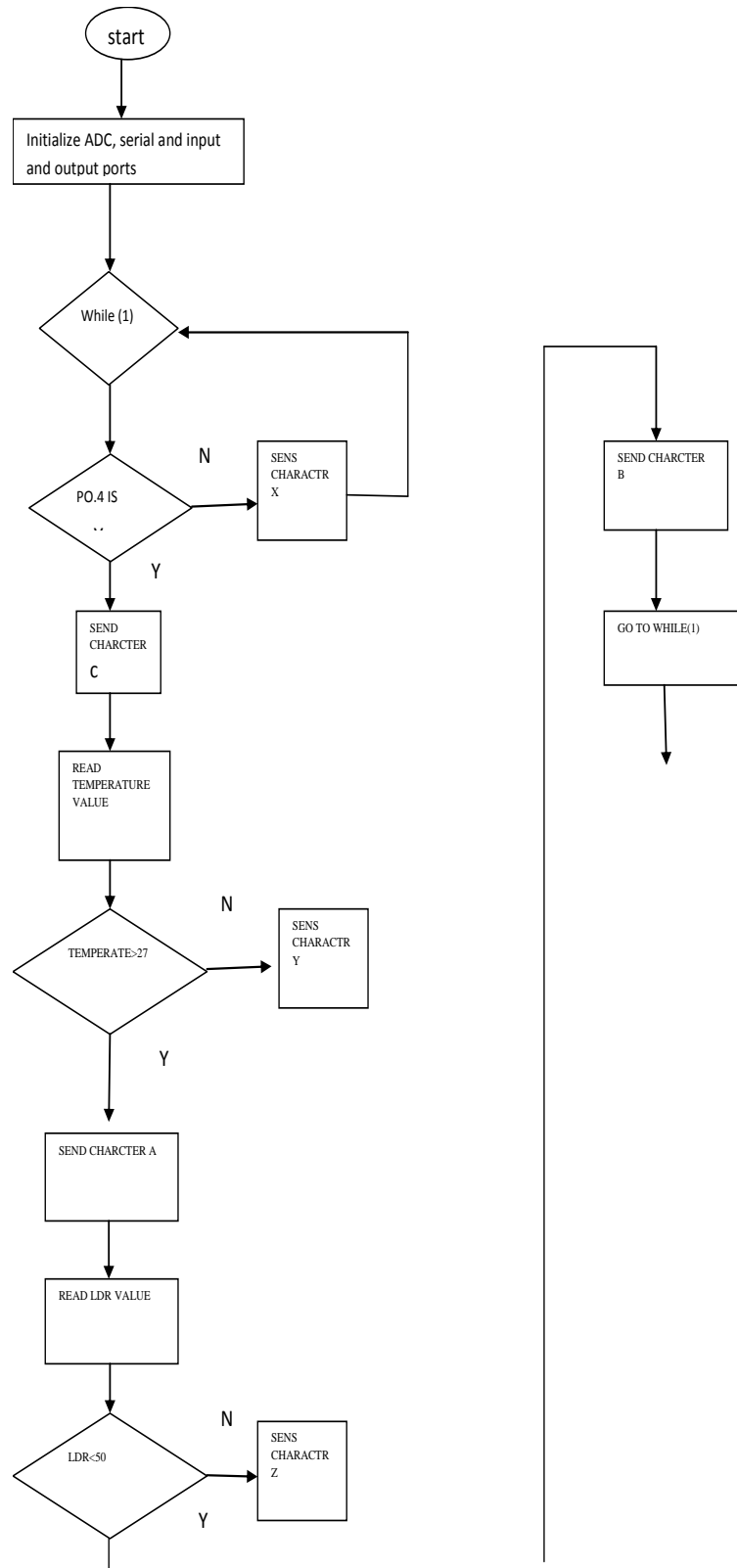
The Zigbee receiver can be controlled with the following steps:

camera was used along with the Wi-Fi router for transferring the live data transfer from the place under scrutiny to the main station.

Live data can be seen through mydlink.com web site need to login through web site

This has reduced the power usage due to the wired connection from a camera to the DVR section total power used because of Zigbee is 0.1w and Wi-Fi is 12w and for wired connections the total power used is 28w.
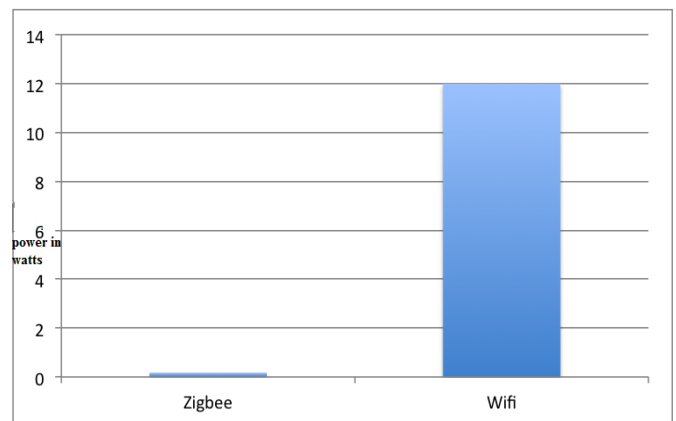
VI.CONCLUSION

In this paper, Wireless sensor network are used to control and moniter the electrical appliances. The widely-used indoor wireless technologies include Bluetooth, Wi-Fi and Zigbee. Wi-Fi and Bluetooth are short range in home wireless technologies with high data rate transmission. The home automation system Synco living allows you to control your lights, heating, ventilation, and air conditioning, conveniently switch electrical appliances on and off, and monitor the rooms of your consumption data. The system also shows you which windows are open, tells you about the current outdoor temperature and barometric pressure and provides an easy, convenient way to control lights and blinds. The system is expected to be developed for many other applications

V.RESULTS AND DISCUSSION

The experimental setup for sensing the temperature and the person detection was developed and the Zigbee was used for transmitting the sensed data to the main station and the appliances were controlled accordingly. We could find that the energy if the wired connection and the wireless communication would be varying. The wireless communication would reduce the amount of energy that is transferred from the sensor unit to the main unit. And the IP

such as intelligent community administration system, remote industrial control system, and remote patient monitoring system. The performance results in confirm that WSN based home automation system is practically applicable in multi-storey building environment.

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