Energy Conservation in Smart Home Using Wireless Sensor Network

[1]Dr.S.MaryPraveena, [2]A.K.Kavitha and [3]R.Kanmani,
[1]Associate Professor, [2,3]Asssitant Professor,
[1,2,3]Department of EC Engineering, Sri Ramakrishna Institute of Technology, Coimbatore, TamilNadu, India

Abstract: Wireless sensor networks (WSNs) are used in this work to implement a smart home control network. The goals are to reduce the unnecessary energy consumption of a smart home. An isolated WSN with one coordinator, which is integrated into Arduino Uno, is established in each room. The coordinator is responsible for transferring environmental parameters obtained by WSNs to the management station. The control messages for home appliances are directly transferred using WSNs. Additionally, analysis of the illumination of a fluorescent lamp along with Passive infra red sensor were presented.

In this paper we used passive infra red sensor that turn light on automatically when person pass by, later turn off after a certain predefined delay for even more energy conserving. The energy saving of lighting systems relative to those without smart control was evaluated. Numerical results indicate that the electricity consumption can be reduced by at least 40% under the smart control. Moreover, a prototype for the proposed smart home control network with illumination of light was implemented. Experimental tests demonstrate that the proposed system for smart home control networks is practically feasible and performs well.

Keywords*: Appliance Control, Energy Saving, Smart Homes, Smart Lighting Control, Wireless Sensor Networks (Wsns), Passive Infra Red Sensor.*

I. INTRODUCTION

Numerous studies [1]–[3] tell us that smart homes (or) intelligent buildings can use energy more efficiently than traditional buildings. Thus, several researchers have advocated building smart homes for reducing energy consumption. Almost all proposed smart home architectures in the literature adopt the wireless sensor network (WSN) as the dominant technology. The WSN, rather than Wi-Fi, has been popularly employed for remote control and monitoring applications Humans usually inside their home interact with the environment settings like light, air, etc., and regulate accordingly. If the settings of the environment can be made to respond to human behavior automatically, then there are several advantages. The automation of home settings to act according to the inhabitant requirements is termed as intelligent home automation system. Ambient intelligence responds to the behavior of inhabitants in home and provides them with various facilities[4]. In general, intelligent home automation system consists of clusters of sensors, collecting different types of data, regarding the residents and utility consumption at home. Systems with computing capabilities analyze the assimilated data to recognize the activities of inhabitants or events. These can automate the domestic utilizations effectively and also can support the inhabitant by reducing the costs and improving the standard of living. In the recent past, several research activities were actively involved with IoT such as [5]–[7] . Most of the research activities related to IoT are confined to management of resource constraint devices , and different mechanisms of interconnection[9],[10].. According to it can be envisaged that the next generation systems and services will encompass several domains such as e-Governance, Health Care, Transportation, Waste Management, Food Supply Chains, and Energy & Utilities[8,9]. New technologies and applications built on top of smart devices may fulfill the vision of Intelligent Infrastructure. There are several examples of intelligent home automation or “Smart Home Monitoring” in research labs around the world, such as the GatorTech Smart House Casas [11]Smart Home iDorm[12] , Georgia Tech Aware Home[13] , Place Lab[14], etc. To date, there has been no complete development of a monitoring smart home of commercial perspective, nor any investigation into how such a house is perceived by either the inhabitants or their careers. The smart homes designed so far are for different purposes such as information collection and decision support system for the wellbeing of the inhabitants ,storing and retrieving of multimedia data and surveillance, where the data is captured from the environment and processed to obtain information that can help to raise alarms, in order to protect the home and the inhabitants from burglaries, theft and natural disasters.

This paper illustrates an effective low-cost and flexible solution for condition monitoring and energy management in home. The basic operations include remote management and control of domestic devices such as electric lamp; water heater etc., unobtrusive monitoring of domestic utilizations and providing ambient intelligence to reduce the energy consumption through IoT technology are the key functions of the developed system. This will support and reschedule the inhabitant operating time according to the energy demand and also we used we used passive infra red sensor that turn light on automatically when person pass by, later turn off after a certain predefined delay for even more energy conserving.

II. IMPLEMENTATION OF PROTOTYPE AND PERFORMANCE EVALUTION OF PROPOSED SMART HOME CONTROL SYSTEM

A. System Block Diagram of Smart Home Control Network

The block diagram of the smart home control system is composed of three parts—data collection, communication, and appliance control, as shown in (Fig.1) Data collection is realized using WSNs. The information thus obtained in Arduino Uno is sent by the Zigbee transreciever wirelessly to the management station. After the environmental information is received, the management station determines the states of all home appliances to optimize the power consumption. Additionally we have proposed Passive infra red sensor that turn light and Fan ON automatically when person pass by, later turn OFF after a certain predefined delay for even more energy conserving. Related components that are required in constructing a smart home control network are described below.

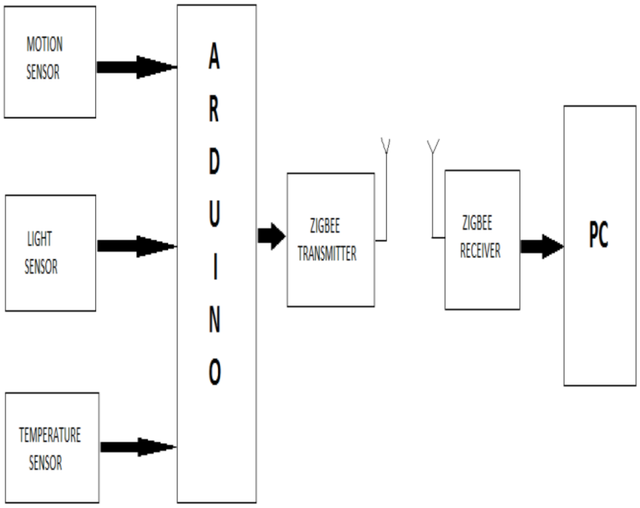

Fig.1.Block diagram for transmitter and receiver side

B. Passive Infra Red Sensor

- PIR sensors allow us to sense motion, almost always used to detect whether a human has moved in or out of the sensors range shown in (Fig.2).
- PIRs are basically made of a pyroelectric sensor, which can detect levels of infrared radiation. Everything emits some low level radiation, and the hotter something is, the more radiation is emitted.

The PIR sensor undergoes two changes, include the Following.

- When a warm body like a human or animal passes by, it first intercept one half of the PIR sensor, which causes a *positive differential* change between the two halves.
- When the warm body leaves the sensing area, the reverse happens, whereby the sensor generates a *negative differential* change. These change pulses are what is detected.
- Once the human motion is detected that turn light on automatically when person pass by, later turn off after a certain predefined delay for even more energy conserving.
- The output of sensor converted to digital that easy connecting with Arduino Uno.

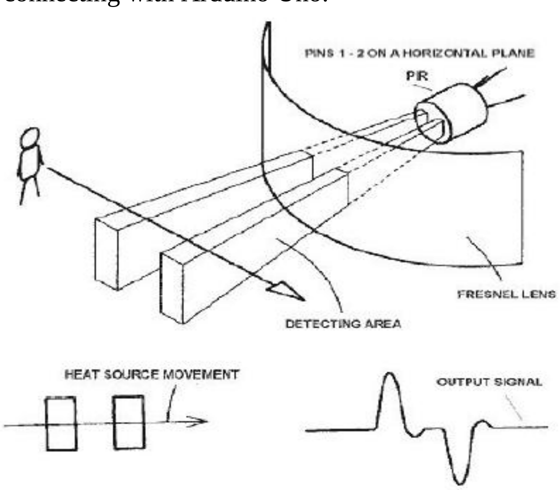

Fig.2.Passive Infrared sensor Detection

C. Temperature Sensor

- In this paper LM35 used is displayed in (fig.3.). The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in °C).
- The LM35 series are precision integrated-circuit temperature sensors, with an output voltage linearly proportional to the Centigrade temperature.
- The output of sensor converted to digital that easy connecting with Arduino Uno.
- The low output impedance, linear output, and precise inherent calibration of the LM35 make interfacing to readout or control circuitry especially easy.

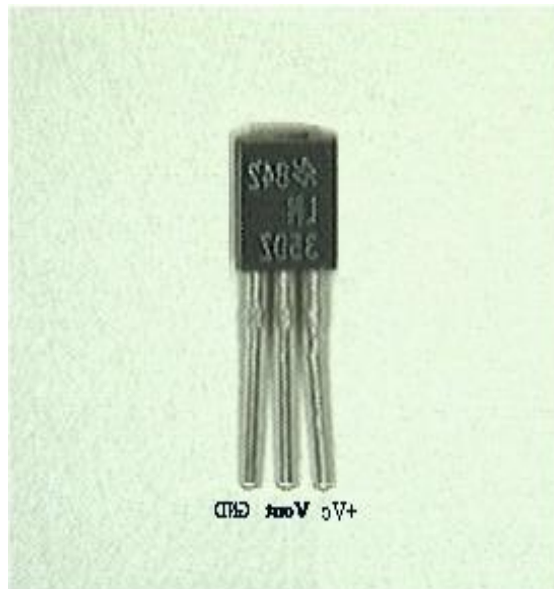

Figure 3: LM35 Sensor

D. Light Dependent Resistor Sensor

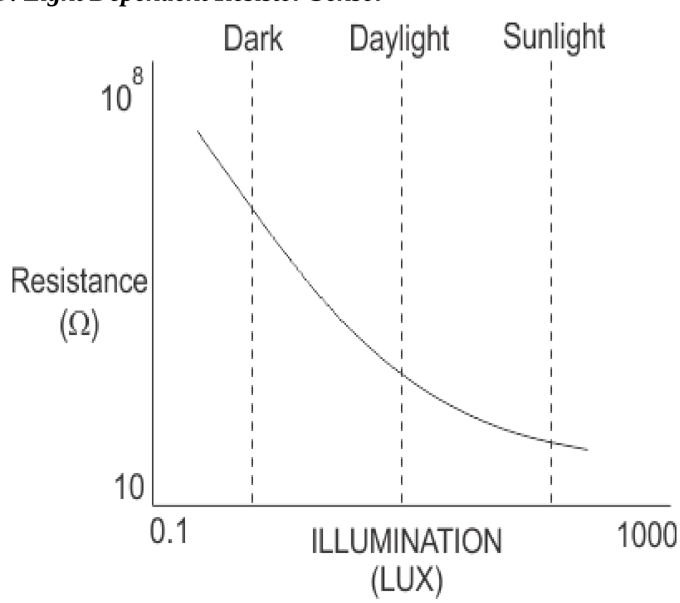

Fig.4. Resistance (vs.) illumination curve

- LDR’s are light dependent devices whose resistance is decreased when light falls on them and that is increased in the dark.

- When a light dependent resistor is kept in dark, its resistance is very high. This resistance is called as dark resistance.
- It can be as high as $10^{12}\ \Omega$ and if the device is allowed to absorb light its resistance will be decreased drastically. The outputs are converted into digital which is connected to Arduino easy.
- If a constant voltage is applied to it and intensity of light is increased the current starts increasing shown in (fig:4).

E. Arduino Uno

In this paper Arduino Uno used is displayed in (fig.5). The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. "Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform.

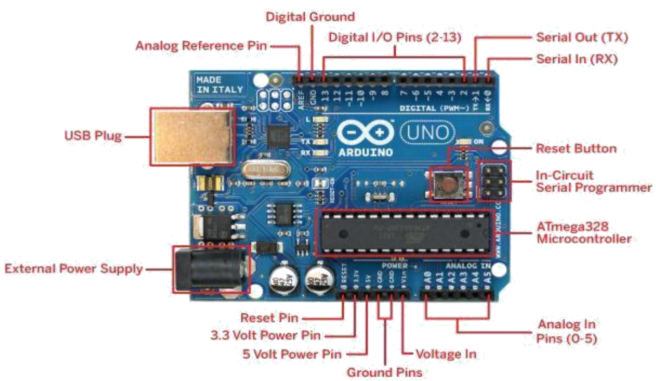

Figure 5: Arduino Uno

F. Zigbee Transreciever

ZigBee used is displayed in (fig.6.)is a specification for a suite of high level communication protocols using small, low-power digital radios based on the IEEE 802.15.4-2003 standard for Low-Rate Wireless Personal Area Networks (LR-WPANs), such as wireless light switches with lamps, electrical meters with in-home-displays, consumer electronics equipment via short-range radio. The technology defined by the ZigBee specification is intended to be simpler and less expensive than other WPANs, such as Bluetooth. ZigBee is targeted at radio-frequency(RF) applications that require a low data rate, long battery life, and secure networking.

Fig.6.Zigbee Module

G. System Prototype

To demonstrate the feasibility of the proposed system architecture, a prototype is constructed, as shown in (Fig.8), (Fig.9). The prototype consists of the ZigBee, WSN, Arduino Uno and PC. An isolated WSN,which includes various sensor nodes and one coordinator that is deployed in each room to collect environmental information, such as temperature, illumination, human detection and other information that is sensed using Ardunio Uno shown in a(Fig.9,10,11) is integrated with Zigbee transmitter that take sensing parameter wirelessly to Zigbee receiver. The sensed output from the zigbee transmitter is configured with Zigbee receiver using X-CTU software and click on Terminal Tab to monitor data received wirelessly from Arduino shown in (fig.12).The Received information are then transmitted to PC using Android Apps so that we can direct the home Appliance with PC.

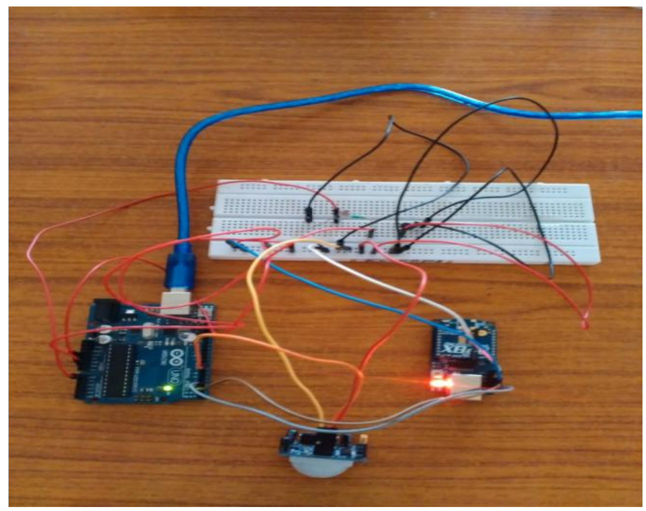

Figure 8: Transmitter circuit display

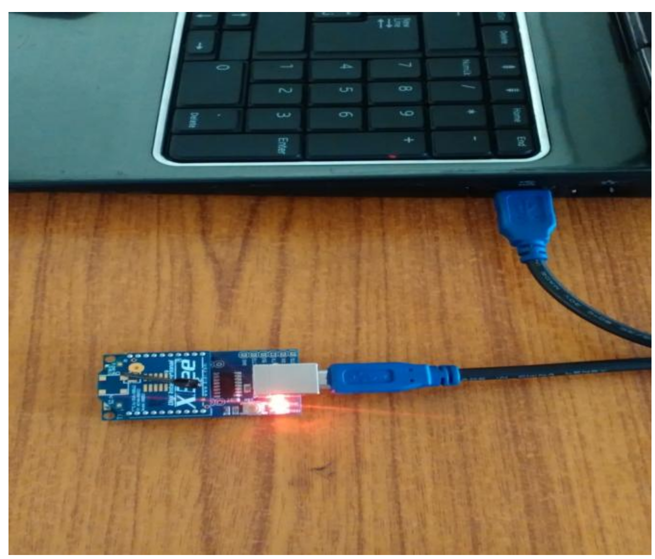

Figure 9: Receiver circuit display

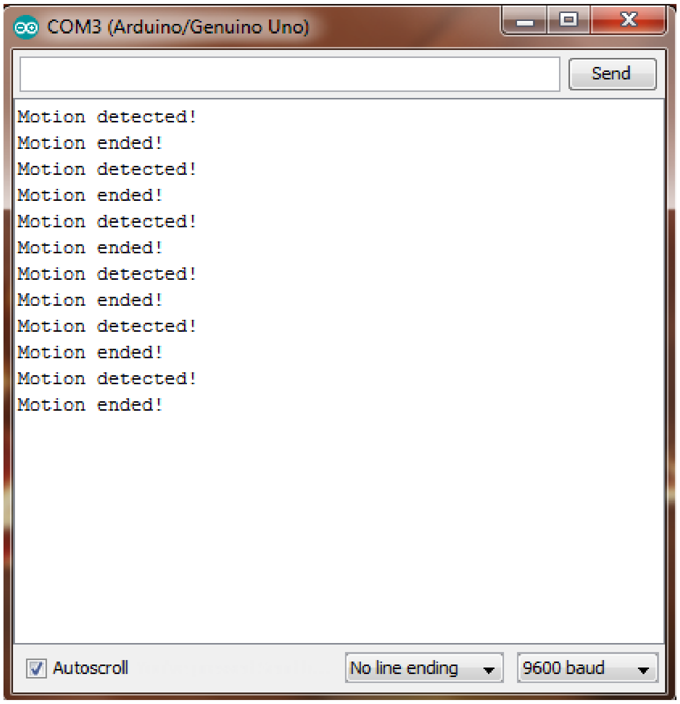

Figure 10: Human motion display

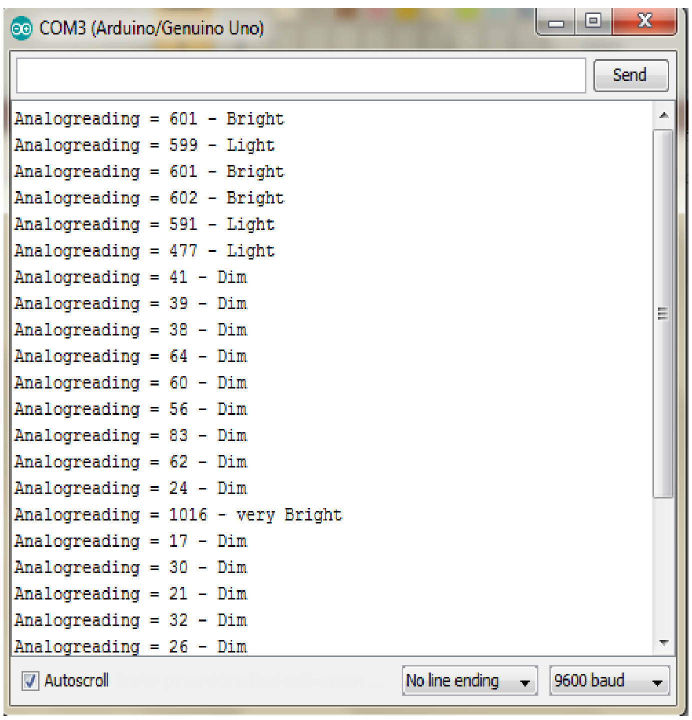

Figure 11: Light illumination Display

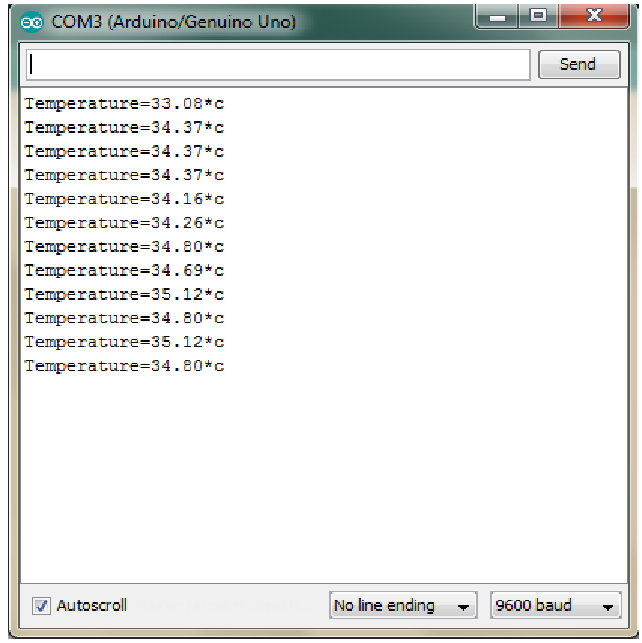

Fig.12. Temperature Display

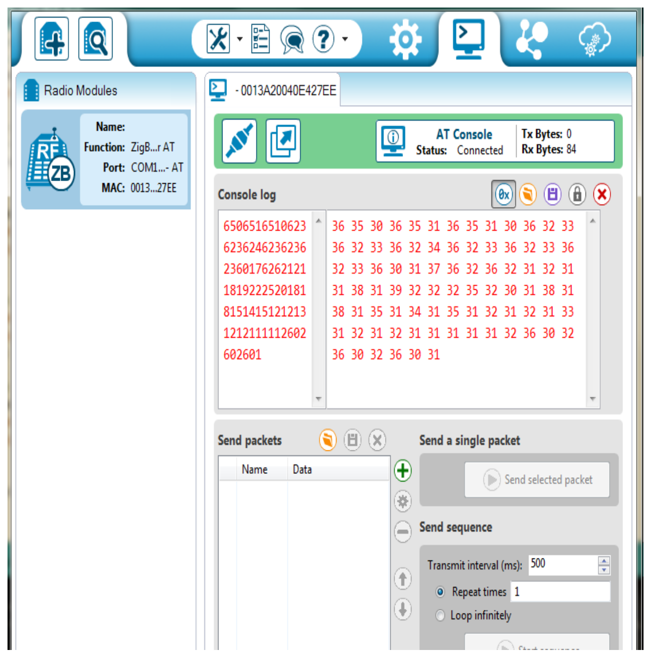

Figure 13: Packet from Arduino to zigbee receiver

III. RESULT AND DISCUSSION

First, the prototype system, which adopts the illumination of a fluorescent lamp along with Passive infra red sensor were presented Initially, all three LED strip lamps in the model house are in the OFF state. The led gets ON when the motion is detected and the light condition is between (0-200 lux).

ILLUMINATION ALGORITHM

D-Dark ,M-motion detected

If D>0 ,M=0 Light OFF

D>0,M=1 Light ON

In the (table.1) the illumination of the light is shown when the motion is detected .The output of the sensor are given to the Arduino Uno which is then connected to the Zigbee transmitter is configured with Zigbee receiver using X-CTU software and click on Terminal Tab to monitor data received wirelessly from Arduino and output can be viewed in the Arduino serial Monitor shown in (Fig.10).

Table.1.Illumination of light when motion is detected

Condition	Range(lux)	Motion sensing	Light
Dark	0-200	Motion not detected	OFF
Dark	0-200	Motion detected	ON
Dim	200-400	Motion detected	ON
Bright	400-600	Motion detected	OFF
Very bright	>600	Motion detected	OFF

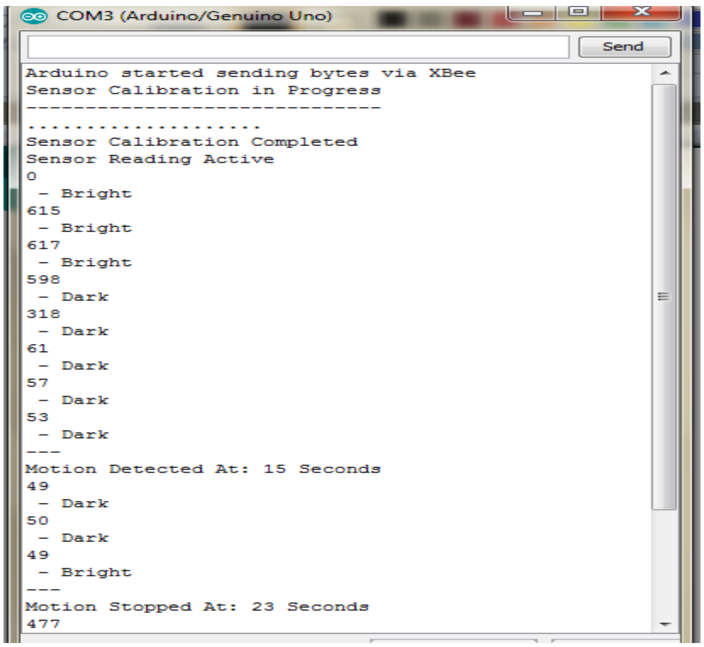

Figure 14: Final result from Arduino serial monitor

CONCLUSION

This paper has designed a prototype and an Illumination of light for smart homes. The proposed smart home control network employs the WSN for data sensing. The proposed network infrastructure possesses the advantages of WSNs and Passive infrared sensor. It simplifies the problem of unnecessary wastage of energy .It is also highly scalable and can be applied to intelligent buildings. A prototype of the proposed smart home control network with the illumination of lighting control was implemented. Practical experiments were conducted to demonstrate that the implemented prototype system works well and that the proposed smart home control network provides a considerable energy saving.

References

[1] R. Missaoui, H. Joumaa, S. Ploix, and S. Bacha, "Managing energy smart homes according to energy prices: Analysis of a building energy management system," *Energy Buildings*, vol. 71, pp. 155–167, Mar. 2014.

[2] C. Molitor *et al.*, "Multiphysics test bed for renewable energy systems in smart homes," *IEEE Trans. Ind. Electron.*, vol. 60, no. 3, pp. 1235–1248,Mar. 2013.

[3] D. M. Han and J. H. Lim, "Smart home energy management system using IEEE 802.15.4 and Zigbee," *IEEE Trans. Consum. Electron.*, vol. 56, no. 3, pp. 1403–1410, Aug. 2010.

[4] M. Eisenhauer, P. Rosengren, and P. Antolin, "A development platform for integrating wireless devices and sensors into ambient intelligence systems," in *Proc. 6th Annu. IEEE Commun. Soc. Sensor, Mesh Ad HocCommun. Netw. Workshops*, Jun. 2009, pp. 1–3.

[5] S. Hong, D. Kim, M. Ha, S. Bae, S. Park, W. Jung, and J. E. Kim,"SNAIL: An IP-based wireless sensor network approach to the internetof things," *IEEE Wireless Commun.*, vol. 17, no. 6, pp. 34–42, Dec. 2010.

[6] N. Bui, A. P. Castellani, P. Casari, and M. Zorzi, "The internet ofenergy: A web-enabled smart grid system," *IEEE Netw.*, vol. 26, no. 4,pp. 39–45, Jul.–Aug. 201[7] A. Iera, C. Floerkemeier, J. Mitsugi, and G. Morabito, "The internet of things," *IEEE Wireless Commun.*, vol. 17, no. 6, pp. 8–9, Dec. 2010.

[7] A. Gluhak, S. Krco, M. Nati, D. Pfisterer, N. Mitton, T. Razafindr alambo, "A survey on facilities for experimental internet of things research," *IEEE Commun. Mag.*, vol. 49, no. 11, pp. 58–67, Nov. 2011.

[8] M. Zorzi, A. Gluhak, S. Lange, and A. Bassi, "From today's INTRAnet of things to a future INTERnet of things: A wireless- and mobility related view," *IEEE Wireless Commun.*, vol. 17, no. 6, pp. 44–51,Dec. 2010.

[9] A. Sehgal, V. Perelman, S. Kuryla, and J. Schonwalder, "Management ofresource constrained devices in the internet of things," *IEEE Commun.Mag.*, vol. 50, no. 12, pp. 144–149, Dec. 2012.

[10] S. Helal, W. Mann, H. El-Zabadani, J. King, Y. Kaddoura, and E. Jansen,"The gator tech smart house: A programmable pervasive space," *IEEEComput.*, vol. 38, no. 3, pp. 50–60, Mar. 2005.

[11] D. J. Cook, "Learning setting-generalized activity models for smart spaces," *IEEE Intell. Syst.*, vol. 27, no. 1, pp. 32–38, Jan.–Feb. 2012.

[12] F. Doctor, H. Hagras, and V. Callaghan, "A fuzzy embedded agent based approach for realizing ambient intelligence in intelligent inhabited environments," *IEEE Trans. Syst., Man Cybern., A, Syst. Humans*,vol. 35, no. 1, pp. 55–65, Jan. 2005.

[13] J. A. Kientz, S. N. Patel, B. Jones, E. Price, E. D. Myantt, and G. D. Abowd, "The Georgia tech aware home," in *Proc. Extended Abstracts Human Factors Comput. Syst.*, 2008, pp. 3675–3680.

[14] I. S. Larson, K. Tapia, E. Beaudin, J. Kaushik, P. Nawyn, and J. R. Rockinson, "Using a live-in laboratory for ubiquitous computing research," in *Pervasive Computing* (Lecture Notes in Computer Science), vol. 3968,K. Fishkin, B. Schiele, P. Nixon, and A. Quigley Eds. Berlin, Germany:Springer-Verlag, 2006, ch. 22, pp. 349–365.