IJCSE International Journal of Computer Sciences and Engineering Open Access
Survey Paper Vol.-7, Special Issue-18, May 2019 E-ISSN: 2347-2693

Design and Development of Energy Efficient Lighting Controller

Amrita Saha[1*], Debabrata Paul[2], Roni Jana[3], Soham Datta[4], Amartya Roy[5]

[1,2,3,4,5]Department of Electrical Engineering, Pailan Technical Campus, Kolkata, WB, India

[*]*Corresponding Author: amrita2saha@gmail.com, Tel.: +91 8479067233*

Available online at: www.ijcseonline.org

***Abstract*—** In the paper we have developed a model classroom to use artificial light with respect to the incoming daylight with a purpose to save energy. The classroom is assumed to be divided into two parts according to the no. of occupant present and the region of operation will vary according to the presence of occupant in the working plane. Different sensors are used to obtain several data like Infrared sensor, Light sensor, occupancy sensor to obtain no. of occupant, daylight and region of presence of occupant. A microcontroller is used to which is connected with the sensors to obtain the input data and sends the data as an output to the relay which is connected with the load. The relay will operate according to the sensor values and will be displayed in the LCD display. The presence of occupant will turn on the load depending on the lux value and will turn off if the occupant leaves.
From the above paper we can save energy and utilize daylight.

***Keywords*—** Daylight, Artificial Light, Energy Efficient, Light Sensor, Occupancy Sensor, Infrared Sensor, Microcontroller

I. INTRODUCTION

In the present era of automatic control, automatic system plays an important role. Automation leads to efficient and energy conserving system if implemented in daily life can be energy efficient. Integration of available daylight with artificial light is indispensable for the concept of energy efficient lighting control [1]. Daylight if brought in contact with artificial light can provide better lighting control as daylight is Dynamic in nature and thus gives a healthy and efficient working condition [2]. Thus to adapt to interior lighting control with daylight is an efficient way to reduce energy demand in lighting [3]. Lighting control logic when developed and installed in a light controller system, light output of lamps can be controlled monitoring the available daylight from the window and accordingly controlling the artificial light [1]. Infrared Sensor as a door sensor is commonly used for energy saving lighting control to develop automatic light switching system and will lead to energy efficient lighting control [4]. Microprocessor / Microcontroller based system with light sensor and occupancy sensor based lighting control may be used as energy efficient lighting control. The occupancy sensor is used to detect human movement and position in the room and light sensor value will accordingly control the artificial light reducing power consumption. [5, 6].

The paper aims in reducing the daily consumption of energy in artificial light implemented in a model classroom has been developed using light sensor, occupancy sensor and infrared sensor which monitors daylight illuminance, occupant position and no. of occupant in the classroom respectively providing an energy efficient light control system with a microcontroller receiving input and delivering output simultaneously and accordingly controlling the light load provided with a LCD Display to display occupant count and daylight illuminance (lux).

II. PROPOSED ENERGY EFFICIENT LIGHTING CONTROL SCHEME

In our project we have designed a model classroom with automatic turn on and turn off of load with respect to the sensor output. This room is provided with a door for entry and exit purpose and a window for the incoming daylight which can be distributed in the working plane. The room is divided into two parts virtually to utilize the proper orientation of occupant in the room. When the no. of occupant in the room is more, they will get distributed in both the halves and we can save energy as the load of the next half can be saved.

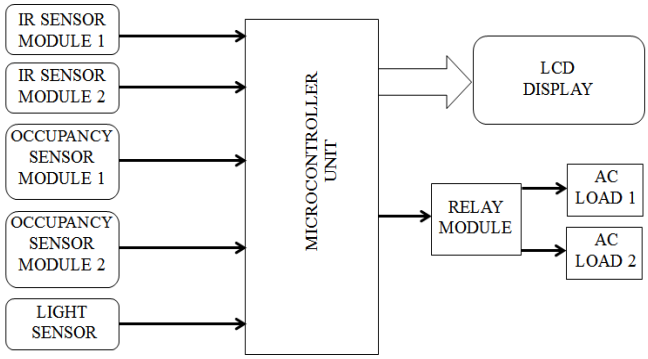

Figure 1. Block diagram of Energy Efficient Lighting Controller

The door is mounted with two Infrared Sensor (IR Sensor) which is used as a occupant counter and detects the no. of occupant present and the value is displayed in the LCD Display. The value is sent to the microcontroller as a input and the value of IR Sensor plays an important role in the operation of the whole circuit. If the value of the IR Sensor is 1 then the rest of the sensors will operate else the system will remain off.

A Light Sensor is used to measure the daylight illuminance entering the classroom. The lux value is obtained from Light Sensor is passed as a input to the microcontroller. A standard lux value is considered which when coming in sufficient amount from the sunlight will turn off the artificial load and when the lux value decreases from the considered value, it will turn on the load depending on the no. of occupant and the position of the occupant. Since the daylight is dynamic in nature, it will change with the movement of the sun and thus the artificial load will operate accordingly. When the daylight is sufficient for the working plane, the artificial light will remain off or else if the daylight is below the considered value the light will be on depending on the position of the occupant.

A Occupancy Sensor is used along with the IR Sensor and Light Sensor. The two halves of the room is each mounted with a Occupancy Sensor with individual working region and sensitivity range. If the no. of occupant present in the room are less then they are assumed to settle in one halve and if the no. of occupant is more then they will accommodate in both the region. Depending on the value of Light Sensor and Infrared Sensor, Occupancy Sensor will opearate. When occupant is present and Light Sensor value is above the considered value, the Occupancy Sensor will sense the position of the occupant but load will be off. If the Occupant is present and the Light Sensor value is below the considered value, the load will operate individually or both the load will work together depending on the position of the occupant detected by the Occupancy Sensor.

Accordingly when the occupant leaves the room, the Infrared Sensor counts Zero (0) and the load will turn off automatically.
As the operation of the load is Automatic depending on the considered parameters we can save energy and increase the efficiency of the system by the proper use of daylight.

III. DEVELOPMENT OF ENERGY EFFICIENT LIGHTING SYSTEM

A. Circuit Development

Relevant For the development of Energy Efficient Lighting Scheme we have several sensors working together simultaneously according to the developed logic. In our model we have used:

- Microcontroller ARDUINO UNO - Atmega328P for receiving the sensor input and delivering the output to the relay model connected with the two different loads in two different working regions.
- Infrared Sensor - Two Infrared Sensor Module (IR1 and IR2) is used as the visitor counter that counts the number of occupant entering and leaving the classroom and the number of occupant is displayed in the LCD Display placed outside the classroom where the two sensors works simultaneously. When IR1 is high first and then IR2 is high the counter increases the value with 1. Similarly when the IR2 is high first and then the IR1 is high the counter decreases the value with 1.

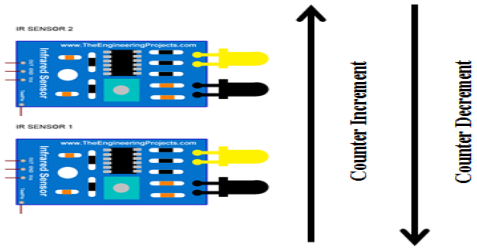

Figure 2. Logic of Visitor Counter

- Light Sensor – BH1750 module is used as a light sensor which measures the incoming daylight lux value placed in the window and the lux value is displayed in the LCD Display.
- Occupancy Sensor – PIR (Passive Infrared) Sensor is used as an occupancy sensor that detects the position of the occupant in the classroom with two PIR sensors working in two different region operating two different load.
- Relay Module – Make a bridge between control circuit and power circuit.

The output from the three different sensors is delivered to the microcontroller which is connected to the Relay Module that is accordingly operating the two loads.

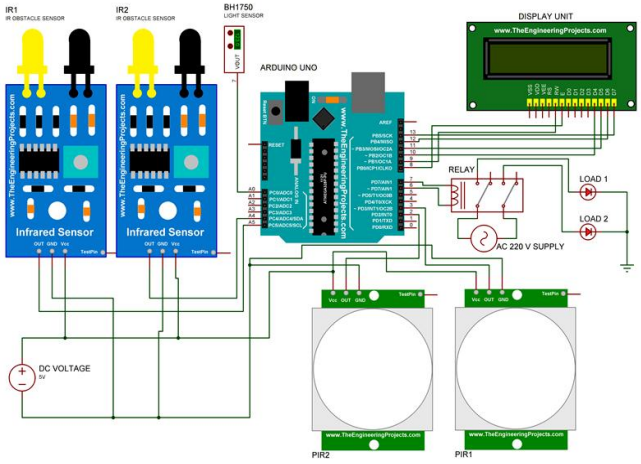

Figure 3. Circuit diagram of the controller

B. Boundary Condition

The boundary condition of the system given bellow.

Table 1. Boundary condition of the system

Infrared Sensor	Light Sensor	Occupancy Sensor 1	Occupancy Sensor 2	Load 1 Status	Load 2 Status
LOW	X	X	X	OFF	OFF
HIGH	LOW	X	X	OFF	OFF
HIGH	HIGH	LOW	HIGH	OFF	ON
HIGH	HIGH	HIGH	LOW	ON	OFF
HIGH	HIGH	HIGH	HIGH	ON	ON

Where, infrared sensor low means no students in the room, high means students present in the room, light sensor low means, present light condition is above threshold value and high means bellow threshold value, X means don't care condition.

C. Flow chart of the system

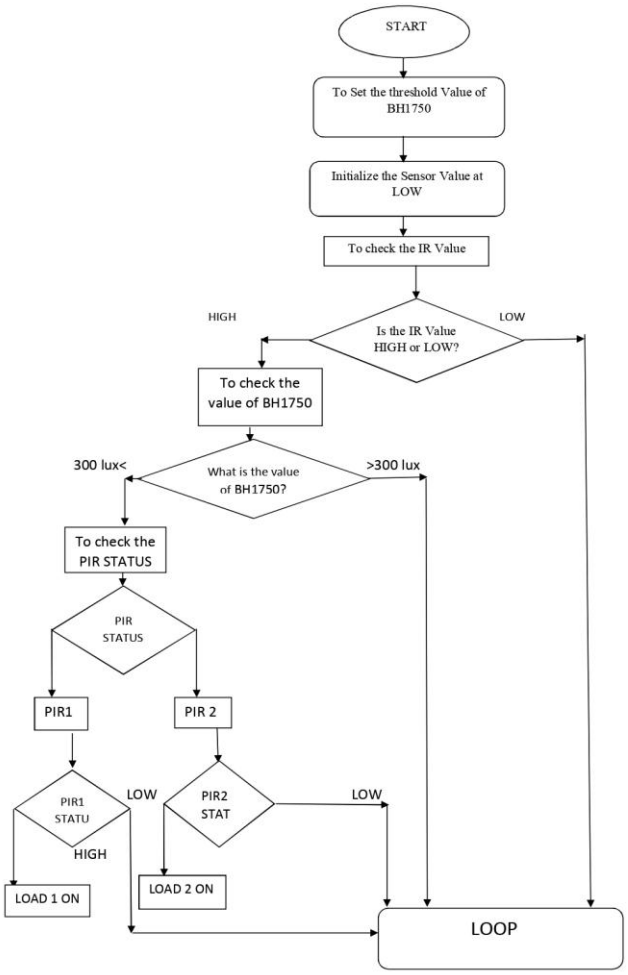

Figure 4. Flow chart of the proposed system

D. Actual Developed System

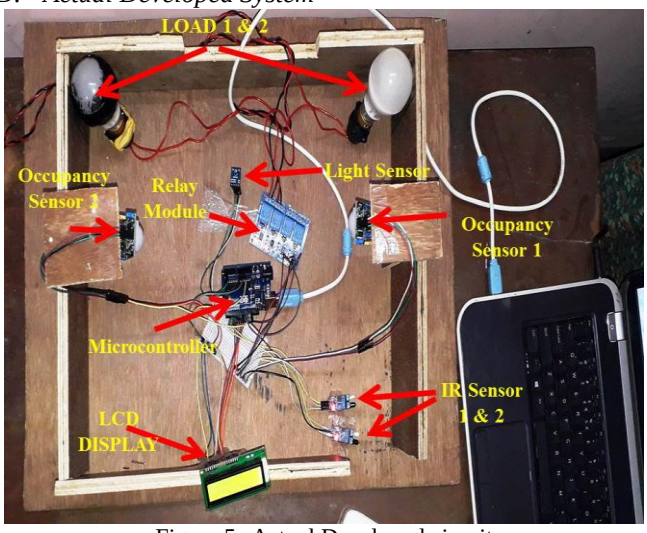

Figure 5. Actual Developed circuit

IV. EVOLUTION OF PROPOSED SCHEME

In the above proposed lighting control system we have made a model implementing the several sensors working together under a developed lighting logic. In the evaluation table we have represented:

Table 2. Evaluated Table

Infrared Sensor (no. of Students)	BH1750 Reading (Lux)	PIR Sensor 1 (No. of Students in position 1)	PIR Sensor 2 (No. of Students in position 2)	Load Status (Position 1)	Load Status (Position 2)
5	550	5	0	OFF	OFF
6	250	6	0	ON	OFF
5	600	0	5	OFF	OFF
6	123	0	6	OFF	ON
10	530	2	8	OFF	OFF
20	116	10	10	ON	ON
0	230	0	0	OFF	OFF
0	690	0	0	OFF	OFF

In the above observation table we have shown the operation of the two loads with the input of all the sensors working together. We will discuss few working condition of the above observation table.

- When IR value is HIGH, the BH1750 value is >300 lux and the PIR1 is LOW and PIR2 is HIGH and then the LOAD1 will be LOW and LOAD2 will be LOW as well since the value of the incoming daylight is sufficient for the working plane and thus artificial light is turned OFF.
- When the IR value is HIGH, and the BH1750 value is >300 lux and the PIR1 is LOW and PIR2 is LOW then

the LOAD1 will be LOW and LOAD2 will be LOW as well since both the PIR Sensor has sent a LOW thus there is no occupant present in the working plane thus the artificial light is turned OFF.

V. CONCLUSION

From the paper we can conclude that if the daylight is properly used it reduces the need of artificial light, thus reducing energy consumption. If the sensor based logic circuit is implemented in the classroom that operates on the developed logic receiving input from the different sensors it leads to an Energy Efficient Lighting Controller System maintain the considered lux value in the working plane.
On the application of the system we can save energy reducing the energy demand in our daily life.

ACKNOWLEDGMENT

Thanks to the Department of Electrical Engineering, Pailan Technical Campus. Special thanks to Prof. (Dr.) Nirmalendu Chatterjee, Ex Professor of Electrical Engineering Department, Jadavpur University, Kolkata-32 & Prof. (Dr.) Biswanath Roy, Professor of Electrical Engineering Department, Jadavpur University, Kolkata-32
We have done this project on the final semester of our diploma career. I am very thankful to my classmates and teachers, without them we could not have written this paper.

REFERENCES

[1] Pradip Kr Maiti, Akash Deep Singh, Biswanath Roy, *"Design and development of daylight responsive RF light controller"* IEEE Calcutta Conference (CALCON), 2017, **India**, pp.**309-313**, **2017.**
[2] Dheeraj Bansal, Munish Kumar, Nilanjan Dutta, Hammadur Rahman, Avijit Singha, Md. Akhtar Alam, Amartya Roy, *"Integration of Artificial & Day Light to Reduce Energy Demand"*, Luminescence-2017, National Student Congress on Illumination, Kolkata, **India**, **2017.**
[3] L. Parise, F. Lamonaca, D.L. Carnì, *"Interior lighting control system: A practical case using daylight harvesting control strategy"* 2015 IEEE 15th International Conference on Environment and Electrical Engineering (EEEIC), **Rome**, pp.**719-724**, **2015.**
[4] Ranjit Singh Sarban Singh, Ahamed Fayeez Tuani Ibrahim, Sani Irwan MD Salim, Wong Yan Chiew, *"Door Sensors for Automatic Light Switching System"* 2009 Third UKSim European Symposium on Computer Modeling and Simulation, Athens, **Greece**, pp.**574-578**, **2009.**
[5] Ying-Wen Bai, Yi-Te Ku, "*Automatic room light intensity detection and control using a microprocessor and light sensors*", IEEE Transactions on Consumer Electronics, Vol.**54,** Issue.**3**, pp.**1173-1176**, **2008**.
[6] Jayashri A.Bangali, Arvind D.Shaligram, *"Energy Efficient Lighting Control System Design For Corridor illumination"*, International Journal of Scientific & Engineering Research, Vol.3, Issue.4, pp.1-6, 2012.

Authors Profile

Ms. Amrita Saha, Final year students of Department of Electrical Engineering, Pailan Technical Campus, Kolkata – 700104.

Mr. Debabrata Paul, Final year students of Department of Electrical Engineering, Pailan Technical Campus, Kolkata – 700104.

Mr. Roni Jana, Final year students of Department of Electrical Engineering, Pailan Technical Campus, Kolkata – 700104.

Mr. Soham Datta, Final year students of Department of Electrical Engineering, Pailan Technical Campus, Kolkata – 700104.

Mr. Amartya Roy, B.Tech (WBUT), M.Tech (Jadavpur University), Working as an Assistant Professor from Department of Electrical Engineering, Pailan Technical Campus, Kolkata - 104. He has published more than 5 research papers in reputed international journals. His main research work focuses on condition monitoring system, illumination engineering He has 7 years of teaching experience and 2 years of Industry Experience.