IJEE 0973-7383 Volume-9 • Number-2 June -Dec 2017 pp. 54-56 available online at www.csjournals.com

Sensor Based Lighting Control System for Energy Efficient Building Environment Using Real-Time Occupancy Measurements

Mr. Rahul Mishra, Dr. Shelej Khera, Mr. Manoj Kumar, Mr. Vikrant Verma
Department of ECE, BRCM College of Engineering & Technology, Bahal
rahulmishraoct12@gmail.com, shelej@brcm.edu.in, manojkumar@brcm.edu.in, vvikrant@brcm.edu.in

Abstract: This paper presents the implementation of a sensor based lighting control system to be deployed in a college hostel building. The aim is to conserve energy by taking real-time occupancy measurements in hostel galleries and rooms to switch OFF the electrical appliances automatically when not in use. An Occupancy Sensor is a lighting or heating control device that detects occupancy of a space by people and turns the lights and/or Heating, Ventilation, and Air Conditioning (HVAC) system on or off automatically, using infrared, ultrasonic, microwave, or other technology. Occupancy sensors are typically used to save energy and provide automatic control. The occupancy sensors used here are PIR (Passive Infrared Sensors), Ultrasonic Sensors and Dual-Technology sensors. The main controlling element implemented here is a high performance eight-bit microcontroller of Atmel make. The system is designed, developed, implemented and tested in the hostel building and finally the energy saved has been calculated.

Key-Words: PIR, Ultrasonic Sensors, Microcontroller, Occupancy sensors, energy conservation.

INTRODUCTION

The occupancy sensors remain application-sensitive devices. The goal is to gain the full advantages of occupancy sensor operation while avoiding possible negative outcomes, most notably nuisance switching (lights are switched under false conditions, such as turning off while somebody is still in the room but has been motionless for several minutes). As a result, thoroughly understanding the characteristics and requirements of the application and subsequently making appropriate design decisions — sensing technology, coverage patterns, sensor location, special features, and commissioning — are critical for ensuring a trouble-free application. A motion-sensing light is one that is activated by a motion sensor rather than by a conventional light switch. A motion-sensor can either replace conventional light switches or be placed onto an existing lighting fixture. While motion-sensing lights are normally associated with outdoor lighting applications, they are becoming increasingly popular indoors in places such as pantries, hallways, and backdoor rooms. Installing an indoor motion-sensor switch: Pick the room inside where a motion-sensor switch would be able to replace a light switch. This can be in closets, pantries, foyers, hallways, or anywhere else that you stay only briefly and need the light on only a short amount of time. Keep in mind that you want the motion detector to switch on when someone enters the room, but not merely when someone passes the room.

PROPOSED WORK

The proposed work is to design and develop a computation intensive embedded system to survey the occupancy status of different parts of a building during day and night hours.

- Priory an ultrasonic sensor based visitor counter will be developed and installed in a gallery to know the statistics of occupants at different hours of the day and night.
- An embedded system consisting of a PIR sensor and ultrasonic sensors will be developed and deployed inside a room to detect the occupancy/ vacancy for the control of luminaries and fans.
- Another embedded system consisting of an ultrasonic sensor will be developed and deployed at proper positions inside the gallery for the control of luminaries at different hours of the day and night.
- Algorithms will be developed and modified according to the statistical data obtained from deployed sensors about the occupancy at different locations.

IMPLEMENTED WORK

[1] Gallery Occupancy Based Lighting Control

- Initialize 16-bit counter and store minutes in a variable 'realtime' for system run time equivalent to RTC.
- Read the values from PIRs.
- If PIR-1 is triggered then relay-1 is ON
- If PIR-2 is triggered then relay-1 and relay-2 both are ON
- If PIR-1 and PIR-2 both are triggered then relay-1 and relay-2 both are ON
- If PIR-3 is triggered then relay-2 and relay-3 both are ON
- If PIR-2 and PIR-3 both are triggered then relay-1 and relay-2 and relay-3 all are ON
- If PIR-4 is triggered then relay-3 is ON
- If PIR-3 and PIR-4 both are triggered then relay-2 and relay-3 both are ON

Calculation of Occupancy

- Take a global variable named 'count'. It will count the time of ON state of appliances.
- If any of the relay is triggered then the appliance ON and an eight bit timer start to count the minutes. When all the relays are OFF then it will add the appliance ON time to the previously saved timer value.

Calculation of Total Energy Saved

We can see the total energy saved on the LCD screen. The system itself calculates the net percentage of total energy saved i.e. obtained after deploying occupancy sensors in the galleries of hostel building. The formula for the calculation is given below:

Percentage Energy Saved = 100 – {(value of 'count') / (value of 'realtime')} * 100

[2] Room Occupancy Based Lighting Control

1. Start the system deployed in the room
2. Check the value of single PIR sensor installed inside the room
3. (Default state: the person starting the system is already inside the room) Thus if PIR = 1 then IN = 1, OUT = 0 and PRESENT = 1 and the Relay will be ON.
4. If any person exits the room then Ultrasonic-1 detects first and then Ultrasonic-2 detects the person and the status of IN = remains same, OUT = incremented and PRESENT = decremented.
5. If any person enters the room then Ultrasonic-2 detects first and then Ultrasonic-1 detects the person and the status of IN = incremented, OUT = remains same and PRESENT = incremented.
6. If the only person present in the room exits then the status of PRESENT = 0 that shows zero occupancy inside the room. Under this condition the microcontroller will wait for 20 seconds and after that if no is motion detected, it will turn the relay OFF and the relay will be ON again if the PIR detects any kind of motion inside the room or if PRESENT status change. If status of PRESENT > 0 then relay remains ON.

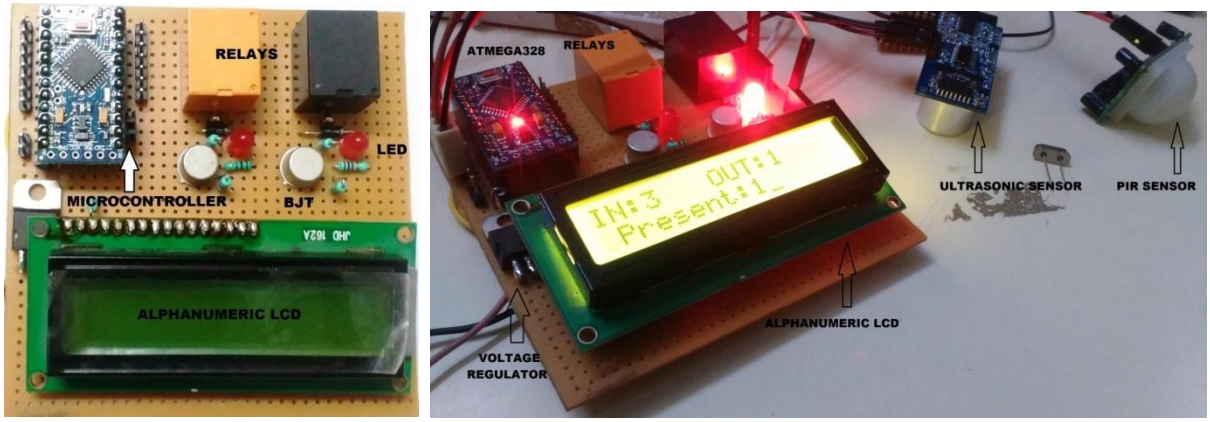

Figure-1: Occupancy based Light Controller

Figure-2: Ultrasonic Sensors deployed on both sides of the room entrance

RESULTS & CONCLUSION

From the experimental results, we can know that an array of PIR-based modules mounted on walls at appropriate distance from each other could classify the direction of movement, the distance of the body from the PIR sensors and the speed level of movement during two-way, back-and-forth walking and even identify the walking subjects. A ceiling-mounted PIR-based module could also classify the direction, distance and speed of walking subjects, but does not perform subject identification well.

REFERENCES

[1] Han Z., Gao R.X., Fan Z. Occupancy and indoor environment quality sensing for smart buildings. Proceedings of 5th European DSP Education and Research Conference (EDERC'12); Austria. 13–16 May 2012; pp. 882–887.

[2] Tsai C.-H., Bai Y.-W., Chu C.-A., Chung C.-Y., Lin M.-B. PIR-sensor-based lighting device with ultra-low standby power consumption. IEEE Trans. Consum. Electron. 2011;57:1157–1164.

[3] Tsai C.-H., Bai Y.-W., Cheng L.-C., Lin K.-S., Jhang R.J.R., Lin M.-B. Reducing the standby power consumption of a pc monitor. In Proceedings of the 1st Global Conference on Consumer Electronics; Tokyo, Japan. 2–5 October 2012; pp. 520–524.

[4] Erickson V.L., Achleitner S., Cerpa A.E. POEM: Power-efficient occupancy-based energy management system. In Proceedings of the 12th International Conference on Information Processing in Sensor Networks,; Philadelphia, PA, USA. 8–11 April 2013; pp. 203–216.

[5] Gopinathan U., Brady D.J., Pitsianis N.P. Coded apertures for efficient pyroelectric motion tracking. Opt. Express. 2003;11:2142–2152.

[6] Shankar M., Burchett J.B., Hao Q., Guenther B.D., Brady D.J. Human-tracking systems using pyroelectric infrared detectors. Opt. Eng. 2006;45:106401.

[7] Hao Q., Brady D.J., Guenther B.D., Burchett J.B., Shankar M., Feller S. Human tracking with wireless distributed pyroelectric sensors. IEEE Sens. J. 2006;6:1683–1696.