Design of Smart and Intelligent Power Saving System for Indian Universities

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Abstract Now-a-days power management plays a vital role in reducing the consumption and efficient utilization of the resource. In traditional system, manual operation of electrical devices in university gets unnoticed, that leads to maximum wastage of power i.e., with different device operating even when the classroom is abandoned. These extended hours of operation leads to maximum power wastage. In order to overcome this problem, we have designed a "smart and intelligent power saving system for Indian Universities", where every classroom is equipped with passive infrared sensor (PIR) which responds to occupancy, and corresponding devices are switched ON /OFF automatically. The entire system is monitored and controlled by the central base station.

1 Introduction

The economy of any nation mostly depends on energy utilization in different fields of science and technology. Therefore, efficient energy utilization and consumption in every field is a burning research issue in the present day scenario. In a developing country like India, the gap between electricity supply and its requirement in terms of both capacity and energy has been steadily grown. The formidable challenge of meeting the energy needs and providing adequate and varied energy of desired quality to user in a sustainable manner and at reasonable cost, improving efficiency has become critical component of energy policy [1]. In India, almost all the places adopt manual switching system for the electrical appliances like lights and fans, which often goes unattended in public places, class rooms, seminal halls etc. This results in considerable energy wastage as well as under-utilization of resources. Similar situations demand for a smart and automatic energy utilization system to reduce the gap. This paper, aims for the efficient energy utilization in a university campus. In most of the Indian schools/ colleges/ Universities, the class rooms, seminar halls, Auditoriums, toilets are left with lights and fans in switched ON mode even when there is no occupancy in the same. This situation has motivated for the design of a wireless sensor network based smart energy monitoring system, that considers the human occupancy in a particular room and controls the electrical devices like lights and fans automatically without any human intervention. The state of the electrical

lights, fans and the sensors in various class rooms are monitored centrally through the base station.

2. Related Work

Electricity is wasted in an enormous amount in any university of India. The authors of [2] have tried to analyze the electricity profile of a University of the Aligarh Muslim University, India. This is also a major hub of research and innovations. The analysis says that 66% of the total electric supply is being consumed by the offices, departments and street lights whereas rest 34% is being consumed by the staff quarters, halls of residences and line losses. Similar situation exists in most of the universities in India. Almost all the Universities consume more electricity than their sanctioned limits while meeting the technological demands and facilities. The increased consumption also imposes high penalty on the Universities. Such an alarming situation demands for the smart utilization of the electricity and energy conservation. In the International scenario also the authors of [3] have made a study on the wastage of electricity in the classrooms of Shandong University. They have calculated that by saving 30% of energy, an amount of 150 k to 200 k Yuan of electricity fee will be saved. The authors have suggested to install sensors on every lamp of the class room, so that the light goes ON /OFF as per the occupancy of anybody in the sensor zone. However, deploying sensors for each lamp and coordinating the communication of several sensors is a tedious task. Recently various works have been done in designing the general overview of the remote access approaches to control devices in which switches of the different lamps and fans are controlled automatically according to the need and requirement, so as to avoid energy wastage, and save expenditure. Controlling the electricity consumption in the university according to the occupancy, as well as required light intensity in any particular area according to the need and requirement [3] [4], direction of movement as well as the speed of the movement of human being are monitored using the concept of dual sensors [5].

Various lights can be monitored and controlled all around using the client-server architecture. Doppler sensor is used for entity detection and user interface that enable the remote monitoring and control of the street lights and run through the computerized unit located in the computer center consisting of the computerized unit that has TCP/IP connection.

3. Proposed System Model

We have proposed a smart energy monitoring system for a university campus by deploying a wireless sensor network around it. The sensors are planned to be deployed at the entrance doors of every class room, halls, office and toilets of the building. Similarly the sensors are planned to be deployed at the corridor lamps as well. The sensors at the entry of every room would detect the occupancy inside it and would turn ON /OFF the electrical devices like the lights, fans, and other switch points to run the overhead projectors, hand dryers etc. The block diagram of the

proposed monitoring system is shown in Fig.1. The sensor SN(1)...SN(n) are deployed at the different rooms entrance. The corridor are deployed with sensor CD(1)....CD (m) around the lamp.
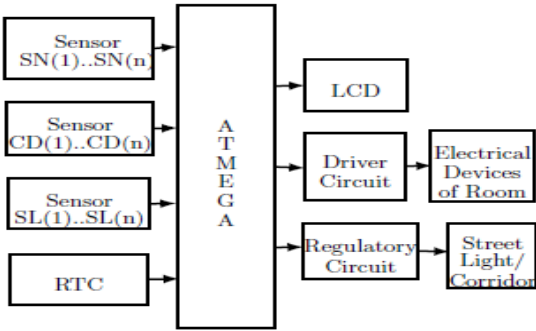

Fig.1: Block Diagram of the System

Here, the sensors are used to detect the occupancy of any room and the corridor. An RTC provides a real time to the ATMEGA micro-controller. The LCD displays the current occupancy in any room and the corresponding devices are controlled using driver circuit. Corridor lights are controlled with regulator circuit optimizing the power utilization.

The PIR sensors installed at the entrance of the class room detects the presence of any person entering and leaving the class room giving the total number of occupancy in that room. Two sensors SN1 and SN2 are placed at the door of any room determining the direction of movement of the person as shown in the Fig.2.
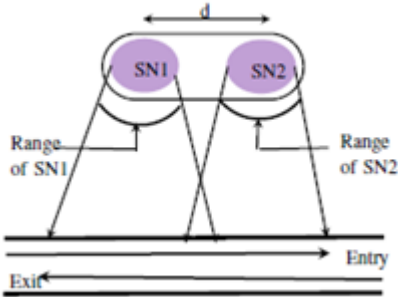

Fig. 2: Direction of student movement

For the entry of any person node SN1 detects first followed by node SN2, incrementing the occupancy by 1. Similarly, for an exit case, the node SN2 detects first followed by node SN1, decrementing the occupancy counter by 1. The proposed monitoring system is designed in such a way that, the electrical devices in the room get switched ON as soon as the occupancy counter gets a non-zero value, and they remain in the same state till the value of the occupancy counter becomes zero again.

All the electrical devices are switched OFF as the counter becomes zero. A room having multiple doors can also be designed in the similar way. The data collected from all the sensor nodes are communicated to an ATMEGA microcontroller that controls the entire operation of the electrical devices.

4. System Hardware Description

The circuit diagram of our proposed model is shown in Fig. 3. It consists of ATMEGA microcontroller (ATMEGA328P), PIR sensor, LCD display, a RTC (RTCDS1302), and the driving circuit for controlling the loads of the classroom.

ATMEGA328P (U1) is a single chip with inbuilt flash memory of 32bytes and RAM of 2KB. It is used as a central processing unit, which control the entire operation. There are three PIR sensors connected to pin 12, 15, 16 of microcontroller (U1) of which two sensors are used to detect the occupancy of classroom and the other is used to detect the presence of any entity in the corridor.

A 16x2 liquid crystal display (LCD1) is interfaced to microcontroller (U1) that shows the current occupancy of any room. LCD1 modules with pin 4, 5, 6 as control signals are connected to pin 18, 8, and 17 of micro-controller (U1). The command signals are given to the LCD to perform some predefined tasks and pin 11, 12, 13, and 14 as data pins are connected to pin 11, 6, 5, and 4 of U1 that displays the data on the LCD.
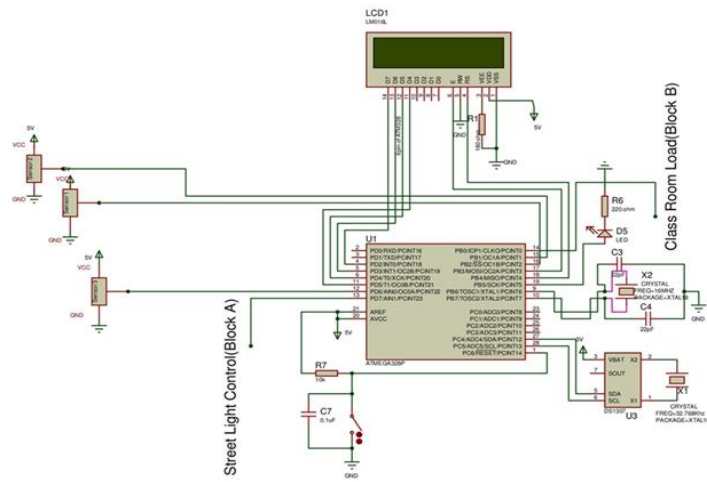

Fig.3: Circuit Diagram of the System Model

A RTC (RTCDS1302) contains a real-time clock/calendar and of 31 bytes of static RAM. It communicates with micro controller U1 via a simple serial interface, where serial data (SDA) at pin 5, serial clock (SCL) at pin 6 is connected to pin 27 and pin

28 of micro-controller. Data can be transferred to and from the RAM of 1 byte at a time or in a burst of up to 31 bytes. In addition, it has the features of dual power pins for primary and backup power supplies providing the updated time even if the circuit resumes from power failure.

The Driver Circuit is shown in Fig. 4. It is used to check the load in the class room, which is controlled by a 5v relay (RL3) driven by a transistor where switching takes place according to the instruction given by the micro-controller (U1).
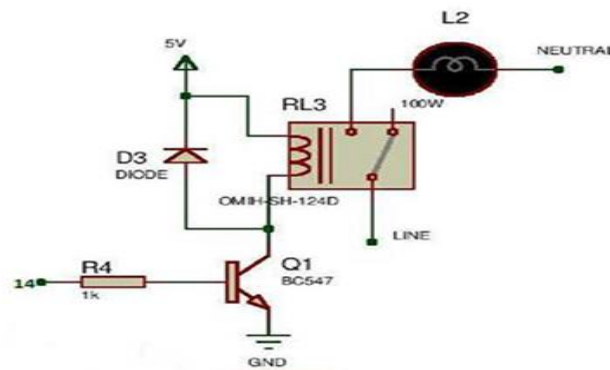

Fig.4: Driver Circuit (Block B)

5. System Software Description

The flow chart in Fig. 5. describes the working principle of controlling any room electronic devices such as lights, fans, and other points for dryer, projector etc in different conditions and situations according to the occupancy in the rooms in the university. In which, if any sensor node from SN(1)…..SN(n) gets the data then it sends to the micro controller, and waits for its consecutive sensor nodes data, if the consecutive sensor node also sends the data within the fixed time limit then the count value (i.e., the number of students inside the class room) gets incremented by one other remains the same. As long as the count value is greater than zero, all the of the electronic device of the class room remains switch ON, and once it becomes zero, then all the electronic devices gets switched OFF automatically.
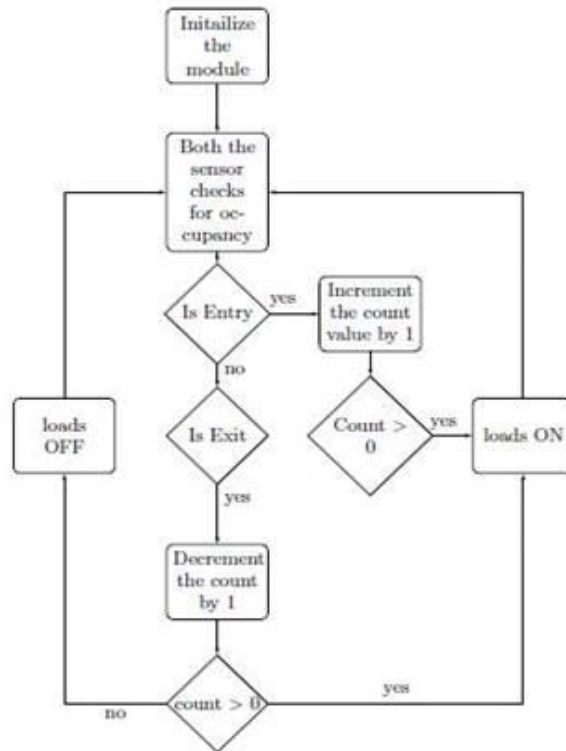
Fig. 5: Flow Chart of Smart Class Room

All the corridor lamps are controlled according to the time. If time received from the real time clock is greater than peak hours and less than peak-off hours then all the corridor lamps burns with full intensity, and if the received time becomes greater then peak-off hours and less than peak hours then the corridor lamps burn with reduced intensity. Mean while if any entity is detected, the corridor lamps will burn with full intensity as long as the entity get clears.

6. Observation

Fig. 6. shows the different cases of the corridor burning under different condition. In case 1, corridor lamps are OFF. In case 2, the corridor lights are ON automatically burning with the full intensity i.e., during the peak hours, and in case 3, the corridor lamps are in minimum intensity level i.e., during the off-peak hours. Also, during the off-peak hours if any traffic gets detected then the street lights restores its full intensity until the traffic gets clear.

As calculated in Table 1 we can save up to 81180 kWh energy per year from university room by controlling various electrical devices and nearly 15552 kWh

energy per year can be saved from street light/corridor of the university by reducing the intensity of the light during the off-peak hours.

Fig. 6: Different Cases for corridor lamp

6. Conclusion

This paper presents the hardware development of the power saving system in the university. The dual PIR sensor system for monitoring direction of movement of human being and human count in various room of university. The system also decreases corridor light intensity (dimming) to save the energy consumption during off-peak hours. This system minimize the energy consumption and provides an autonomous power control in the university where classroom devices are switched ON/OFF according to the occupancy and the corridor lamps are controlled according to real time, date, season, and traffic by varying the intensity during the peak/off peak hours. This entire system provides an efficient utilization of the resources and saves the power wastage when compared with the conventional system.

Table 1: Case Study of Energy Consumption in NIT Rourkela, India

Average time of lectures in any classroom per day	5 hrs
Average number of classes running simultaneously	60
Time for which the electricity supply remains ON in each room/hall	8 hrs
Average load per class	14.4 kWh
Average electricity loss per day per class (for 3 lectures per day)	6.15 kWh

Loss for 60 class per day	369 kWh
Loss per month	8118 kWh
Loss per year(220 working days)	81180 kWh
Total Street light/corridor	180
Average power consumed per day	324 kWh
Average power consumed per month	9720 kWh
Average loss per month	1296 kWh
Average loss per year	15552 kWh

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