A Low Cost Real Time Embedded System for an Automated Room Light Control

Arun Radhakrishnan
Lecturer in Dept of ECE,
Jimma Institute of Technology,
Jimma University.

Vuttaradi Anand
Lecturer in Dept of ECE,
Jimma Institute of Technology,
Jimma University.

Abstract

Recently, many researches have been carried out to save the energy in many aspects such as producing a device which consumes very less energy or designing a system which helps to reduce the power consumption using the existing devices.

In this paper, a room light management system is proposed based on real time clock and PIR sensor which is named as an automatic light management system (LMS). This proposed system will be able to provide the necessary intensity of light on various timings and with satisfaction of users and will save a lot amount of energy also.

In this paper the light management system and the algorithm which helps to decide whether to switch on or off the lights are discussed. The decision making algorithm will check whether any occupants are there in the room and if any occupants are there, then it will check the current time of that particular location and based on the time it will decide the status of light. Our proposed system can promise to minimize the energy consumed for lighting in a room and to provide it efficiently with user satisfaction.

1. Introduction

In recent days energy saving has become an important thing in our day to day life. Many traditional power saving techniques such as using electrical devices which consumes very less power or cutting off the entire power supply for a scheduled time for a particular area are not efficient and it causes a lot discomforts to the users and cost may also increase to use a low power electrical device.

Buildings are responsible for up to 40% of energy usage. Most part of this energy is used mainly for maintaining good lighting such that the workers feel comfortable. Nowadays the newly constructed modernised or automated buildings may have lighting system to improve the comfort of occupants and to save the energy. But there are a large number of old buildings which contain the traditional lighting system. To reduce the energy consumption in those types of buildings and to help the owners of that building in terms of saving electricity bill, an intelligent and an effective method is discussed in this paper.

Because of advancement in chip and sensor technology very cheap and portable methods to measure our surroundings are available.

2. Existing system

This section describes about the most commonly used light management system in buildings. Since this method is going to use real time clock before entering into that part it is necessary to know the operation of existing systems. It can be concluded that energy loss is there with a light management system when the system illuminates a light which is in an area which is not being used currently at that particular time or when it illuminates a light even though sufficient lighting is available to work when occupants are there. The most commonly used lighting systems are explained below.

2.1 A Switch operated manually

In this method a user has to switch ON and OFF the required lights. Since the user can switch on and off the lights as per their preferences there is a chance of keeping the lights in on state even though it was not needed during that time. This may occur because of carelessness of user and therefore a large amount of power is wasted.

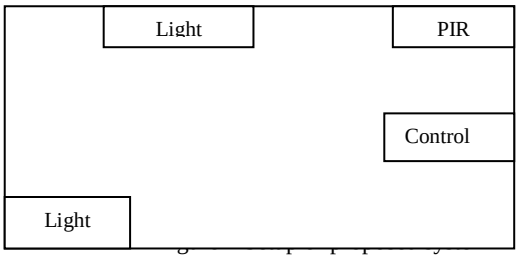
2.2 By Detecting Occupants

The lighting system with occupant detection uses passive infrared sensor (PIR). This PIR sensor detects any occupant present in that particular area. If any occupant is there then this system automatically switches ON the lights. If timers are not used in this type of system then the lights will be kept in ON state even after the user left the place. Because of this fault also a large amount of energy will be wasted.

Then another drawback about this type of system is, it will switch ON the lights when there is an occupant present in that area during day time also. But actually there is no need to switch on the light then. This system is not going to check the time before switching on the lights. Because of this also a large amount of energy can be lost.

3. Proposed system

The proposed system overcomes all the drawbacks of existing systems. This system takes two things into account before taking any action, namely (1) human presence and (2) Time. The system consists of a PIR sensor (Parallax 555-28027) and a Real time clock (DS1307). The PIR sensor is used to detect whether any occupants are there in that room and real time clock is used to store the current time in that room. Both of this will work in a combined manner to form an algorithm which will be implemented in our system to decide whether to switch on the light or not.



This approach first checks whether any occupants are there in the room or not. If anybody is there in that room then it checks the time in that room. Based on both of these it will decide whether to switch on the system or not.

4. System design

4.1Block diagram

This system can be implemented using a PIC 16F877A, a Real Time Clock, A PIR sensor and the relays which are going to control the lights.

A PIR sensor is used to detect whether a human has moved in or out of the sensor's range by sensing motion. These types of sensors are made of Pyroelectric sensors, which detect different levels of Infrared Radiation. Apart from Pyroelectric sensors, a group of supporting circuits combined with some resistors and capacitors will be there in the sensor package. It also contains Micro Power PIR motion Detector IC within it, which takes the output of the sensor and does some minor processing on it to emit a digital output pulse from the analog sensor. The connection diagram for PIR with PIC shown in figure 3.

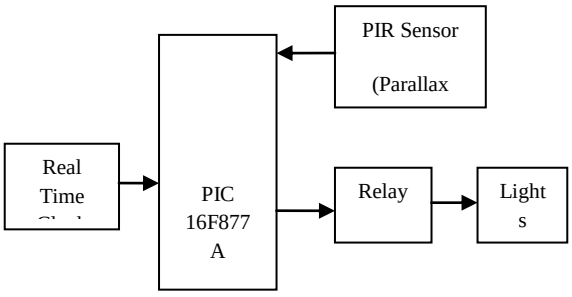


Figure 2 Block Diagram for the proposed

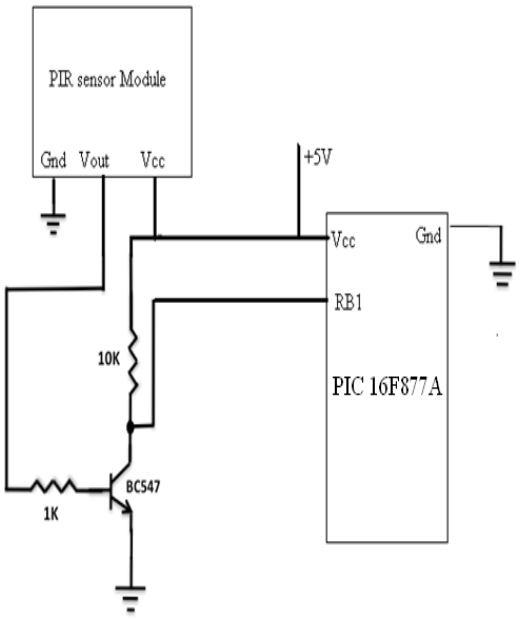


Figure 3 Connection diagram of PIR sensor with PIC

The output of the PIR sensor module is connected to RB1of PIC16F877A. When the motion is sensed, this output is high at about 3.3 V (PIR sensor module has a 3.3Volatge regulator IC within it). Still it is possible to use this voltage as a valid logic high for PIC16F877A, but it is preferred to use this voltage to drive the base of an NPN transistor (BC547) so that at the collector we will have the full swing of the logic voltages. Now, the PIC 16F877A monitors the voltage at the collector of the transistor.

During the normal condition, the transistor is cut off, and the collector output is at logic high (+5 V). When the motion is sensed, the high output from the sensor module saturates the transistor and the voltage at the collector drops down to logic low. Then this change is observed in RB1 of PIC16F877A and it concludes that some occupants are there in the room.

A real time clock is battery-backed which allows us to keep track of time even if the power is lost. A Real Time Clock is very useful for constructing a digital clock, timers, alarm clocks and data logging purposes. Out of the available real time clocks in markets the DS1307 is the most popular RTC, and works best with 5V based chips.

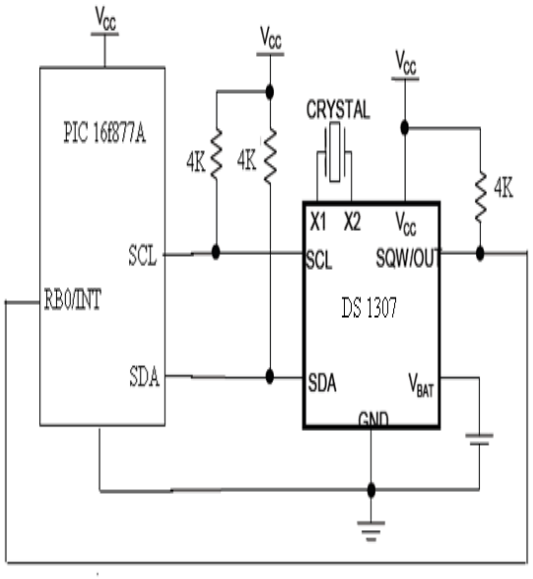


Figure 4 Connection diagram of real time clock with PIC

The proposed system also uses a PIC16F877A microcontroller unit which is the heart of this proposed system and it is programmed to collect the sensed data from PIR sensor and time from DS1307. The RTC DS1307 will automatically update the processing unit after programmed time delay.

The PIR sensor will sense whether any occupants are there in the room and sends a signal to the microcontroller if there is any occupant in the room. If anybody is present in the room then the microcontroller checks with the time sent by DS1307 and it checks whether the current time is day or night. If it decides that the current time in that room is night then it will connect the relay by the way the light is switched on which is connected with relay. If the microcontroller decides the current time is day then it will not connect the relay and thus the lights will not be switched on.

5. Algorithm:

Step 1: Start

Step 2: Check whether any occupant is there in the room using PIR sensor.

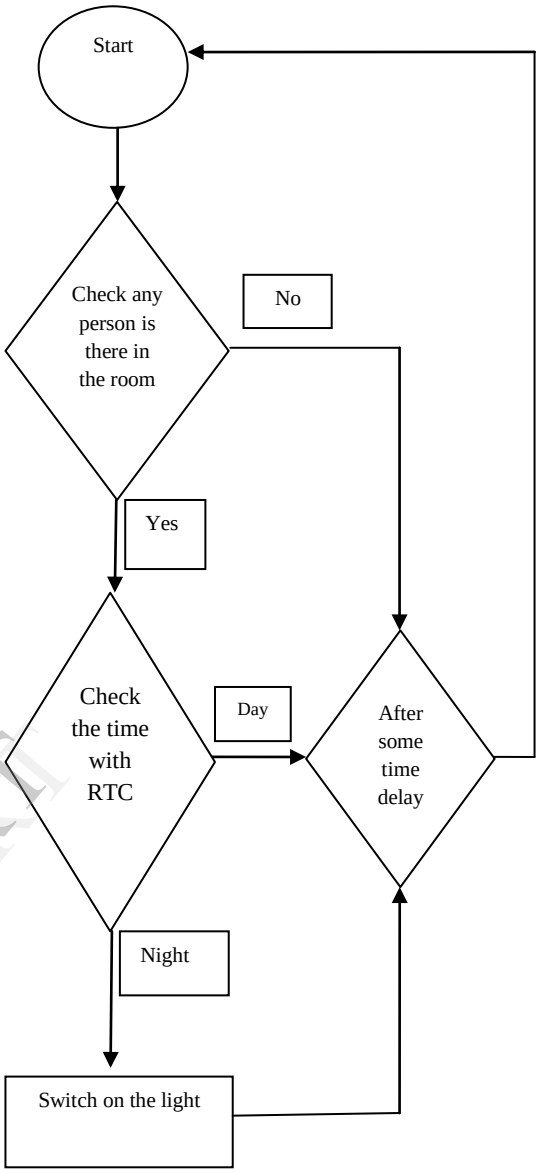
Step 3: If any occupant is there then check the current time from real time clock. If nobody is there then after some time delay again go to step 1.

Step 4: If the time is night then connect the relay such that the lights will be switched on. Otherwise don't connect the relay and after some time delay proceed to step 1.

As per the algorithm our system will first check whether any occupants are there in the room with the help of PIR sensor where the system has been installed. If any occupants are there then it will check the time through the real time clock DS1307. By analysing the time it will first decide whether its day or night currently. If it is night then it will connect the relay, then the lights will be switched on which is connected to relays. If it is night then the relays will not be connected and it will wait for some time and again it will start from the first.

While checking for occupants, if no one is there in the room then the system will wait for some time (delay), which can be programmed in the microcontroller then it will start from the first step.

6. Flowchart



7. Results

The proposed system has been implemented in a room with four lights each of 40 watts. Since it is normal classroom where evening classes are also conducted, the intensity required has been set to 500 lux which was set as the reference level in microcontroller. Before implementing this system, around 800 watts of energy was consumed per day. After implementing this system in that room it has been considerably reduced to 480 Watts. Thus on using this system a large amount of energy can be saved.

8. Conclusion and Future work

The proposed system can reduce the power consumption to the maximum limit and also this system will help us to keep the working environment in a pleasant and comfortable manner.

In this system the number of person present in the room (Person counter) can be included and also the data transmission from PIR sensor to microcontroller can be implemented through wireless such that the system will become a scalable one, in the sense, a single system can control a large number of rooms. This can be extended to control the lights in verandas and large storage areas.

9. References

[1] "Intelligent Energy Conservation System Design Based on Hybrid Wireless Sensor Network" Hung-Cheng Chen, Teng-Fa Tsao Chun-Liang Hsu IPCSIT vol. 23 (2012)

[2] F.O'Reilly & J.Buckley, "Wireless Sensor Network Control of Fluorescent Lighting using Dimmable Ballasts and Daylight Substitution", 40th International Universities Power Engineering Conference, Cork, Ireland, 7-9 September 2005.

[3] Intelligent Lighting System Using Wireless Sensor Networks A.A.Nippun Kumaar, Kiran.G, Sudarshan TSB IJASUC Vol.1, No.4, December 2010

[4] Microchip Technology Inc. PIC16F877A Datasheet, RevisionC,2003.

[5]http://www.parallax.com/detail.asp?product_id=555-28027

[6]http://datasheets.maximintegrated.com/en/ds/DS1307.pdf

[7] Intelligent road lighting control systems -- experiences, measurements, and lighting control strategies by Liping Guo 2009