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Automated Energy Saving and Safety System Using Microcontroller

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***Abstract*—This paper reports on a system that can save electricity. Many times we leave the room and hall without switching off lights and fans, thus electricity is wasted. In this work we have presented a system in which energy will be saved based on number of people entering in or leaving out of the room.If there is no person in the room, then light and fan will be switched OFF. On the other hand as soon as any person enters the room, light and fan will be switched ON. On the basis of the intensity of sunlight we can increase or decrease the intensity of light. Simultaneously we can vary the speed of the fan sensing theroom temperature. The more temperature the more speed of the fan. A smoke sensor module is used for detecting any smoke within the room and provides safety by alarming the audio device.**

Keywords- Energy saving; Microcontroller; Sensors; Speaker; Safety system.

I. INTRODUCTION

Electricity is one of earthshaking resources in this century. It is the major source of power for most of the country's economic activities. Moving towards energy sustainability will require modifications not only in the way energy is supplied, but also in the way it is used as well. Many times we do not turn off the light or fan at the time of deserting the room, thus electricity is wasted. By raising public awareness we can reduce the wastage of electricity. But it is not enforced due to carelessness. In this case we can use home automation system. Home automation is the automatic or semi-automatic control and monitoring of household appliance and residential home features like doors, gate & even the windows [1].Home automation can be done by different way. Gill k. [2] developed a Zigbee-based home automation that works through a common gateway with Wi-Fi network in order to switch home appliances. Chao-lin Wu [3] established a mobileagent based integrated control architecture for home automation system. The above automation systems only for personal relaxation .When we think to save energy require an intelligent system that can perform switching in the presence of the human body. Reference [4] discussed a system that can perform switching home appliances in the presence of the human body by using PIR sensor. It is costly and we can use visitor counter in the place of intelligence system mentioned above. Golay Marcel J.E [5] worked on the logic of the bidirectional binary counter. This counter has many restrictions and we can follow microcontroller based bidirectional visitor counter [6] and Design of bidirectional coherent counters by Dean K.J [7].

In order to save energy Wei Yan and S.Y.R Hui built a system [8],which has a central energy saving unit that can change the input main voltage of 220v to a variable voltage within 220v to 170v, is used to control a large lighting network and dimming is used to control light intensity. Reference [9] constructed a wireless security control systems & sensor network for smoke and fire detection. They used a smoke detector device that detects smoke & issues an alarm toalert nearby people

The objective of our proposed system is to save the energy or power, used in places like an office or room where the lighting is very essential for the people. At the same time when people are not present in the monitored area the lighting can be made off. This system also serves us to know about thenumber of visitors in the monitored area such as a room or office. When people come to that area, according to the LDR output lighting can be made sufficiently brighter. By using thissystem, we can also fine-tune the speed of the Fan depending on the room temperature measured by the temperature sensor. A smoke sensor module [10] is used for detecting any smoke within the room and provides an alert by the audio alarming device. This work can be used in various rooms like seminar hall, conference hall where the capacity of room is limited andshould not be exceeded. This work will display the actual number of persons inside the room. Automatic Room light andfan Controller with Visitor Counter can be used in class rooms, study rooms in colleges. This work can also be used in our home because many times we come out of our bedroom orany other room without turning off the room light. It is used only when one single person cuts the rays of the sensor hence it cannot be used when two person cross simultaneously.

II. DESIGN OVERVIEW

The design demonstrates here, has 3 modules. The first module is “Visitor counter”, the second module is “Automatic room light and fan controller” and the third is “Safety unit”. Visitor counter is used to determine and display the number of persons entering in and getting out from any room like seminar hall, conference room etc. The automatic room light and fan controller is used to turn ON/OFF the home appliance.When the number of persons within the room is zero, light andfan stays OFF. When persons are present, the light and fan made ON, where light intensity and speed of the fan are controlled by sensors. As a Safety unit a smoke sensor moduleis used for detecting any smoke within the room and provides an alert by the audio alarming device. LCD display positioned outside the room which shows the number of people within the room. We show the block diagram of our work in Fig.1.

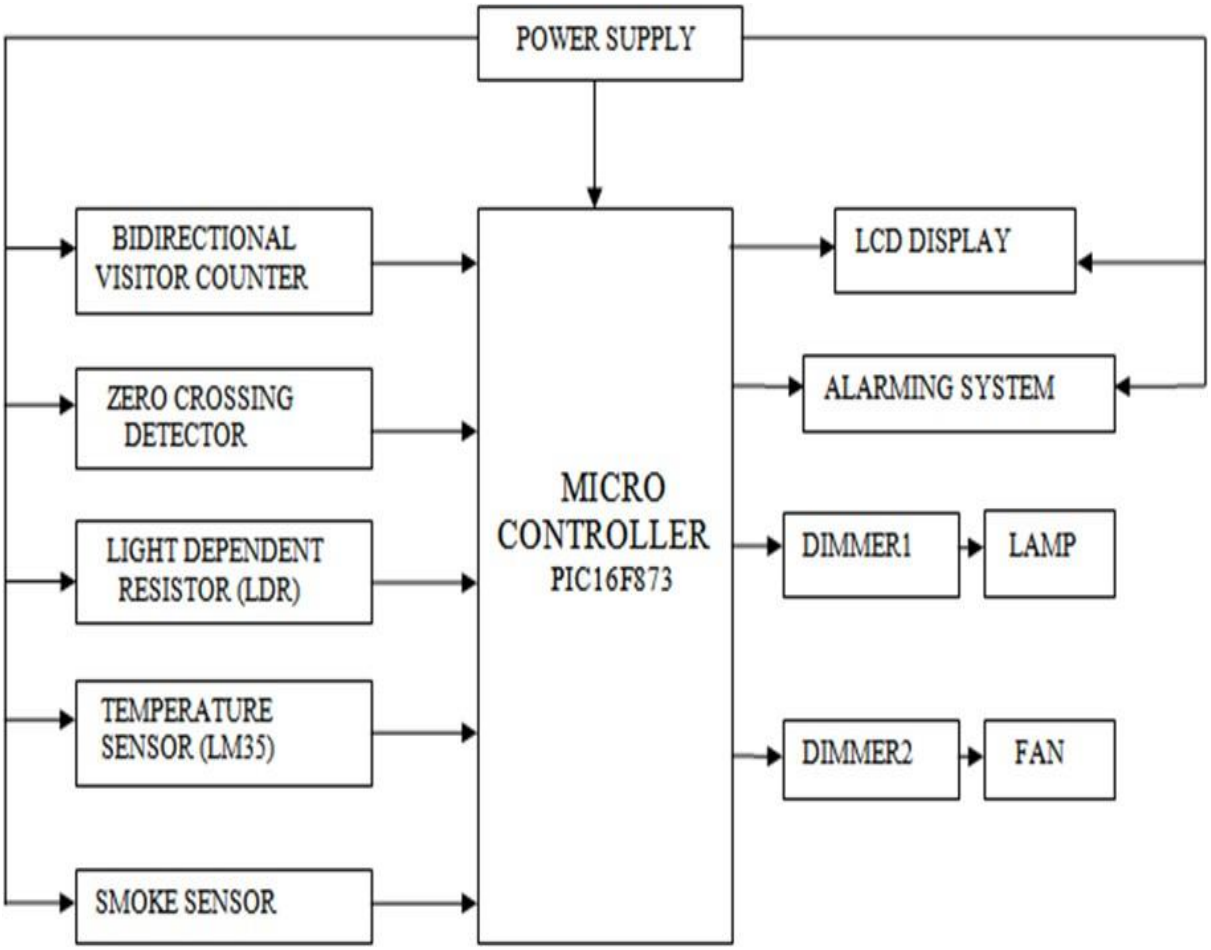

Fig. 1. Block Diagram of automated energy saving and safety system.

Here we draw on five circuits as input of a microcontroller (MCU) [11] and four circuits as output. The input circuits are: 1) bidirectional counters, 2) LDR, 3) temperature sensor, 4) zero crossing detector and 5) smoke sensor .The output circuits are 1) LCD display, 2) lamp,3) fan, and 4) audiodevice. If a person enters in the monitored area, the IR sensors[12, 13] of visitor counter will activate and sense the person. By sensing the person, the counter sends a signal to the micro controller. After that the LDR [14] checks the light intensity of the monitored area, whether it is bright or dark. LDR output will settle on the ON or OFF status of the lamp. We can also regulate light intensity depending on the brightness of the monitored area. By using this system we can change the speedof Fan according to the room temperature calculated by the temperature sensor LM35 [14], which are connected to the microcontroller. Also to show the room temperature using the LCD [14] display. This system does not save power but it is comfortable for human being. A smoke sensor module is used for detecting smoke within the room and provides an alert by the audio alarming device.

III. CONSTITUENT SUB MODULES

A. Bidirectional Visitor Counter

The objective of the unit is to count the objects (persons) entering and exiting the room. So we need some sensors to detect the objects, a control unit which calculates the objects & a display unit to show the number of persons inside the room. Visitor counter module is a major part of energy saving system. It acts like a switch for the monitored place where is automated. Here two pairs of IR transmitter-receiver are used in the passageway. One pair making up IR transmitter IR TX1 and receiver phototransistor RX1 is set up at the entry point ofthe passage, while the additional pair consisting IR transmitterIR TX2 and receiver phototransistor RX2 is set up on the way out of the passage. The IR signals from the IR LEDs ought to incessantly fall on the respective phototransistors; an electroluminescent IR LED propagates along a straight line in onward direction. Infrared photo receiver which operates in a reverse bias is a type of photo detector proficient of converting

light into either current or voltage, depending upon the mode of operation. The reverse current will go on to flow as long as the light beam is not broken. As each person passes (when entered) , the light beam is broken , the reverse current dropsto the dark current level (pin 6, (inverting)) , which compares with the reference current level (pin 7, (non-inverting)) in the LM339 (comparator) , the output (pin 1) of LM339 connected to Microcontroller (Pin 11, RC0) and the counter augmented by one. Similarly at the time of exit, the current drops to the dark current level (pin 4, (inverting)), also compared with the reference current level (pin 5, (non-inverting)),the output (pin 2)of LM339 connected to Microcontroller(Pin 14, RC3) and the counter is reduced by one, shows in the LCD display. From the output of bidirectional counter, input to the MCU thelight and the fan will high or low respectively.

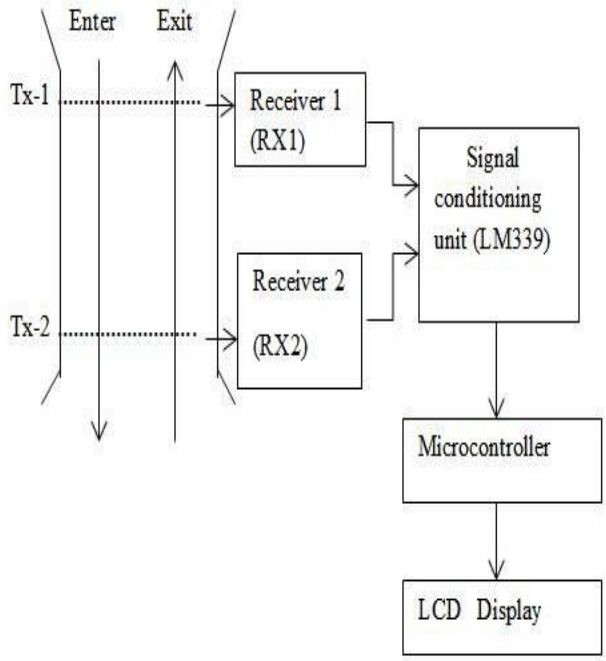

Fig. 2. Design of Bidirectional visitor Counter

B. Automated room light and fan controller

The automatic room light and fan controller is used to turn ON/OFF the home appliance. When the number of persons within the room is zero, light and fan stays OFF. When they are present, the light and fan made ON, where light intensity and speed of the fan are controlled by sensors. The heart of our automation system is a microcontroller, which is configured by programming in the Micro C Pro, an advanced C compiler for the PIC Microcontroller Unit. By using the following flow chart we can write the source code.

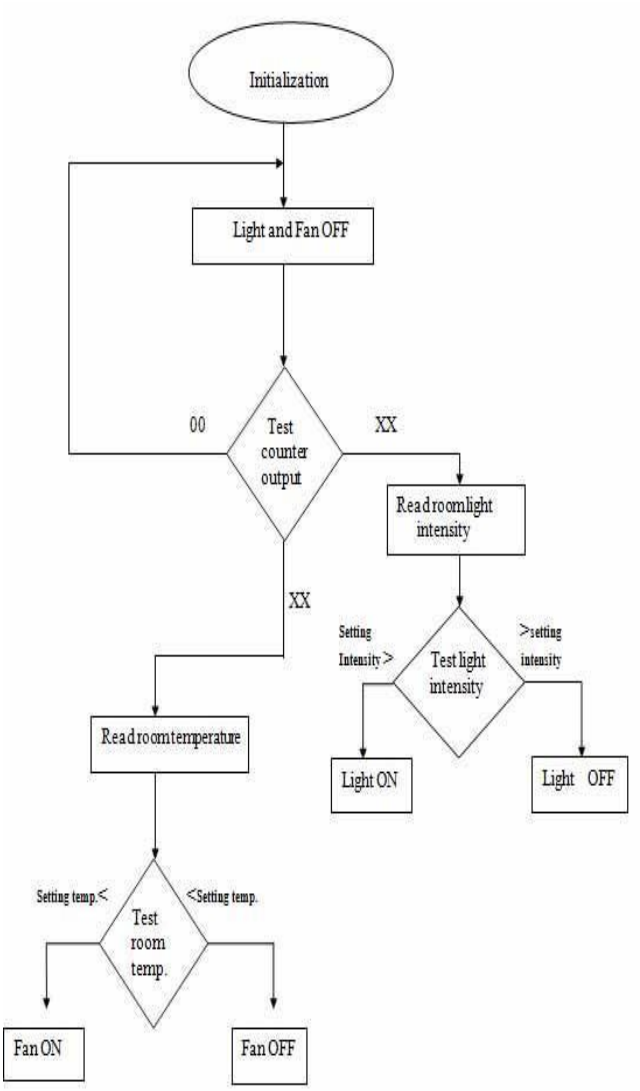

Fig. 3. The Flow chart of the designed system

PIC16F873 is used as microcontroller for this work which is manufactured by Microchip Technology Inc. The microcontroller is powered with +5V through a battery (for the convenience of the work).For the functioning of the microcontroller a crystal oscillator is used. The microcontroller get input signals from the bidirectional visitor counter, LDR, temperature sensor LM35 and send output signals to the LCD display, light, & fan. Regard as a particularroom or office in a building which is connected to our experimental kit.

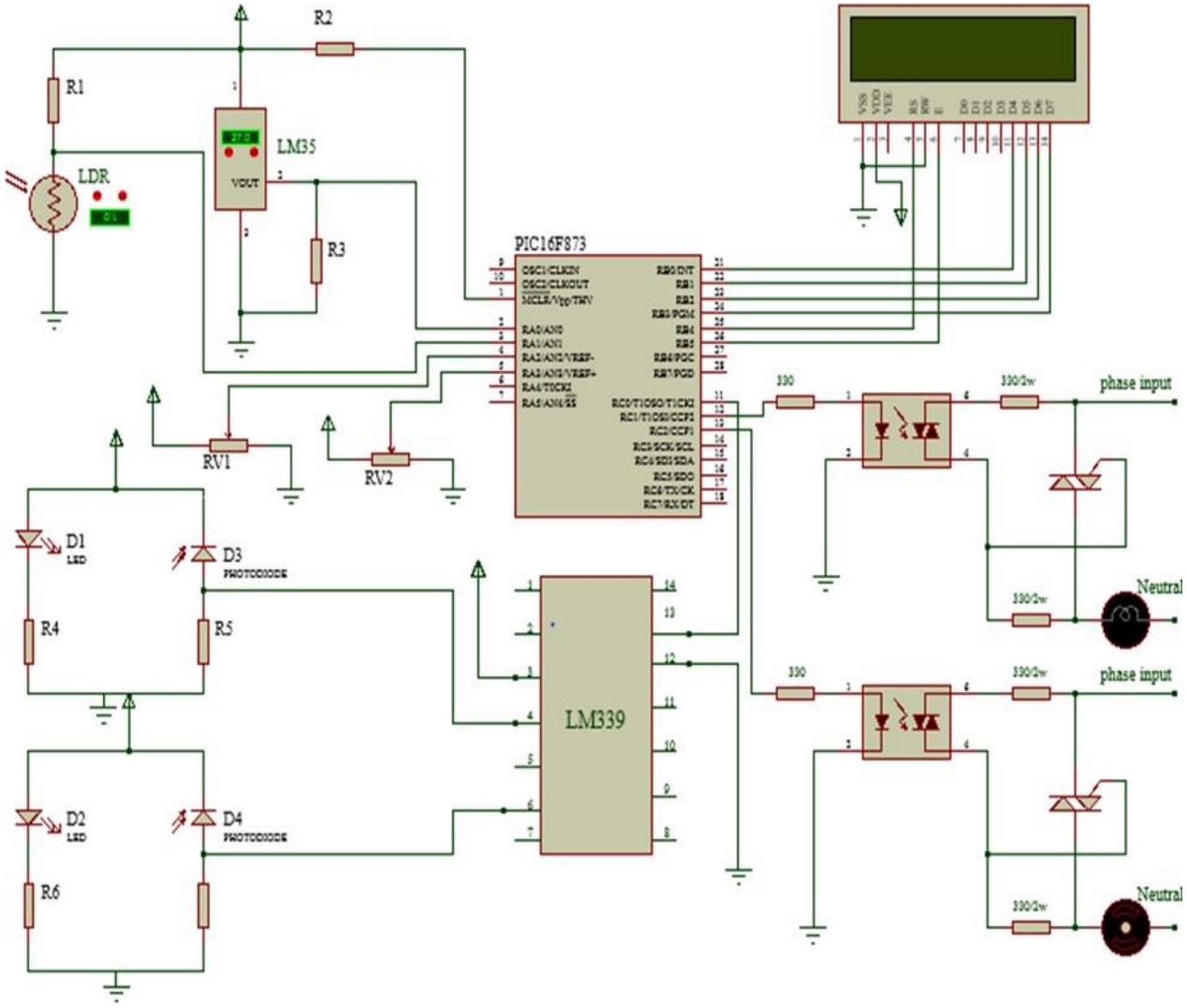

Fig. 4. Circuit diagram of automatic room light and fan controller unit

Light dependent resistor as the name suggests depends on light for the variation of resistance. When light falls on the narrow piece, the resistance decreases. In the deficiency of light the resistance can be 10k to 15k.Hence voltage drop across LDR also changes with the intensity of exposing light. The variable voltage of LDR is applied to the input of the MCU (pin 3, RA1), is compared with threshold voltage applied to the MCU (pin 5, RA3).When the voltage is less than the threshold voltage MCU provides 1 (high voltage) to the dimmer1 circuit which switches the light, through theoutput pin 13 (RC2).Light intensity can be controlled by the variable voltage drops of LDR.

Here we make use of LM35 temperature sensor whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 is rated to operate over a−55° to +150°C temperature range. It varies 10mv of the output voltage of LM35 for the change of per degree centigrade temperature. The variable voltage of LM35 is applied to the input of the MCU (pin 2, RA0), is compared with threshold voltage applied to the MCU (pin 4, RA2).When the voltage is greater than the threshold voltage, MCU provides 1 (high voltage) to the dimmer2 circuit which switches the fan, through the output pin 12 (RC1). The speed of the fan can be controlled by the variable voltage drops of LM35. With the increase of output voltage of LM35, the speedof the fan is also increased.

We bring into play an LCD display which has 14 pins, where pin 4 is connected to output pin 25 (RB4) of MCU, pin 6 to output pin 26 (RB5) of MCU, pin 11 to output pin 21 (RB0) of MCU, pin 12 to output pin 22 (RB1) of MCU, pin 13to output pin 23 (RB2) of MCU and pin 14 of the LCD displayis connected to output pin 24 (RB3) of MCU.

The room temperature and the threshold temperature are shown (1, 3) and (1, 9) lines of LCD respectively. The room light intensity and threshold intensity are shown (2, 3) and (2, 9) lines respectively. The liquid crystals can be controlled through an applied electric voltage so that light is allowed to pass or is blocked. By carefully controlling where and what wavelength (color) of light is acceptable to pass, a backlight provides LCD monitor's brightness. In fig. 5 we show the experimental setup of our projected system.

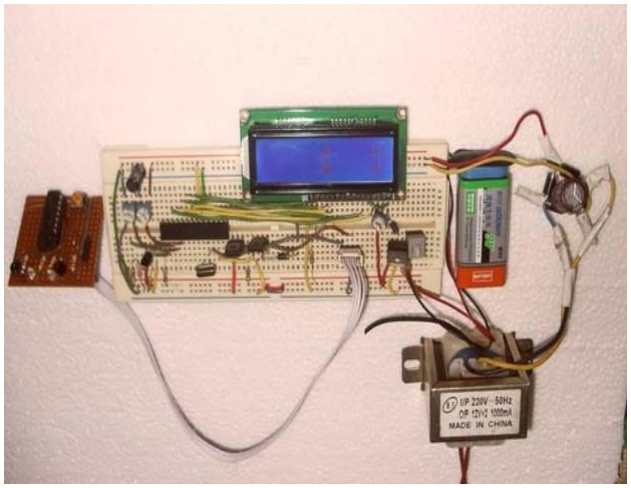

Fig. 5. Experimental Setup

C. Smoke sensor unit

Smoke sensor module [10] is used for detecting smoke within the room. When smoke sensor senses smoke, that is, when the sensor's smoke sensing branch voltage exceeds the reference level called threshold level the output of the sensoris activated and the microcontroller receives the sensor output and the microcontroller send an output signal to act an alarming system. This system also contains 5w (4 ohm speaker) alarm. After sensing the smoke the sensor is kept inactive for 5 minutes. By using the following flow chart we can write the source code for the security control unit.

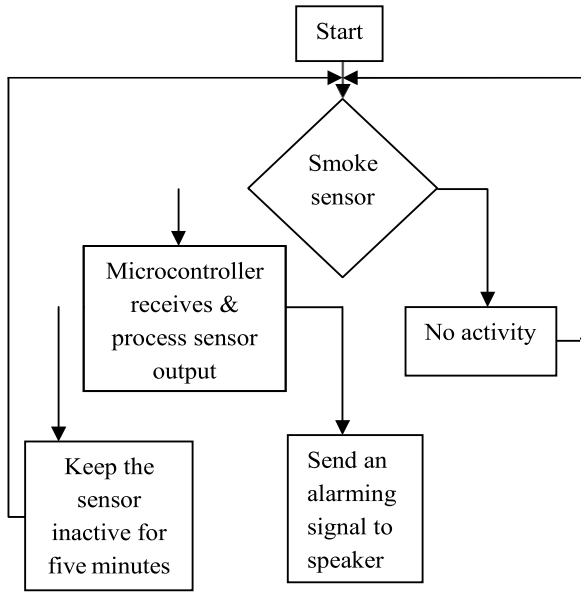

Fig. 6. Flow chart of the smoke sensor

The hardware implementation for smoke sensor is given below

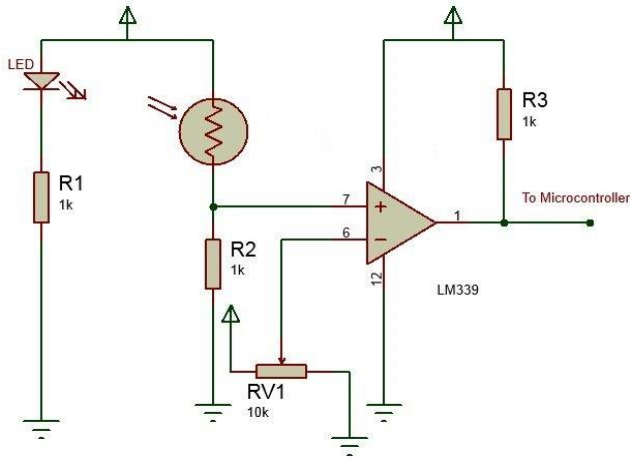

Fig. 7. Smoke sensing circuit

IV. PERFORMANCE

We have implemented this work in our experimental room only for three persons. From counting unit we got the following result as shown in TABLE I.

TABLE I. RESULTS FOR COUNTING UNIT

Counting Unit		
Enter	Person	Visitor Counter
	No person	00
	1st person	01
	2nd person	02
	3rd person	03
Leave	1st person	02
	2nd person	01
	3rd person	00

When a person entered the room we got the output given in TABLE II from Automatic room light and fan controller Unit. When there was no man inside the room, the Light and Fan remained off. TABLE III shows the performance of safety system.

TABLE II. LIGHT AND FAN BEHAVIOUR FOR SUNLIGHT AND ROOM TEMP.

Automatic room Light and Fan Controller			
Sunlight	Lamp	Room Temp.(°C)	Fan
Yes (Above the required level)	OFF	≤25	OFF
Yes (Below the required level)	ON(Gradually increased intensity)	26	ON
NO	ON (Max. intensity)	>26	ON(increased speed)

TABLE III. BEHAVIOUR OF SAFETY UNIT

Safety Unit	
Smoke	Alarm
Yes	ON
No	OFF

V. CONCLUSION

Home automation with considering Energy Saving System is not limited for any particular purpose, it can be used anywhere in a developing industry with little modifications in software coding according to the necessities. This concept can be used in many developing countries in order to save their limited power. It ensures that our work will not only be usable in the future but also provides the flexibility to adapt and extend, as needs change.

In our scheme we associated all the sensors to micro controller with the wires. This can be originated with wireless such that we can put different sensors in different places. This sensor will turn on the micro controller with the signals instead of using wires. We can send this data to a distant location using mobile or internet. Voice alarm system can be included to indicate that the room is full & persons can't enter inside. This system can also be applied to various loads like pressure, force and etc. by increasing the number of ports of the micro controller.

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