

# Automatic Home Lighting solutions using Human Detection, Sunlight Intensity and Room Temperature

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**ABSTRACT:** In this paper we are going to discuss various methods for automatic switching of home lighting systems, controlling the intensity of lights depending on the intensity of sunlight and controlling the fan depending on the temperature of the room. Our design basically is divided into three blocks human detection circuit, LDR based light detection circuit and temperature sensor based fan of off controller circuit. The first circuit will control the main switch which will be turned on only if a person is detected; it is based on IR sensor and microcontroller. The second circuit is based on LDR, it is used to detect the intensity of the sunlight and depending on the intensity of sunlight number of led glowing will be controlled. The third circuit uses LM35 as a temperature sensor to control the switching of the fan. The human detection circuit can also be used to count the number of person present in the room. The basic idea behind this paper is to save the amount power wasted when the home lighting system is on even in the absence of human being. The system will restrict the turning on the lights with enough amount of sunlight entering the room and turning on the fan with the room temperature below the par temperature. The design also gives the user flexibility to switch on the devices neglecting the control system.

**Key Words:** Human Detection, Sunlight Intensity, Room Temperature, LDR, IR sensor, LM35.

## 1. INTRODUCTION

In recent years the people are looking forward for the automation in there day to day life. And even now the people are eager to save energy consumed in day to day life. 19% of energy use in the world is used for lighting, and 6% of greenhouse emissions in the world derive from this energy used for lighting [9]. Energy saving has attracted great attention as a global issue because of recent environmental problems. Most of the people are trying to produce energy using renewable source of energy and actually investing large amount of money in such products. Instead the people should use the energy in an efficient way. People are becoming lazy to switch off the lights while leaving the room. So the large amount of energy is wasted if the light is ON in the absence of human being. Generally in public and private sector companies, offices most of the people are not interested to switch OFF the consumer electronic appliances like fan, light etc, if they are not present. As more and more

consumer electronic and home appliances are used, the size of them is becoming large; power consumption in home area tends to grow. Moreover, useless power consumption occurs in the absence of human being in public and private sectors. Using the automation in switching the home lighting system large energy will be saved which will in turn save the money of the owner of the house. The amount of energy saved will be unnoticeable for single house but if it is used in all private and public sector and large number of homes it can certainly contribute in large amount of savings of energy and money.

With the advancement of sensor and technology the size of electronics components is reducing day by day, so embedded systems can be used in many simple applications. One such application is the use of embedded system in automation of switching of home lighting system. With the advancement of technology the world is moving towards the automation. Now the people are looking forward for automation in all simple tasks they need to do. The people are trying to reduce human efforts. The automatic switching of home lighting system actually reduces the human efforts. By the use of automatic switching the person will not have give attention towards turning OFF the lights while leaving the room, this system also helps to reduce the power wasted when the lights, fans and other electric appliance are ON in the absence of any person.

The system also counts the number of person entering or leaving the room. The counting system is very reliable in public or private sector as it gives the number of person present in the area. Counting the visitors help to maximize the efficiency and effectiveness of employees, floor area and sales potential of an organization. All the system is built using low power microcontroller which is efficient in turning the main switch and displays the count. The components used are IR sensor for detection of human being, LDR for detection of amount of light intensity and LM35 to control the switching off fan. In our project the light is replaced by clusters of LED as lamp. The lamp is divided into three groups of led. According to the intensity of sunlight the group of LED glowing is controlled, in the absence of sunlight all the LED glowing illuminating the room.

## 2. HUMAN DETECTION

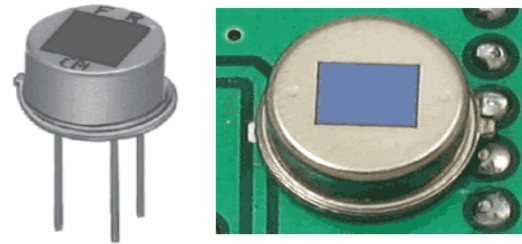
The basic need of any automation home environment is the detection of human being. The turning OFF and ON of the main switch is directly dependent on the presence of human being. If a person is detected then the main switch is turned ON using a relay circuit and in the absence of any person the whole system will be turned OFF. Due to advancement of technology there are various methods for detection of human being. There are various methods for identifying and tracking user position such as Cricket, Mote Track or GPS. GPS offers a scalable, efficient and cost effective location services that are available to the large public. However, the satellite emitted signals cannot be exploited indoor to effectively determine the location. [6] As the satellite signal cannot penetrate the wall, none of the above proposed methods can be used for detection of human being inside the building.

Various sensors can be used for the detection of human being one of the most used sensor is PIR sensor. RSSI is another common method used for the detection of human being which is based on RF signal. Both the methods have their own merits and demerits. One of the methods for detection of person is based on pressure sensor but this method is too costly as it requires large number of distributed pressure sensor. The method proposed in this paper is quite simpler than the above two methods which is based on simple IR sensor. The method proposed tries to overcome the demerits of the two methods which are commonly used for the detection of human being.

Let us first discuss the two methods which are based on PIR sensor and RSSI based system.

### 2.1 PIR SENSOR

PIR sensors are commonly used with a variety of sensors in diverse applications for building smart environments, such as healthcare, smart energy system and security. [8] PIR sensors are more complicated than many of the other sensors (like photocells, FSRs and tilt switches) because there are multiple variables that affect the sensors input and output. To begin explaining how a basic sensor works. The PIR sensor itself has two slots in it each slot is made of a special material that is sensitive to IR. When the sensor is idle, both slots detect the same amount of IR, the ambient amount radiated from the room or walls or outdoors. When a warm body like a human or animal comes in the vicinity of the sensor, it first intercepts one half of the PIR sensor, which causes a positive differential change between the two halves. When the warm body leaves the sensing area, the reverse happens, whereby the sensor generates a negative differential change. These change pulses are what is detected. [1]

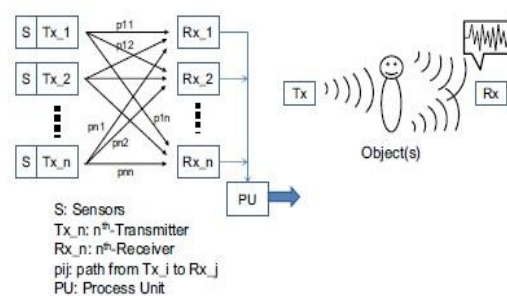


The main disadvantage of PIR sensor is that it just checks for the change in temperature, the change in temperature is a slow process so the switching of the electrical appliances will suffer a delay. As the temperature is higher, the difference to human body temperature is decreasing as well as the detection accuracy, which is not the case with radio signal's RSSI. Also when there is no movement for a period of time, the PIR sensor is unable to detect presence, which is not the case with our method (100% accuracy). [1] So looking upon the disadvantage PIR sensor cannot be used for detection of human for switching the main electrical switch.

### 2.2 RSSI BASED SYSTEM

RSSI system definitely has many advantages over PIR system. The innovative use of the received signal strength indicator (RSSI) will yield new applications in human position estimation and energy efficiency in small areas or homes. The use of RSSI system is increasing as the system is wireless and according to [7] the field accuracy of the RSSI system is 70%. In [6] a comparison is made between indoor and outdoor tracking system, in the paper RSSI system is used for the indoor tracking system. The human detection technique using Zigbee module and RF signal with PIR and IR sensor is proposed in [4].

The proposed system judges whether or not a human exists in a path between a transmitter (Tx) and a receiver (Rx) in a wireless sensor network in a small area or home by processing the received signal strength indicator (RSSI) values.[7]

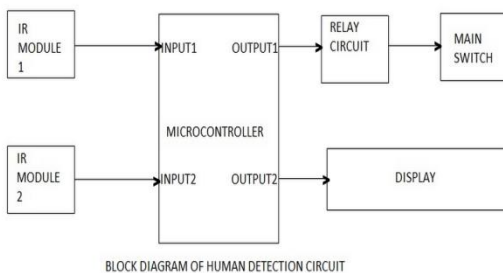


As shown in figure and according to [7] RSSI system requires large number of RF signal transmitter and receiver. The basic disadvantage of RSSI system is its

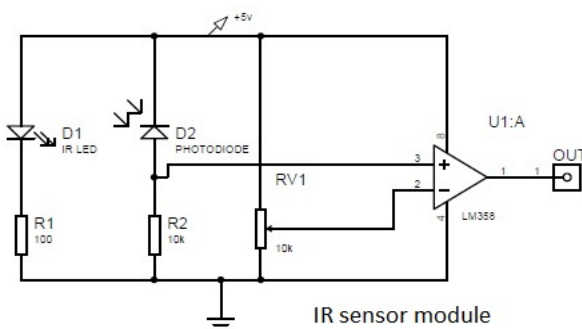
complexity. The RSSI system is very complex as compared to the PIR sensor. Another disadvantage of RSSI system is that it undergoes RF interference as the signal used in RSSI system is RF and the signal used in mobile communication and various other electronics appliances such as internet and radio is also radio frequency so it can easily interfere the RSSI system, making a false switching. Due to the disadvantage of both the systems based on PIR and RSSI system this propose a new methodology using simple IR sensor to count the number of people present in the room. Method proposed in this paper overcomes the disadvantage of PIR sensor and is also very easy to understand and implement with less requirement of circuitry.

### 2.3 ADOPTED METHODOLOGY

In this paper different method of detecting a person is adopted. The method proposed is based on simple IR sensor. In the circuit two IR sensor is used which are interfaced to a single microcontroller. The Block diagram of human detection circuit is as shown below.



#### 2.3.1 IR SENSOR

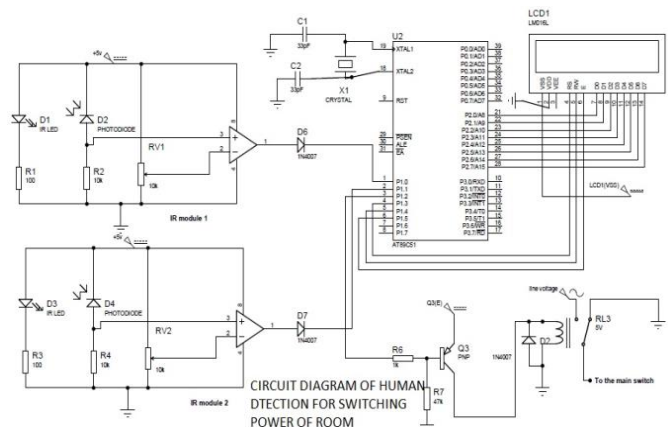


IR sensor consists of an IR transmitter LED and a photodiode at the receiver end. The photodiode converts the light into current which is converted into voltage and which is compared against a fix voltage to get the output. The main problem with the IR sensor is its range. The range of IR sensor can easily be increased by the adjusting potentiometer at the receiver end. When no person crosses the line of IR sensor the output of the IR sensor is low and when a person crosses the IR

sensor the infrared light is reflected back and light falls on photodiode and output of the IR sensor is high. The output of photodiode is ranges from 2.8v for 20cm to 0.4v for 200cm. So the reference voltage can be accordingly adjusted to get the proper range of IR sensor.

#### 2.3.2 OPERATION OF THE CIRCUIT

In the circuit the two IR sensors are placed at the entrance of the room one after the other at a distance of around 50 to 100cm. The working of the circuit is as explained. While entering the room the person will cross the first IR sensor and then the person will cross the second IR sensor. While leaving the room person will cross the second IR sensor and then the person will cross the first IR sensor. So the counter is incremented when the person enters the room and decrement when the person leaves the room. And when the counter value is zero then the output of microcontroller is low turning OFF the main switch of the room. And when the counter value is greater than zero then the output of microcontroller is high turning ON the main switch of the room using relay. The circuit also displays the count value of the person present in the room. This method is basically design for home. As generally the size of door is not that large as compared to other private sectors. Also at home people do not move into the room in a queue so the probability of error reduces. The system can even work in public and private places having different entry and exit point. At such places the single sensor can count the number of people entering and one more sensor at the exit point can count the number of people exiting the place.



#### 2.3.3 ALGORITHM

- 1) Start.
- 2) Initiate the microcontroller.
- 3) Check the interrupt from IR sensors.
  - a. If first IR sensor produces interrupt then check for the interrupt from second IR sensor within 5 seconds and

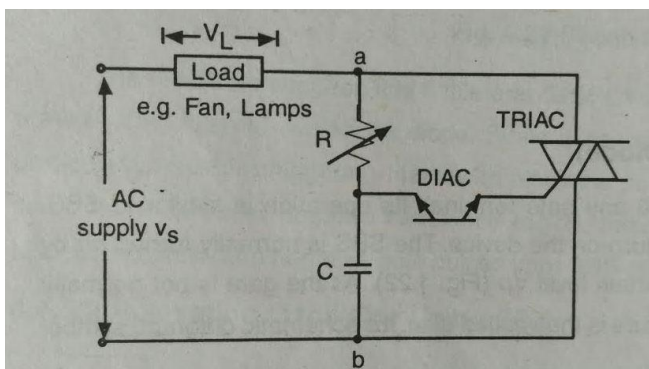
if interrupt is produced increment the count, else exit the loop.

- b. If second sensor produces interrupt then check for the interrupt from first sensor within 5 seconds and if interrupt generated decrement the count, else exit the loop.
- 4) If the count! = 0 then set the output of microcontroller high, turning on the main switch.
- 5) When count = 0 then set the output of the microcontroller low.
- 6) Display the count.
- 7) Repeat steps 3 to 6.

The human detection circuit does not control any individual electrical appliances rather it controls the main switch of the room. So if the room is empty than automatically all the appliances will be turned OFF. A parallel switch is placed connected to the main switch to give the flexibility of manually controlling the power in the room.

### 3. ADJUSTING INTENSITY OF LAMP ACCORDING SUNLIGHT

Another problem of wastage of power at home is high wattage lamp or tube light. If we use less wattage light its intensity is low. And another problem is with less sunlight we feel the requirement of lamp, as its intensity and wattage cannot be adjusted so we have to use the same high wattage bulb or tubes. So we need a lamp whose intensity can be adjusted according to the intensity of sunlight. The intensity of the lamp can easily be adjusted by controlling the voltage to the lamp. The charging time of capacitor can be adjusted using a series resistance. According to the charging of capacitor the voltage supplied to lamp can be controlled, controlling its intensity [12].

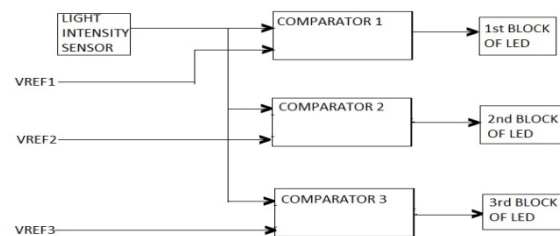


The problem with this solution is that it requires the same amount of energy even with the less intensity. In some designs one must install specific hardware and software to control the lights, resulting in unacceptable costs [3(5)]. In [3] signal of intensity of sunlight is send

to microcontroller and microcontroller controls the number of lights glowing. So this method requires both software and hardware, whereas method proposed in this paper controls the number of led glowing just with the hardware.

### 3.1 METHOD ADOPTED

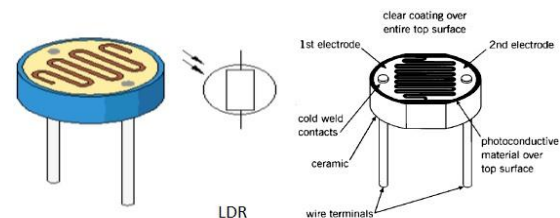
So a better solution is to build a different kind of lamp using led strip. According to [11] each led is of 0.08 watt. This strip of led can be used to build the lamp. 30 led can be used to form a single block of led, each led of 12v. Such three blocks can be used for different levels of intensity. The basic block diagram of the lamp is as shown below.



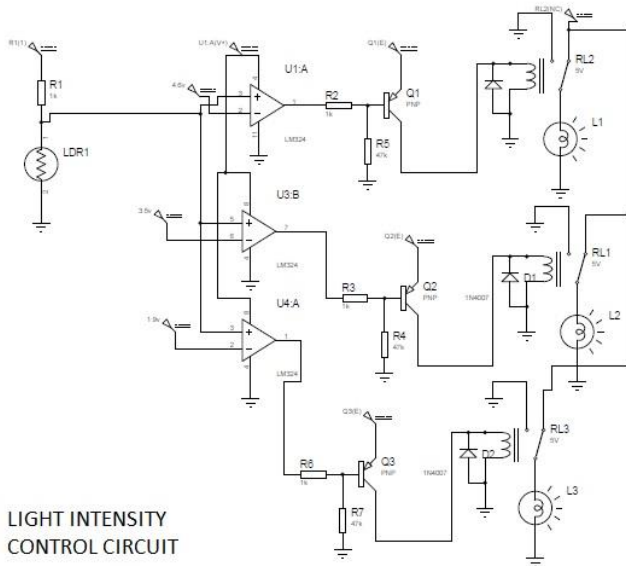
Here the light intensity sensor comprises of LDR and voltage divider circuit. The light sensor and a resistance form a voltage divider bridge, so for different intensity of light different voltages are observed. These voltages are compared with three reference voltages. When there is no sunlight all the comparator outputs are high and all the blocks of led glows. Depending on the intensity of the sunlight the glowing block of led can be controlled. So according to sunlight its wattage can also be controlled.

#### 3.1.1 LDR

The most used sunlight intensity sensor is LDR. LDR is a light dependent resistor. The sensor's resistance varies with change in intensity falling on the sensor.



The theoretical concept of the light sensor lies behind, which is used in this circuit as a darkness detector. The LDR is a resistor as shown in Fig. above, and its resistance varies according to the amount of light falling on its surface. When the LDR detect light its resistance will get decreased, thus if it detects darkness its resistance will increase. [5]



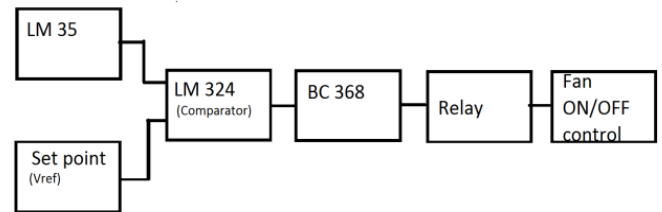
LIGHT INTENSITY CONTROL CIRCUIT

In this section the circuit diagram of the auto adjustable intensity led lamp. Here L1, L2, L3 are the block of led. The AC voltage is first drop down and then rectified to dc 12v. Resistance of the LDR is varied according to the intensity of sunlight falling on the sensor. The LDR sensor should be placed near the window to get the appropriate change in intensity. The voltage at the comparator input changes according to the change in the intensity of sunlight. This voltage is compared with three different reference voltages switching the three led blocks. The output of comparator is given to the PNP transistor to drive the relay. The rectified 12v is given to the NC of the relay as PNP transistor is used. Whenever the sensor output voltage is greater than reference voltage the output of comparator goes high whereas the output voltage to the coil is zero so the bulb glows. With the increase in sunlight the resistance decreases, decreasing the sensor voltage. When the reference voltage is greater than the sensor voltage, the relay is activated and the led lamp is turned on. So the circuit is used to change the intensity of the led lamp according to sunlight entering the room without using any software. Saving large amount of power by using led lamp.

#### 4. AUTOMATIC FAN CONTROLLER

The section is based on automatic turning ON & OFF of Fan for domestic & commercial purposes. Whenever there is increase in temperature we need to turn ON the fan for cooling the room. And whenever temperature decreases there is no need of fan. So, we need to turn OFF the fan. So, in this case we need to turn ON & OFF the fan manually. It will be better & advantageous if we will provide automatic mechanism for turning ON & OFF the fan. In this paper, we are going to provide a reference temperature level. In [14] the method used for controlling the switching of fan is based on atmega controller, but in this paper the method used is based on simple hardware and does not require any

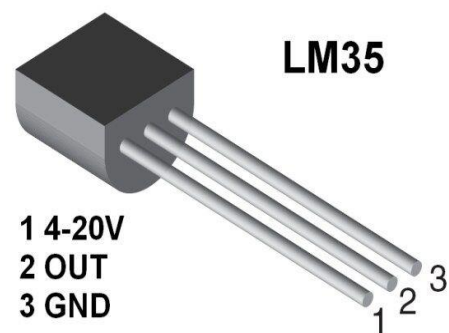
programming. Whenever the room temperature increases above reference temperature the fan will be turned ON automatically & when it decreases below reference temperature, fan will be turned OFF automatically.



#### 4.1 BLOCK DIAGRAM DESCRIPTION

In this LM 35 will sense the temperature & produce the output voltage proportional to it with the sensitivity of 10mV/degree C. This voltage will be compared with the reference voltage set by potentiometer. These two voltages will be compared by LM 324. If the voltage at the output of LM 35 is greater than reference voltage, the comparator output will be high & if it is less than reference voltage comparator output voltage will be low. So if the output is high, transistor will be turned ON & if it is low transistor will be turned ON. Whenever transistor is turned ON relay will be ON so that it will turn ON the Fan mechanism & When ever transistor is turned OFF relay will be OFF, so that it will turn OFF the Fan mechanism.

#### 4.2 LM 35:



The LM35 series are precision integrated-circuit temperature devices with an output voltage linearly-Factor proportional to the Centigrade temperature. The LM35 device has an advantage over linear -55°C to 150°C Range temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. The LM35 device does not require any external calibration or trimming to provide typical accuracies of

