

## Automatic Control System for Lighting of a Single Door Room with Bidirectional People Counter

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### ABSTRACT

This paper presents an automatic control system which turns ON or OFF room light based on counting how many people are present in the room. If there is no person in the room the light remains OFF and when there is any person enters in the room the system turns the room light ON. This system is a bi-directional people counter which contains a pair of ultrasonic distance sensor (HC-SR04), a microcontroller, and a relay. When somebody enters in or leaves the room, he has to cross a pair of sensors. These sensors send information to the micro-controller with the sequence he crossed the sensors. According to the sequence a pre-programmed micro-controller adds or subtracts the number of people present in the room and turns ON or OFF the relay which actually turns the room light ON or OFF.

**Keywords:** Automatic Control, Ultrasonic Sensor, Microcontroller, Bidirectional Counter

### 1. Introduction

Electricity scenario in developing countries like Bangladesh is still not up to the mark. Financial crisis and limitation of natural resources are the major constraint to establish more power plants and upgrade the situation. As a result limited capability of power stations cannot generate enough electricity according to the demand. Beside this power generation limitation, careless using of electrical appliances increases the demand much more. In our daily life, we often keep the lights and fans ON even there is nobody in the room. This happens due to negligence or subconscious mistakes to turn the lights off especially when we are in hurry. Whatever the situation is, the electricity demand rises. To avoid all such situations this paper presents an “Automatic control system for lighting of a single door room with bidirectional people counter”. This system saves unnecessary consumption of electricity and ensures more comfort in busy lifestyle. The complete project is divided into two modules: first module is known as “Digital People counter” and second one is “Automatic control system for lighting”. Main concept of “Digital People counter” is counting the number of persons entering in any room like seminar hall, conference room, class room, etc. This function is implemented by using a pair of ultrasonic distance sensors. No of people counted is incremented if somebody enters into the room and at the same time lights are turned ON. In reverse way, counting is decremented if somebody leaves the room. When the number of persons inside the room is zero, lights inside the room are turned OFF using a relay interface. In such way Relay does the operation of automatic control of lighting [1]. By combining all these, this research implemented a cost efficient automatic lighting system which can restrict the misuse of electricity.

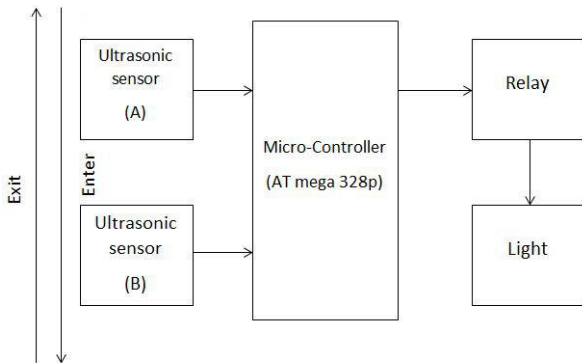
### 2. Background

Automatic system for controlling the lighting makes our regular life more comfortable and it also saves unnecessary wastage of electrical energy. There are different types of automatic control system for lighting is available in the market. Most of them use a pair of IR transmitter and IR receivers as sensing device for detecting human entry or exit [2]. In case of using IR sensors the IR transmitter and IR receiver need to be placed in a straight line on both side of the door. Any kind of deviation in placing the IR transmitter and receiver in a straight line may cause counting error [3]. To avoid this counting error, this project uses ultrasonic sound distance sensor which is placed on one side of a door only. There is no possibility of displacement problem and it gives more accurate counting than IR sensor. Beside these, the cost of the IR based automatic lighting control system is much higher than ultrasonic sound sensor based lightning control system. The cost of automatic control system for lighting based on IR sensor from *MicroTronics Technologies* [4] is about 5200 BDT. Whereas the cost of this system based on ultrasonic sensor is about 1500 BDT. So this project is cost efficient and more reliable than the IR based automatic control system for lighting.

### 3. Design Consideration

The design of this project consists of two parts: first one is designing a people counter and second part is automatic control system for lighting. The people counter is designed in such manner that when anyone enters in a room, he has to pass over the sensor A and then sensor B as shown in the fig-1. When this sequence occurs the people counter counts plus one. In case of exits from the room, a person has to pass over sensor B and then sensor A as shown in fig-1. If this sequence occurs the people counter counts minus one. Thus the counter is designed. Automatic control system for lighting is designed on the basis of number of person present in the room according to the people counting

system. When there is more than or equal to one people in the room the system turns light ON and when there is no people in the room it turns OFF light. The schematic diagram of design consideration is shown in fig-1.



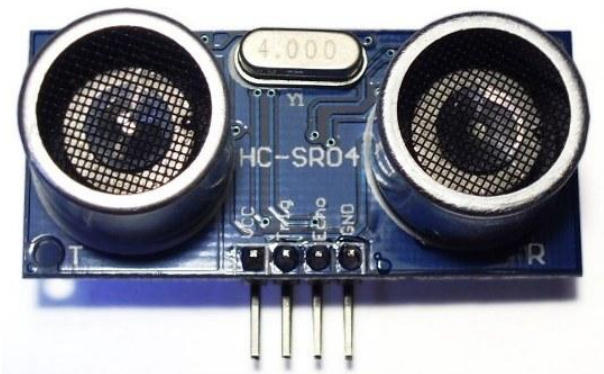
**Fig.1** Schematic Diagram of Automatic Control System for lighting

#### 4. Electrical Components

In this project a pair of HC-SR04 ultrasonic sensor, an ATmega328PU microcontroller and a 6V DC relay is used.

##### 4.1 Ultrasonic Sensor (HC-SR04)

The HC-SR04 ultrasonic sensor uses sonar signal to determine the distance to an object like bats or dolphins do. It offers excellent non-contact range detection with high accuracy and stable readings in an easy-to-use package from 2cm to 400 cm. Its operation is not affected by sunlight or black material [5].



**Fig.2-** HC-SR04 module

##### 4.2 ATmega328PU microcontroller

This is the CPU (central processing unit) of our system. This microcontroller have 32 Kbytes self-programmable Flash program memory, 1Kbytes EEPROM, 2 Kbytes internal SRAM, 8 bit AVR and 23 programmable I/O lines. Operating voltage of this microcontroller ranges between 4.5V-5.5V [6]. This is helpful for multifunctional automated system with low cost and low power consumption.



**Fig.3-** ATmega328PU microcontroller

The various functions of microcontroller are like:

- ❖ *Bidirectional Visitor counters section* – It is bidirectional because 2 sensors are used on a single door. Microcontroller does the function of Reading the digital input from two ultrasonic sound distance sensor and calculates the number of persons from them.
- ❖ *Automatic Room Light controller section* – Microcontroller turns on the Room Light when person count is greater than or equal to one. And turn off lights when count is zero. This is done by Relay. Since relay is used, an AC bulb or DC bulb can be connected as per the requirement.

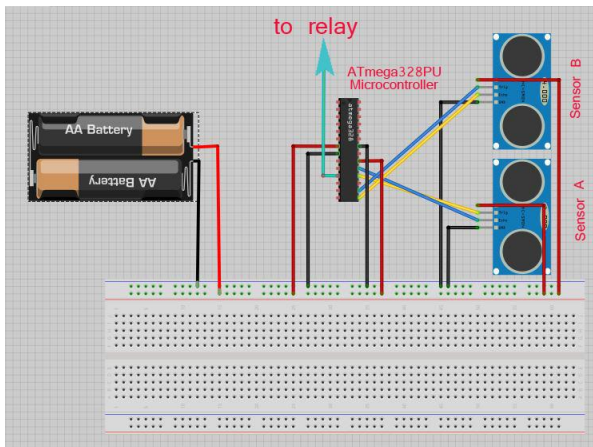
##### 4.3 6V DC Relay

Since microcontroller cannot turn on relay directly, we have used a Relay driver circuit with 6V DC relay. This circuit consists of a transistor which is used to turn on the relay through microcontroller. We have used a SPDT (Single Pole Double Throw) relay. In this project we have provided 2 pin connector as an output of Relay. One of these 2 pins is connected to the normally open terminal of the Relay which is also known as NO contact.

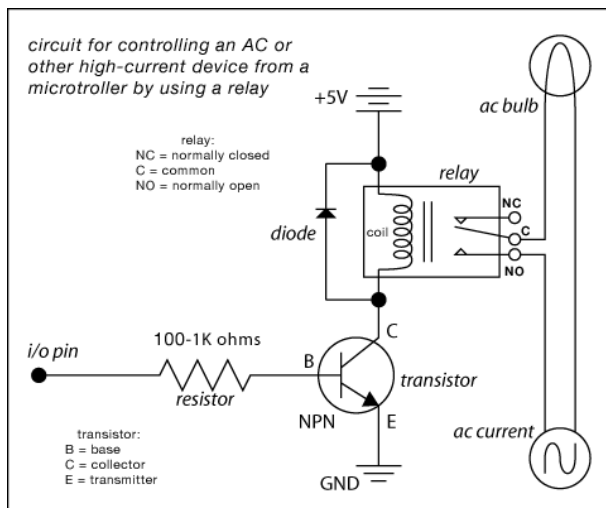


**Fig.4-** 6V DC Relay

#### 4. Circuit Diagram



**Fig.4-** Circuit Diagram of Automatic control System for lighting



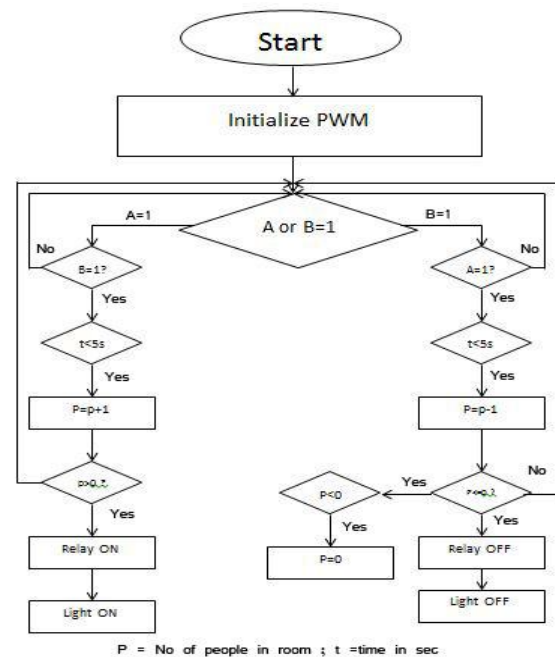
**Fig.5-** Relay setup

There are four pins on each ultrasonic sound distance sensor. Two of them are VCC and GND line and other two are Trig pin and Echo pin. Trig pin of sensor A is connected with the pin no 18 of ATmega328P and Echo pin is connected with pin 19. Trig pin of sensor B is connected with the pin no 16 of ATmega328P and Echo pin is connected with pin 15. The relay pin is connected with pin 11. The sensors send signal to microcontroller when there is an obstacle placed in front of the sensor. Then microcontroller counts whether people enter in the room or exit. If there are any people in the room then microcontroller turns ON the relay which actually turns ON the light of the room. Otherwise the light in room remains turned OFF.

#### 5. Automatic control system for lighting algorithm

The main function of automatic control system for lighting is controlled by an ATmega328PU microcontroller. When the system is plugged in it starts and initializes the PWM. After initializing PWM,

microcontroller checks if there is any person in front of sensor A or sensor B. If it finds any person in front of sensor A then it checks for any person present in front of sensor B. If the sensors respond within 5 seconds according to the sequence firstly A and then B, the microcontroller increases the number of people present in the room by one. When there is more than or equal to one person present in the room, microcontroller turns the relay ON and which actually turns ON the light. After turning ON the light the microcontroller again checks there is any person in front of sensor A or sensor B. If it finds any person in front of sensor B then it checks for any person present in front of sensor A. If the sensors respond within 5 seconds according to the sequence firstly B and then A, the microcontroller decreases the number of people present in the room by one. When the number of people in the room is zero then the microcontroller turns OFF the relay which actually turns OFF the light. And if there is any negative value of people occurs then the microcontroller sets the value to zero because negative number of people is impossible. The microcontroller goes back to check the sensor again. All the time this process continues in a closed loop. The flow chart of the algorithm is given in fig-6.



**Fig.6-** Flowchart of people counter and lighting system algorithm

#### 6. Result and Discussion

The main purpose of this research is to develop an automatic control system for lighting which is cost efficient and more reliable. The cost of this project is much lower than different automatic control system for

lighting available in market. This project overcome positioning problem of IR based control system. Moreover, the system still has limitation like; it works only when one person cuts the rays of the sensor at a time hence cannot be used when two or more persons cross the door simultaneously. An additional camera sensor can solve this problem. We also have to off the switch manually when anybody is present inside the room and want to turn the light off. Above all, this project reduces the wastage of electrical energy which was the main purpose of the project. Besides the lighting control, this project can be used as counting purposes like product counting by using its counting algorithm. Therefore, we can say that this project fulfills its objectives and it can be implemented practically.

## 8. Conclusion

The main purpose of this project is to reduce the unnecessary wastage of electrical energy. In developing country like Bangladesh this project will be very helpful to reduce unwanted consumption of electricity and it will make life more comfortable. The cost of this project is sufficiently lower than different types of automatic control system available in market. By using the circuit and proper power supply of this project we can implement various applications such as fans, tube lights etc.

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