

**National Institute of Technology Karnataka**  
**Surathkal**



**ARDUINO PROJECT REPORT**

**AUTOMATED WASHROOM LIGHT USING ULTRASONIC  
SENSORS**

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## Introduction

Creating an automated washroom light system using ultrasonic sensors can be a good project in the field of embedded systems. Ultrasonic sensors are commonly used to detect objects and distances by emitting sound waves and measuring the time it takes for the waves to bounce back. In this project you will get to know about how you can build such a system.

By designing this system with a user-centered approach, it addresses the practical needs of individuals while promoting energy-conscious behavior. The combination of ultrasonic sensing technology, microcontroller programming, and relay control provides a reliable and adaptable solution that has the potential to make a positive impact on energy consumption and user satisfaction. As technology continues to evolve, projects like this exemplify how innovation can be harnessed for both individual benefit and broader environmental goals.

In this project, a user-friendly automated washroom light system has been developed using Ultrasonic Sensor HC-SR04 as the input device, Arduino UNO microcontroller, and a 2-channel relay module for controlling the output supply. It's been programmed on Arduino IDE, such that switches on when sensor detects the user in the range 30-70cm (about 2.3 ft) and switches off in the range below 30cm (about 11.81 in), the light will automatically turn off if no has been detected as set by the user.

**Aim:** To build an Automated washroom light using ultrasonic sensors.

### Components Required

- 1) ARDUINO UNO
- 2) 2-CHANNEL RELAY (5V)
- 3) ULTRASONIC SENSOR HC-SR04
- 4) POWER SUPPLY
- 5) LED BULB
- 6) CONNECTING WIRES



# Description

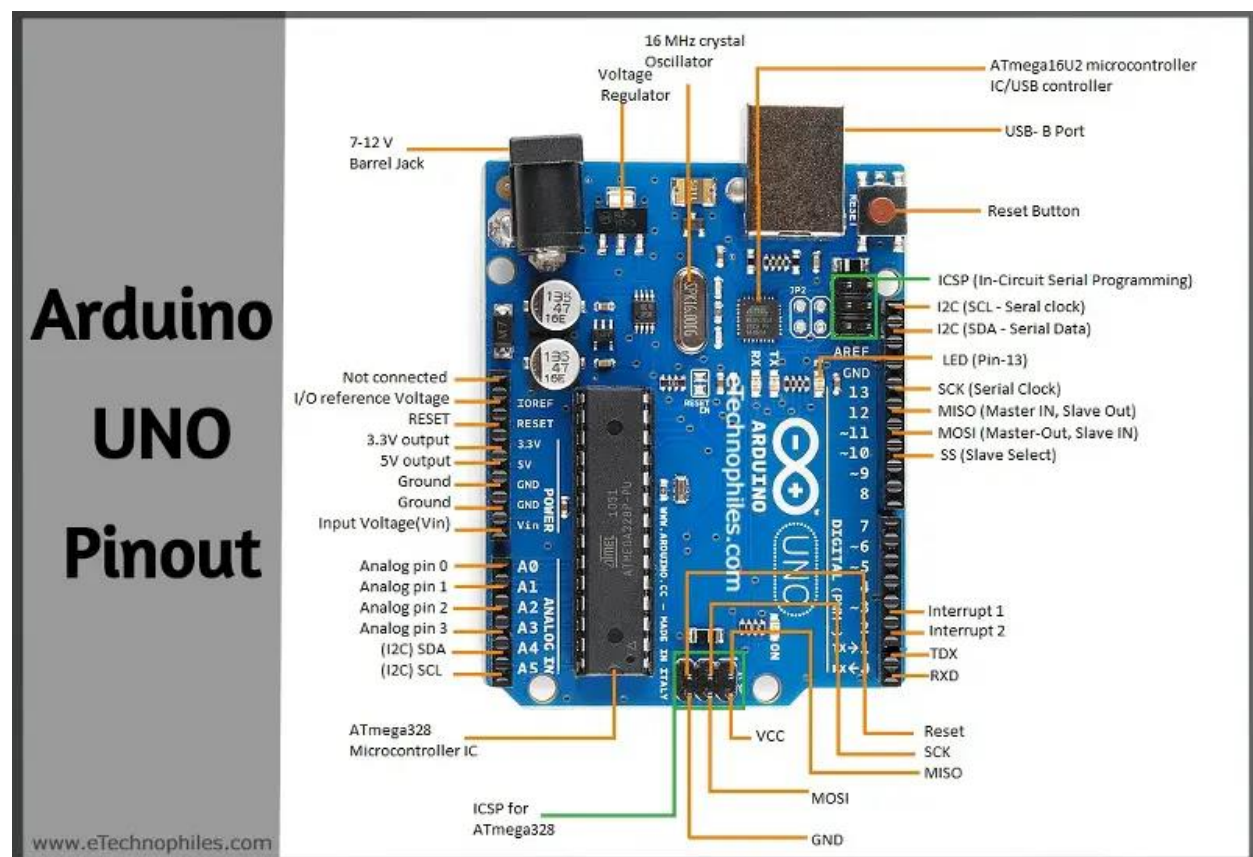
## ❑ ARDUINO UNO

Arduino is an open-source computer hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical and digital world.

The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.

Microcontroller: ATmega328

Operating Voltage: 5V



## ❑ ULTRASONIC SENSOR (HC-SR04)

The HC-SR04 is an ultrasonic distance sensor module widely used for measuring distances and detecting objects. It's an inexpensive and easy-to-use sensor that operates based on the principles of ultrasonic waves. The sensor emits ultrasonic sound waves and measures the time it takes for the waves to bounce back after hitting an object. This time measurement can then be converted into a distance value.

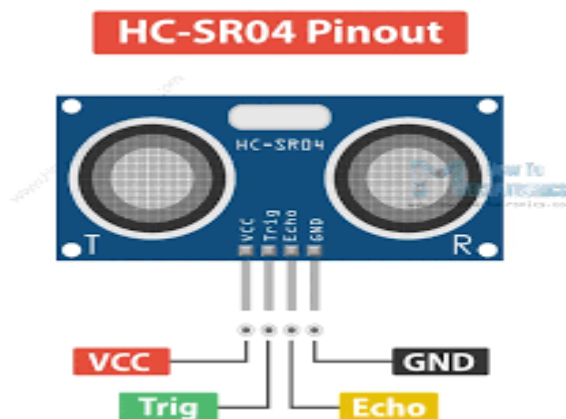
Here are some key details about the HC-SR04 ultrasonic sensor:

Operating Principle:

- 1) The sensor emits a short ultrasonic pulse.
- 2) This pulse travels through the air until it hits an object.
- 3) The pulse is then reflected back to the sensor.
- 4) The sensor calculates the time it takes for the pulse to travel to the object and back.
- 5) The time measurement is used to calculate the distance using the speed of sound.

**Key Components:**

- ❑ **Transmitter:** Emits ultrasonic pulses.
- ❑ **Receiver:** Detects the reflected pulse.



## ❑ 2-CHANNEL RELAY MODULE

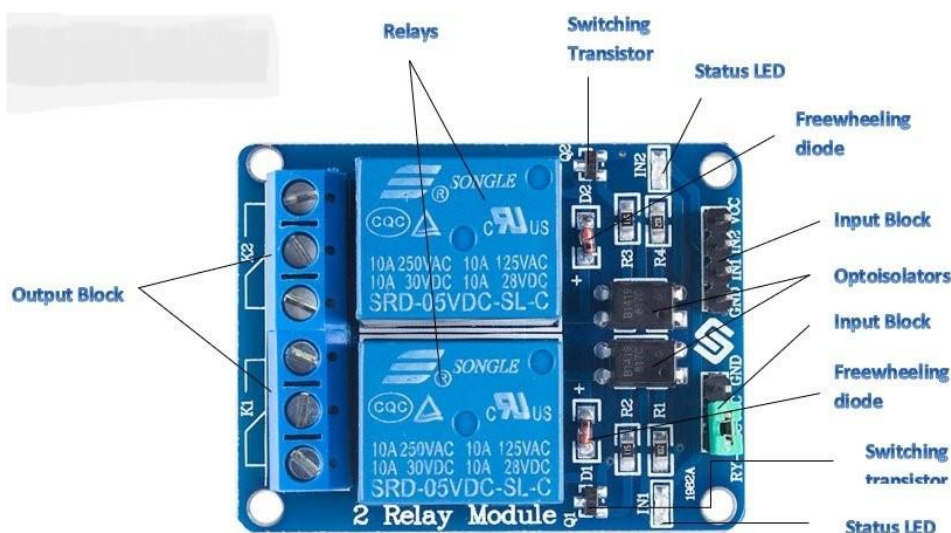
A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal.

We can control high voltage electronic devices using relays. A Relay is actually a switch which is electrically operated by an electromagnet. The electromagnet is activated with a low voltage, for example 5 volts from a microcontroller and it pulls a contact to make or break a high voltage circuit.

Number of Relays: 2

Control signal: TTL level

Rated load: 10A/250VAC 10/30VDC 10A/125VAC 10A/28VDC



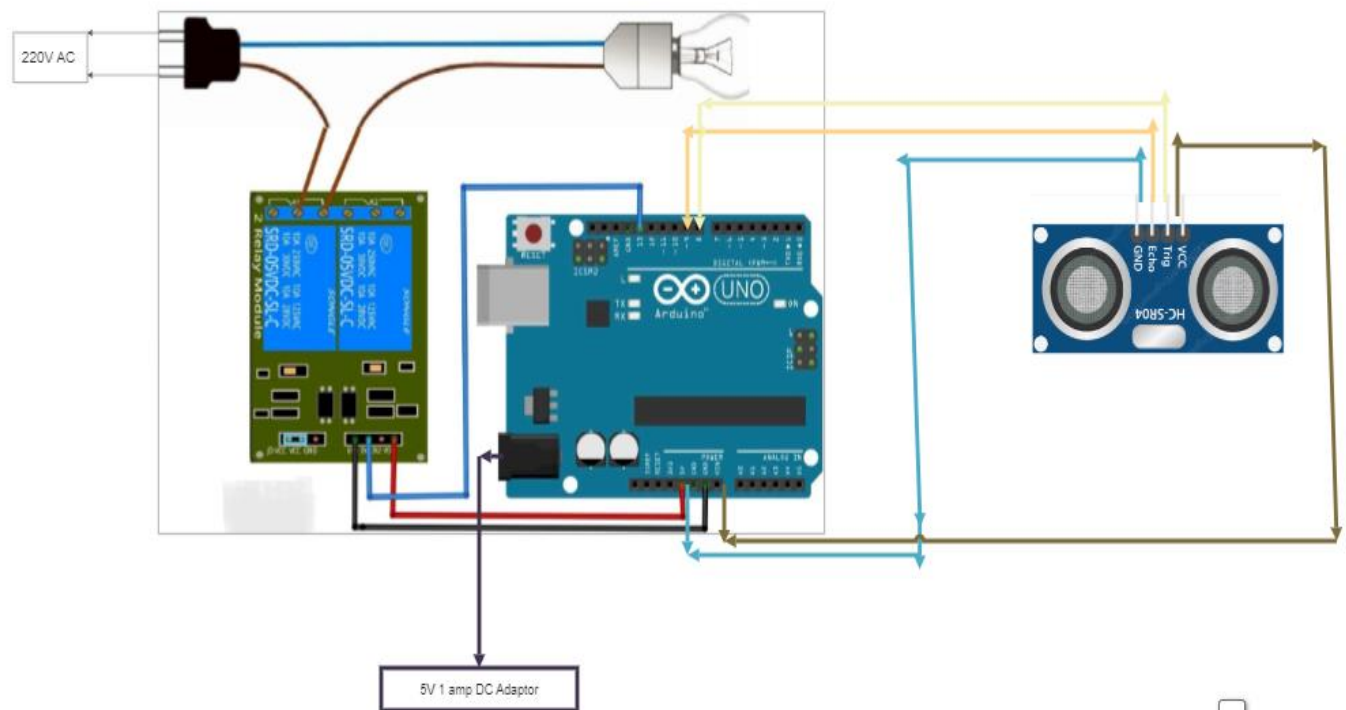
## ❑ ARDUINO IDE

The Arduino integrated development environment (IDE) is a cross-platform application that supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub *main()* into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution.



## BLOCK DIAGRAM OF THE PROJECT

An Overview Circuit connection of the project is show below, which will be detailed in each step of the project we proceed.

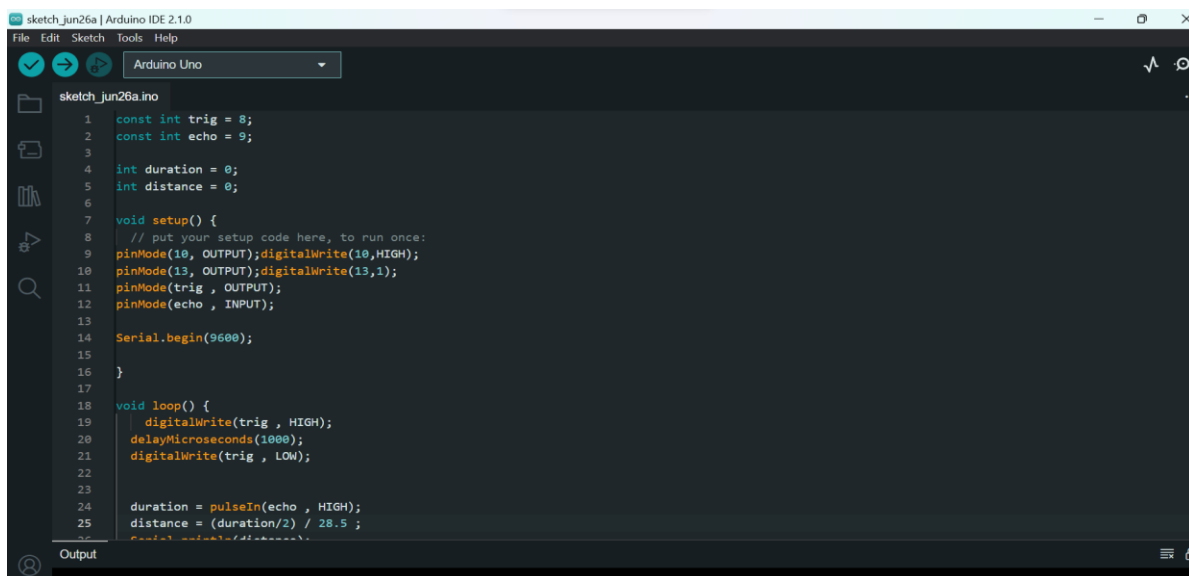


## WORKING, OBSERVATION AND DISCUSSION

### 1) Microcontroller Programing

The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures.

User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution.



```
sketch_jun26a.ino
1  const int trig = 8;
2  const int echo = 9;
3
4  int duration = 0;
5  int distance = 0;
6
7  void setup() {
8    // put your setup code here, to run once:
9    pinMode(10, OUTPUT);digitalWrite(10,HIGH);
10   pinMode(13, OUTPUT);digitalWrite(13,1);
11   pinMode(trig , OUTPUT);
12   pinMode(echo , INPUT);
13
14   Serial.begin(9600);
15
16 }
17
18 void loop() {
19   digitalWrite(trig , HIGH);
20   delayMicroseconds(1000);
21   digitalWrite(trig , LOW);
22
23
24   duration = pulseIn(echo , HIGH);
25   distance = (duration/2) / 28.5 ;
26   //Serial.println(distance);
27 }
```



- **CODE COMPILED AND DRIVEN INTO THE ARDUINO**

The code is given below:

```
const int trig = 8;  
const int echo = 9;
```

```
int duration = 0;  
int distance = 0;
```

```
void setup() {  
  // put your setup code here, to run once:  
  pinMode(10, OUTPUT);digitalWrite(10,HIGH);  
  pinMode(13, OUTPUT);digitalWrite(13,1);  
  pinMode(trig , OUTPUT);  
  pinMode(echo , INPUT);
```

```
  Serial.begin(9600);
```

```
}
```

```
void loop() {  
  digitalWrite(trig , HIGH);  
  delayMicroseconds(1000);  
  digitalWrite(trig , LOW);
```

```
  duration = pulseIn(echo , HIGH);  
  distance = (duration/2) / 28.5 ;  
  Serial.println(distance);
```

```
  if ( distance >= 10 && distance <= 70 )  
  {  
    digitalWrite(13, LOW);  
    for(int i=0;i<900;i=i+1)
```

```
{  digitalWrite(trig , HIGH);
    delayMicroseconds(1000);
    digitalWrite(trig , LOW);
    duration = pulseIn(echo , HIGH);
    distance = (duration/2) / 28.5 ;
    Serial.println(distance);
    if (distance<10){break;}
    delay(1000);
}

else
{
    digitalWrite(13, HIGH);
}

}
```

Mainly setup and loop are the two important function which are predefined, setup deals with the initial state of the relay and sensor module to be on/off and the loop runs the communication of Sensor's receiver/transmitter with the microcontroller which then controls the ON/OFF of the relay circuit depending on the data received upon object identification at a distance.

## 2) Components Testing

We have divided this component testing into 2 parts , as we need AC supply for appliances we can't test those in this stage we will be doing it later on in the project. Now we will see the working of the Ultrasonic sensor and 2-Channel relay modules.

- **HC-SR04 ULTRASONIC SENSOR**



### WORKING

- The microcontroller triggers the sensor by sending a short pulse to the Trigger pin.
- The sensor emits an ultrasonic pulse.
- The pulse hits an object and gets reflected back.
- The sensor detects the reflected pulse and sends a pulse to the Echo pin.
- The microcontroller measures the time between the transmitted pulse and the received pulse.
- Using the speed of sound (approximately 343 meters/second), the distance to the object is calculated.

### CONSIDERATION

- ☐ Make sure to provide appropriate voltage levels to the sensor (usually 5V).
- ☐ Use proper signal conditioning for accurate distance measurements.
- ☐ Ensure a clear path for the ultrasonic pulse to minimize interference.
- ☐ Be cautious about using the sensor in noisy environments, as sound reflections could cause inaccuracies.

- **2-CHANNEL RELAY MODULE**

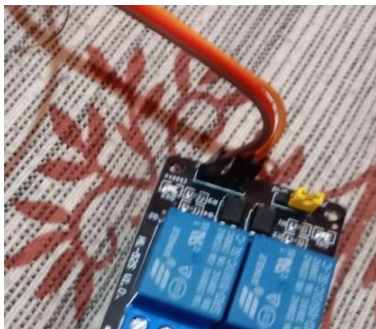
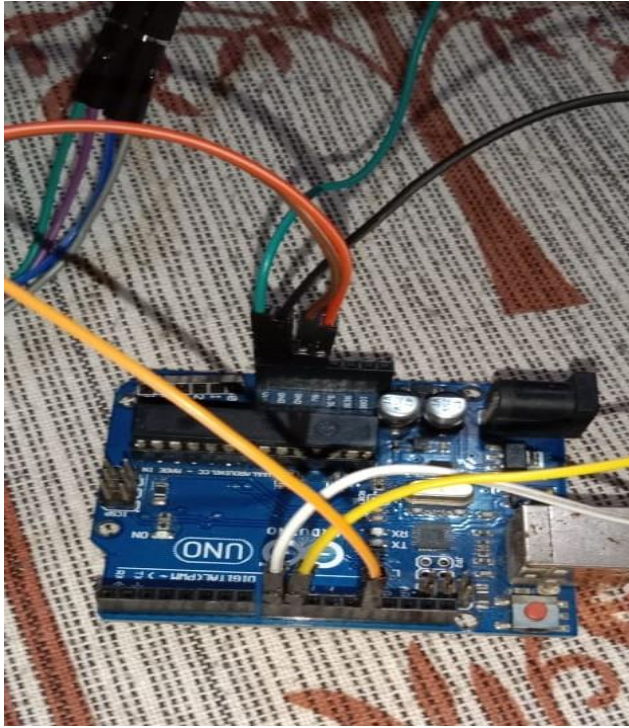


As the relay module works on a electromagnetic model it acts as a automated electric switch controlled by Microcontroller.

In the figure above we can observe the 2 LEDs are on that is because they all are given on(1) in the program when setup proving that our code is working properly and is all set for working and switching with all the 2 relays ,however the appliances are to be given to the screws in open looped or closed loop manner and can directly be connected to a DC device of 5V.

It is helpful in connecting large valued appliances like 220V bulb which can be connected to relay with the external AC supply.

### 3) Circuit connection

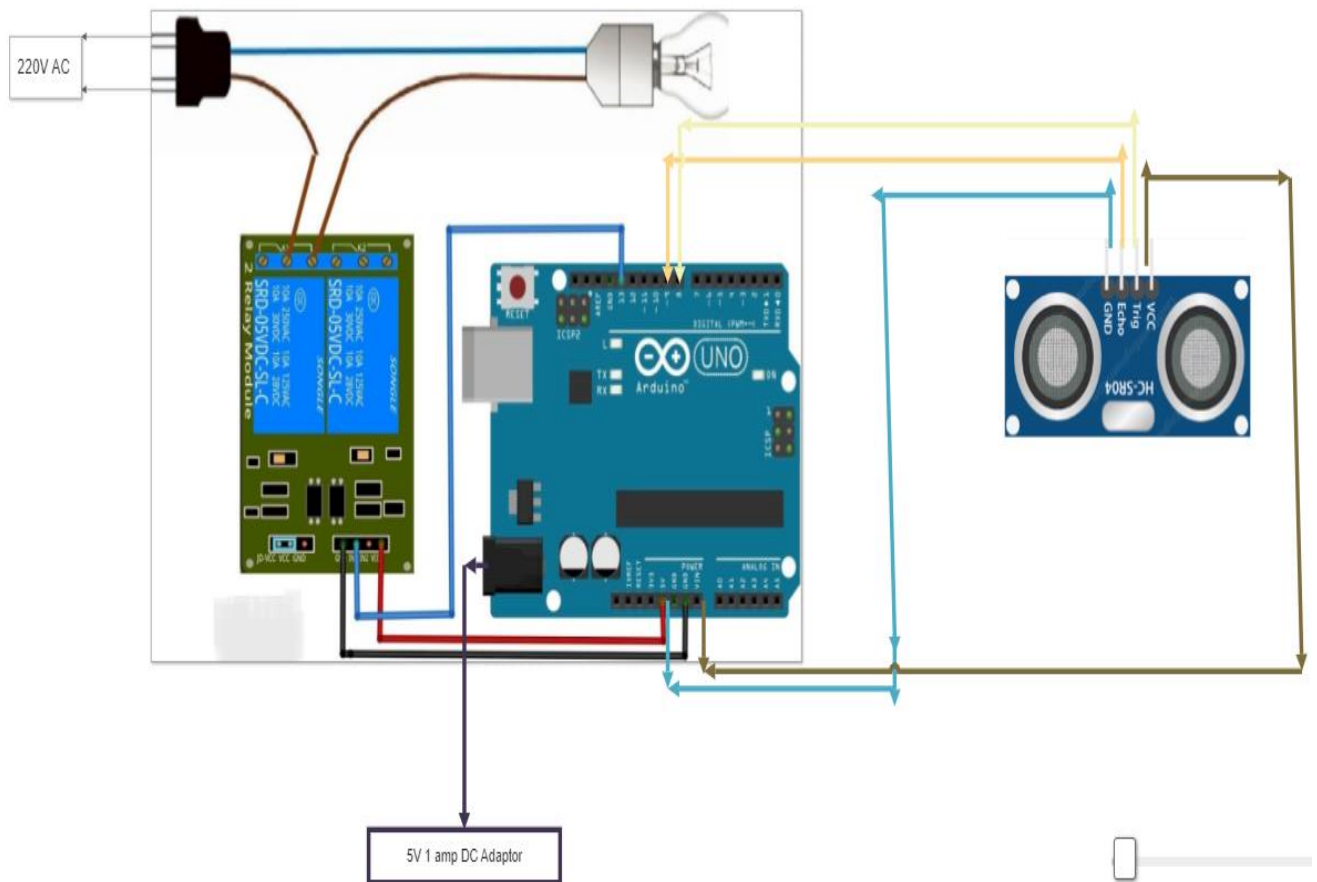


*Figure: HARDWARE PINOUT OF DIFFERENT COMPONENTS USED (This whole setup was installed in my home, so I can't take the full circuit picture of the Project.)*

The system consists of mainly components like HC-SR04 Ultrasonic sensor, Arduino microcontroller and relay circuit, LED Bulb, 5 V 1 amp DC adapter.

The whole system shown in the figure is connected to a 5V 1-amp supply, so the whole circuit is working with a 5 V supply. The connections that are made till now. The light bulb is connected and brought to control.

By this circuit connection we have come across different aspects of Ultrasonic sensor module, Arduino microcontroller, relay circuit and appliances, and how they are connected to fulfill the circuit requirement as shown in the block diagram.



*Figure:* Outcome Model of the project (This whole setup was installed in my home, so I can't take the full circuit picture of the Project.)



## Advantages of Automated Washroom Light

- ❑ **Enhanced Convenience:** Users no longer need to manually switch the washroom light on or off. The system detects their presence as they enter the washroom and automatically turns the light on. When they leave, the light turns off without any user intervention.
- ❑ **Energy Efficiency:** The system's ability to detect user presence ensures that the light is only activated when necessary. This prevents lights from being left on when the washroom is unoccupied, leading to energy savings over time.
- ❑ **Customizability:** The system's parameters can be easily adjusted by the user to suit their preferences. The range at which the sensor activates the light can be set within the 30-70cm range, and the system can also be configured to turn off after a specific duration of inactivity.
- ❑ **User-Centric Design:** The focus on user-friendliness and automation eliminates the need for users to interact with switches, promoting a hassle-free and comfortable experience.

## CONCLUSION

Overall, the development of the user-friendly automated washroom light system utilizing an HC-SR04 ultrasonic sensor, and a 2-channel relay module is a testament to the synergy of technology, efficiency, and user-centered design. This project demonstrates the practicality and versatility of integrating simple yet powerful components to create a solution that addresses energy conservation, convenience, and safety.

By leveraging the capabilities of the HC-SR04 ultrasonic sensor, the system accurately detects user presence within a predefined range. This seamless detection triggers the 2-channel relay module, enabling the automatic control of the washroom lights. The project's success lies in its focus on simplicity and effectiveness, catering to a diverse range of settings, from homes to commercial spaces and beyond.

I am very grateful for working on this project and will be looking forward to more such projects.

*Thank You*