SMART HOME AUTOMATION

Submitted in partial fulfillment of the

requirements Of the degree of

Bachelor of Technology

In Electrical Engineering

Submitted By:

Arshiya Taj (132101)

Jyotik Parikshya (132124)

Harendra Kumar (122117)

Supervisor:

Dr. P. Chandrasekhar

Department of Electrical Engineering

National Institute of Technology, Warangal

2016-2017

Approval Sheet

This project work entitled “Home Automation” by Arshiya, Jyotik & Harendra is approved for the degree of

Bachelor of Technology

in

Electrical Engineering

Examiners

_____

_____

_____

Supervisor (s)

_____

Chairman

_____

Date: _____

Place: _____

Declaration

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/ data/ fact/ source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

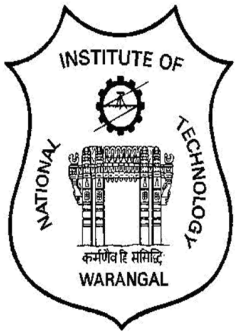
Arshiya Taj

(132101)

Jyotik Parikshya
(132124)

Harendra Kumar
(122117)

Date: 22/04/2017



Department of Electrical Engineering

NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

2016-2017

Certificate

This is to certify that the project work entitled “Smart Home Automation” is a bonafide record of work carried out by

Arshiya Taj	132101
Jyotik Parikshya	132124
Harendra Kumar	122117

submitted to the faculty of “Electrical Engineering Department“, in partial fulfilment of the requirements for the award of the degree of Batchelors Technology in “Electrical Engineering” at National Institute of Technology, Warangal during the academic year 2015-2016.

Dr.V.T Somasekhar
Head of the Department
Dept. of Electrical Engg.
NITW

Dr P.Chandrasekhar
Assistant Professor
Dept. of Electrical Engg.
NITW

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Arshiya Taj	132101
Jyotik Parikshya	132124
Harendra Kumar	122117

Abstract

Home automation is becoming popular due to its numerous benefits. Home automation refers to the control of home appliances and domestic features by local networking or by remote control. Artificial Intelligence provides us the framework to go real-time decision and automation for Internet of Things (IoT).

Technology is a never ending process. To be able to design a product using the current technology that will be beneficial to the lives of others is a huge contribution to the community.

The Home Automation is a wireless home automation system that is supposed to be implemented in existing home environments, without any changes in the infrastructure. Home Automation lathe user to control the home from his or her computer and assignations that should happen depending on time or other sensor readings such as light, temperature or sound from any device in the Home Automation network.

The design is based on a standalone SimpleLink Arduino UNO board and the home appliances are connected to the input/output ports of this board via relays. The communication between the cell phone and the Arduino Uno board is wireless.

CONTENTS

Chapter-01

INTRODUCTION

In recent years, demand for automation has increased. Although its not the need of the hour, it's very popular in developed countries who are willing to invest highly in innovative technologies. India, being a developing country, lacks resources. Hence the main aim of this project is to develop a cheap, energy efficient system which is easy to understand on user side and is durable at the same time.

Smart Home means
A Home that 'Listens' to you…
A Home that 'Talks' to you…
A Home that 'Protects' you and your investments.
A Home that 'Adjusts' to your lifestyle.
A Home that is 'Energy Efficient'...

We have used microcontrollers like Arduino and TI CC3200 for controlling various devices. Bluetooth and wifi modules are used for wireless and cloud connectivity. All these devices are clubbed to implement IOT into domestic loads. Smart algorithms are used for security and other control purposes both for efficiency and luxury.

Automation is a technique, method, or system of operating or controlling a process by electronic devices with reducing human involvement to a minimum. The fundamental of building an automation system for an office or home is increasing day-by-day with numerous benefits. Industrialist and researchers are working to build efficient and affordability automatic systems to monitor and control different machines like lights, fans, AC based on the requirement. Automation makes not only an efficient but also an economical use of the electricity and water and reduces much of the wastage [5]. IoT grant to people and things to be connected Any-time, anyplace, with anyone, ideally using any network and any service [10]. Automation is another important application of IoT technologies. It is the monitoring of the energy consumption and the Controlling the environment in buildings, schools, offices and museums by using different types of sensors and actuators that control lights, temperature humidity etc.

In this project, we have used AC chopper circuit to control the intensity of light and speed of fan motor. Ultrasonic sensors are used to detect movement and monitor the number of people present in a room which can be used for various purposes.

Home automation systems, or smart home technologies, are systems and devices that can control elements of your home environment — lighting, appliances, telephones, home security and mechanical, entry and safety systems. Home automation systems can be operated by electricity or computer chip using a range of different types of switches. Simple device, such as a light can be activated by a signal from motion detector, or can be part of a computerized home automation system. As a very basic definition, we tend to refer to home automation as anything that gives you remote or automatic control of things around the home.

Home automation may designate an emerging practice of increased automation of household appliances and features in residential dwellings, particularly through electronic means that allow for things impracticable, overly expensive or simply not possible in recent past decades. The term may be used in contrast to the more mainstream “building automation," which refers to industrial settings

and the automatic or semi-automatic control of lighting, climate doors and windows, and security and surveillance systems. The techniques employed in home automation include those in building automation as well as the control of home entertainment systems, houseplant watering, pet feeding, "scenes" for different events (such as dinners or parties), and the use of domestic robots. Typically, it is easier to more fully outfit a house during construction due to the accessibility of the walls, outlets, and storage rooms, and the ability to make design changes specifically to accommodate certain technologies. Wireless systems are commonly installed when outfitting a pre-existing house, as they obviate the need to make major structural changes. These communicate via radio or infrared signals with central controller

Home automation can:

1. Increase your independence and give you greater control of your home environment.
2. Make it easier to communicate with your family.
3. Save you time and effort.
4. Improve your personal safety.
5. Reduce your heating and cooling costs.
6. Increase your home's energy efficiency.
7. Alert you audibly and visually to emergency situations.
8. Allow you to monitor your home while you are away.

Control

Remote control

Remote control gives you the convenience of controlling lighting, appliances, security systems and consumer electronics from wherever you happen to be at the time, like your couch, car or even in your bed. There are several different "methods" of controlling devices remotely.

Automatic control

Automatic control adds even more convenience by making things happen automatically, without any effort being necessary. Examples include having your lights turn on at dusk and off at your desired time, having your whole home theater turn on and tune to the desired station after one press of a button on your remote.

Chapter- 02

Literature Review

As already mentioned developed countries are using innovative techniques to improve user experience. In this section, discussed different Home Automation System with their technology with features, benefit and limitations they have. “The Figure 2” shows Basic Architecture of Remote Home Automation. Figure 2: Basic Block Diagram of Home Automation The Home automation system that uses Wi-Fi technology [1]. System consists of three main components; web server, which presents system core that controls, and monitors users’ home and hardware interface module(Arduino PCB (ready-made), Wi-Fi shield PCB, 3 input alarms PCB, and 3 output actuators PCB.), which provides appropriate interface to sensors and actuator of home automation system. The System is better from the scalability and flexibility point of view than the commercially available home automation systems. The User may use the same technology to login to the server web based application. .If server is connected to the internet, so remote users can access server web based application through the internet using compatible web browser. The application has been developed based on the android system [2]. An interface card has been developed to assure communication between the remote user, server, raspberry pi card and the home Appliances. The application has been installed on an android Smartphone, a web server, and a raspberry pi card to control the shutter of windows. Android application on a smartphone issue command to raspberry pi

card. An interface card has been realized to update signals between the actuator sensors and the raspberry pi card. Cloud-based home appliance monitoring and controlling System. Design and implement a home gateway to collect metadata from home appliances and send to the cloud-based data server to store on HDFS (Hadoop Distributed File System), process them using MapReduce and use to provide a monitoring function to Remote user [3]. It has been implemented with Raspberry Pi through reading the subject of E-mail and the algorithm. Raspberry Pi proves to be a powerful, economic and efficient platform for implementing the smart home automation [4].Raspberry pi based home automation is better than other home automation methods is several ways. For example, in home automation through DTMF (dual tone multi-frequency) [11], the call tariff is a huge disadvantage, which is not the case in their proposed method. Also, in Web server based home automation, the design of web server and the memory space required is ejected by this method, because it simply uses the already existing web server service provided by G-mail. LEDs were used to indicate the switching action. System is interactive, efficient and flexible.

The Smart home known as House automation, with the use of new technology, to make the domestic activities more convenient, comfortable, secure and economical. The home automation system includes main components which are:

User interface: as a monitor, computer, or Phone, for example, that can give orders to control System.

Mode of transmission: wired connections (example Ethernet) or Wireless (radio waves, infrared, Bluetooth, GSM) etc.

Central Controller: It is hardware interface that communicates with user interface by Controlling domestic services.

Electronic devices: A lamp, an AC or a heater, which is compatible with the transmission mode, and connected to the Central control system.

The below figure shows projected trends in the smart home market in the coming year.

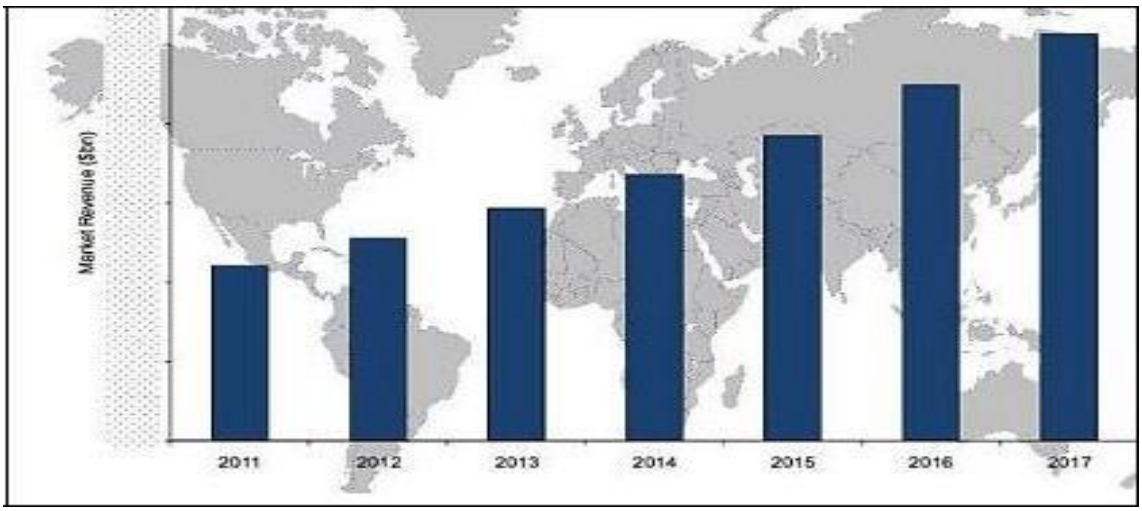


Figure 1.1: Popularity of Smart home in market

Literature Review

In this section, discussed different Home Automation System with their technology with features, benefit and limitations they have. “The Figure 2” shows Basic Architecture of Remote Home Automation.

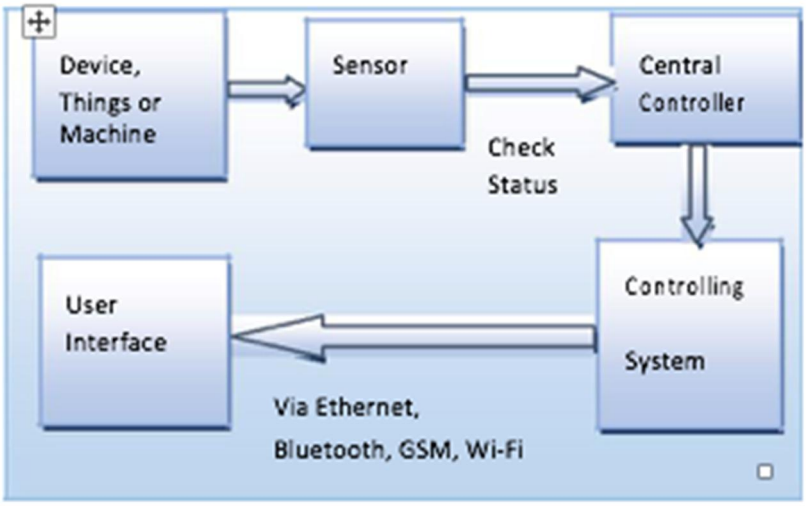


Figure 1.2: Basic Block Diagram of Home Automation

The Home automation system that uses Wi-Fi technology [1]. System consists of three main components; web server, which presents system core that controls, and monitors users’ home and hardware interface module(Arduino PCB (ready-made), Wi-Fi shield PCB, 3 input alarms PCB, and 3 output actuators PCB.), which provides appropriate interface to sensors and actuator of home automation system. The System is better from the scalability and flexibility point of view than the commercially available home automation systems. The User may use

the same technology to login to the server web based application. .If server is connected to the internet, so remote users can access server web based application through the internet using compatible web browser.

2.1 Evolution of System

Raspberry Pi

It is a credit-card-sized single microcontroller computer. Python as the main programming language. It is easy to learn and suitable for real world applications [4]. There are two main types of pi first one is Model A has 25 6Mb RAM, one USB port and no network connection and Model B has 5 12Mb RAM, 2 USB ports and an Ethernet port. It has a Broadcom BCM2835 system on a chip which includes an ARMl176JZF -S 700 MHz processor, Video Core IV GPU, and an SD card. The chip specifically provides HDMI and there is no VGA support. Arduino can successfully work with Raspberry Pi Computers.

Arduino

It is a microcontroller board, not fully computers. In this, written codes are simply executed without any obstacle. It is an 8 bit Atmel AVR Microcontroller which comprises of 32K and 512K of onboard flash memory, 2K of RAM, runs at 8-84MHz clock speeds with voltages of 2.7V-12V.programming is done using C and carries no operating system. The code is written in the computer and then sent through USB cable for execution. Its construction simply covers digital input-output pins that are between 9-54 AND 6-12 analog input pins. Its power consumption is less than 0.5 watt.

SimpleLink CC3200

The SimpleLink™ Wi-Fi® CC3200 LaunchPad™ development kit (with QFN-packaged device) is an evaluation development platform for the CC3200 wireless microcontroller (MCU), the industry's first single-chip programmable MCU with built-in Wi-Fi connectivity. The board features on-board emulation using FTDI and includes sensors for a full out-of-the-box experience. This board can be directly connected to a PC for use with development tools such as Code Composer Studio™ Cloud integrated development environment (IDE) and IAR Embedded Workbench.

Proposed System

The proposed system is to make a house network where all the electrical and electronic home appliances are connected to a micro controller and control them using an android application through the Internet, where there is no distance limitation. System also includes automated applications which are discussed below.

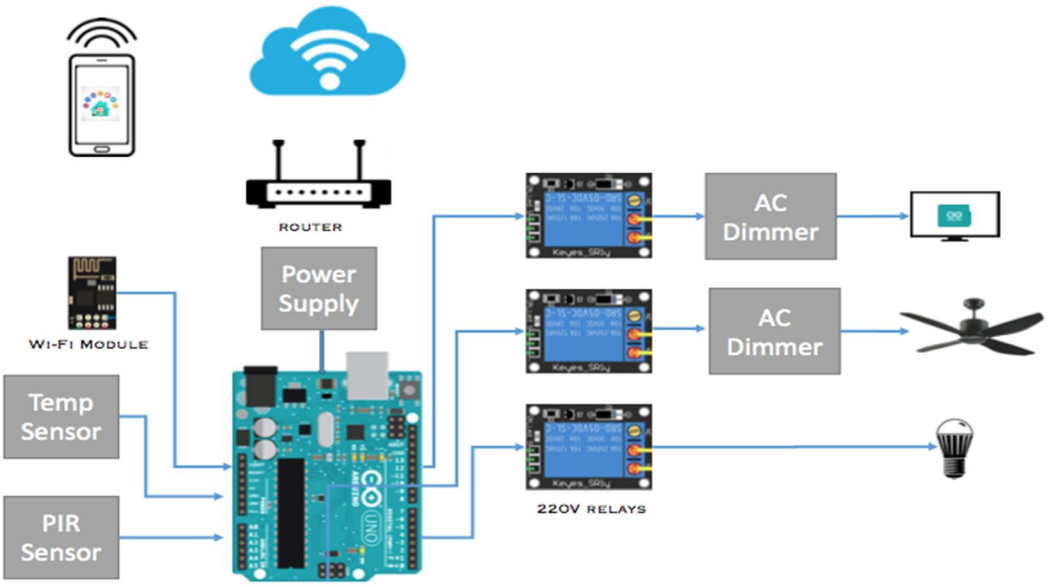


Figure 1.3:block diagram of the system

Conclusion

Based on surveyed study the comparison of home automation systems are presented. Microcontroller, user interface, a communication interface and their performance factor are compared. There are a number of do-it-yourself (DIY) platforms available that allow to create Home Automation system quickly and easily with low cost and high performance e.g. Raspberry pi, Arduino, other microcontrollers, etc. In this review explained different home automation system e.g. Web based, email based, Bluetooth-based, mobile-based, SMS based, ZigBee-based, Dual Tone Multi Frequency-based, cloud-based and Internet based. In future

home automation will more smart and fast. It would be extended to the large-scale environment such as colleges, offices and factories etc.

It has been designed Arduino board with Bluetooth board were developed for home automation. Android Application is used on the cell phone to provide the user interface. The Bluetooth board has I/O ports and relays are used for interfacing with the devices which are to be controlled and monitor. The Bluetooth is password protected to ensure that the system is secure from intruders. The Bluetooth has a range of 10 to 20 m.

CHAPTER 3

Components Description

3.1 Arduino:

Arduino is a popular open-source single-board microcontroller, which is designed to make the process of using electronics in multidisciplinary projects more accessible. The hardware consists of a simple open hardware design for the Arduino board with an Atmel AVR processor and on-board input/output support. The software consists of a standard programming language compiler and the boot loader that runs on the board. The Arduino board is a hardware interface allowing you to control and monitor hardware devices with your computer.

ArduinoUno:

ArduinoUno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

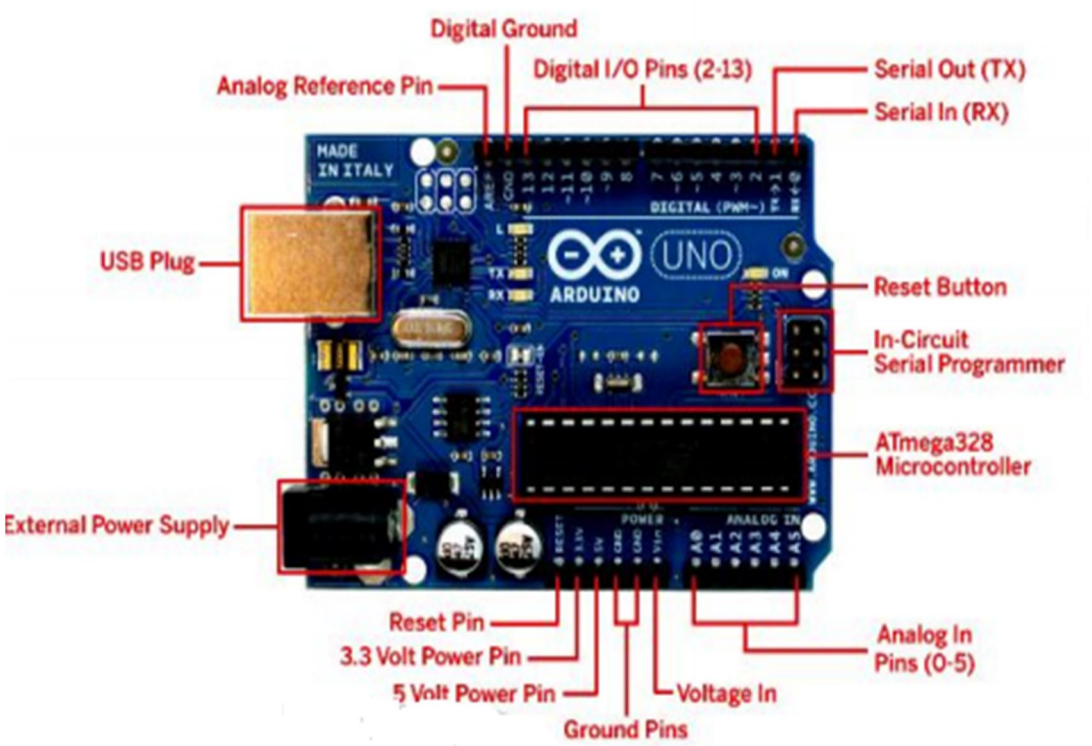


Figure 3.1: Arduino board

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Specifications:

Arduino Uno R3 Specifications

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328)
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz
Length	68.6 mm
Width	53.4 mm
Weight	25 g

3.2 Relay:

Having Arduino control high power devices like lights, motors, doors etc. can be little difficult and dangerous, so we use a relay as a switch between Arduino and the high-power devices.
A relay works on the principle of electromagnetism. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relay have two switch positions and most have double throw switch contacts. There is no electrical connection inside the relay between the two circuits, the link is magnetic and mechanical (electrical isolation).
The relay switch connections are usually labelled as COM, NC, NO.

COM- Common.
NC- Not Closed (Usually this is connected to COM when the relay coil is off).
NO- Not Open (Usually this is connected to COM when the relay coil is on).
There are 5 pins in a relay.
Two pins are for the coil to be excited. The coil is wound on the rod which gets magnetized when current is passed through the coil.
COM is always connected to NC. When the coil is energized, then the COM is connected to NO.

Advantages of relays:

- Relays can switch **AC and DC**, transistors can only switch DC.

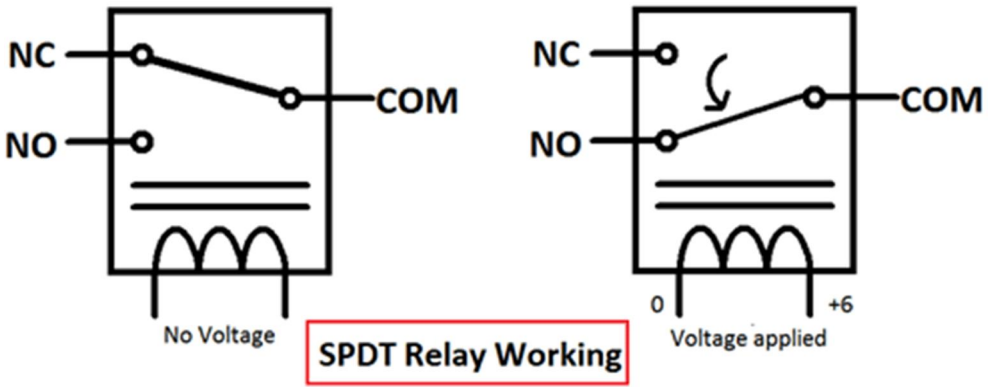


Figure 3.2: Relay internal circuit

- Relays can switch higher voltages than standard transistors.
- Relays are often a better choice for switching large currents (> 5A).
- Relays can switch many contacts at once.

Disadvantages of relays:

- Relays are bulkier than transistors for switching small currents.
- Relays cannot switch rapidly (except reed relays), transistors can switch many times per second.
- Relays use more power due to the current flowing through their coil.
- Relays require more current than many ICs can provide, so a low power transistor may be needed to switch the current for the relay's coil.

3.3 Sensors:

For a closed loop automation, Arduino needs to sense the environment. For that, Arduino uses sensors (which give information about the surroundings).

Sensors are the devices used to detect the physical environment. A sensor converts the

detected parameter into a signal which can be measured electrically.

Sensors used in this project:

1. Temperature sensor.
2. Ultrasonic sensor (Motion sensor).
3. Passive Infra-Red sensor (PIR sensor).
4. Light dependent Resistor (LDR).
5. Soil Moisture sensor.

3.3.1 Temperature sensor:

Different types of temperature sensors are used. The following are mostly commonly used temperature sensors.

- Thermocouple.
- RTD.
- Thermistors.
- Semiconductor sensors.
- Digital Temperature sensors.

In this project, sensor IC is used (which is a semiconductor sensor).

Sensor ICs:

A wide variety of temperature sensor ICs are available.

The silicon temperature sensors differ significantly from other temperature sensors.
The two major differences are-

1. Temperature Range.
2. Functionality.

These can operate over a temperature range of -55°C to +150°C.
A silicon temperature sensor is an integrated circuit, and can include extensive signal processing circuitry within the same package. Compensation circuits are not needed for sensor ICs. Some of these give either voltage or current as output (analogue circuits). Others combine analogue-sensing circuits with voltage comparators to provide alert functions. Some

other sensor ICs combine analogue-sensing circuitry with digital input/output and control registers, making them an ideal solution for microprocessor-based systems.

LM35:

The LM35 series are precision integrated-circuit temperature devices with an output voltage linearly-proportional to the Centigrade temperature. sensor has three terminals and required Maximum of 5.5 V supply. This type of sensor consists of a material that performs the operation according to temperature to vary the resistance. This change of resistance is sensed by circuit and it calculates temperature. The LM35 device does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full −55°C to 150°C temperature range. The output voltage varies by 10mV in response to every ºC rise/fall in ambient temperature, *i.e.,* its scale factor is 0.01V/ ºC.

Features of LM35:

- Calibrated Directly in Celsius (Centigrade).
- Linear + 10-mV/°C Scale Factor.
- 0.5°C Ensured Accuracy (at 25°C).
- Rated for Full −55°C to 150°C Range.
- Suitable for Remote Applications.
- Low-Cost Due to Wafer-Level Trimming.
- Operates from 4 V to 30 V.
- Low Self-Heating, 0.08°C in Still Air.
- Non-Linearity Only ±¼°C Typical.
- Low-Impedance Output, 0.1 Ω for 1-mA Load.

Pin Diagram:

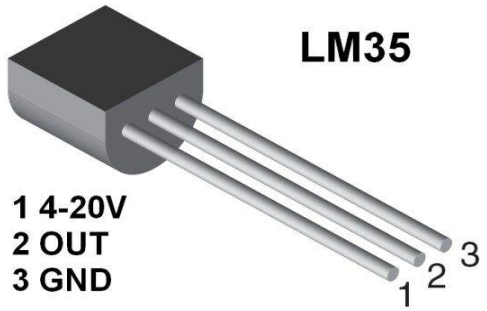


Figure 3.3: LM35

Pin Description:

Pin No	Function	Name
1	Supply voltage; 5V (+35V to -2V)	Vcc
2	Output voltage (+6V to -1V)	Output
3	Ground (0V)	Ground

3.3.2 Ultrasonic sensor:

Ultrasonic sensors utilize the properties of sound. A special sonic transducer is used for the ultrasonic proximity sensors, which allows for alternate transmission and reception of sound waves. The sonic waves emitted by the transducer are reflected by an object and received back in the transducer. After having emitted the sound waves, the ultrasonic sensor will switch to receive mode. The time elapsed between emitting and receiving is proportional to the distance of the object from the sensor.

some objects might not be detected by ultrasonic sensors. This is because some objects are shaped or positioned in such a way that the sound wave bounces off the object, but are deflected away from the Ultrasonic sensor. It is also possible for the object to be too small to reflect enough of the sound wave back to the sensor to be detected. Other objects can absorb the sound wave all together (cloth, carpeting, etc), which means that there is no way for the sensor to detect them accurately.

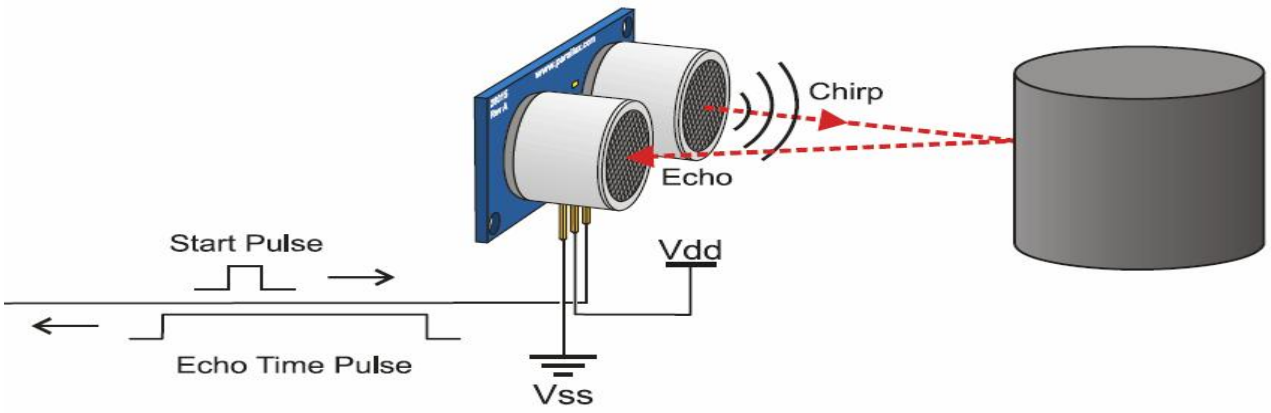


Figure 3.4: Ultrasonic sensor

HC-SR04:

Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules include ultrasonic transmitters, receiver and control circuit.

The basic principle of work:

1. Using IO trigger for at least 10us high level signal,
2. The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back.
3. If the signal back, through high level, time of high output IO duration is the time from sending ultrasonic to returning.

Test distance = (high level time × velocity of sound (340M/S) / 2.

Figure 3.5: Ultrasonic sensor pins

Pins

- VCC: +5VDC
- Trig: Trigger (INPUT)
- Echo: Echo (OUTPUT)
- GND: GND

Features:

- Power Supply: +5V DC
- Quiescent Current: <2mA
- Working Current: 15mA
- Effectual Angle: <15°
- Ranging Distance: 2cm – 400 cm/1″ – 13ft
- Resolution: 0.3 cm
- Measuring Angle: 30 degree
- Trigger Input Pulse width: 10uS

- Dimension: 45mm x 20mm x 15mm

3.3.3 Passive Infra-Red sensor (PIR sensor):

PIR are fundamentally made of a pyro electric sensor, which can detect levels of infrared radiation. Every object that has a temperature above perfect zero emits thermal energy (heat) in form of radiation. We, Homo sapiens, radiate at wavelength of 9-10micrometers all time of the day. The **PIR sensors** are tuned to detect this IR wavelength which only emanates when a human being arrives in their proximity.

Working:

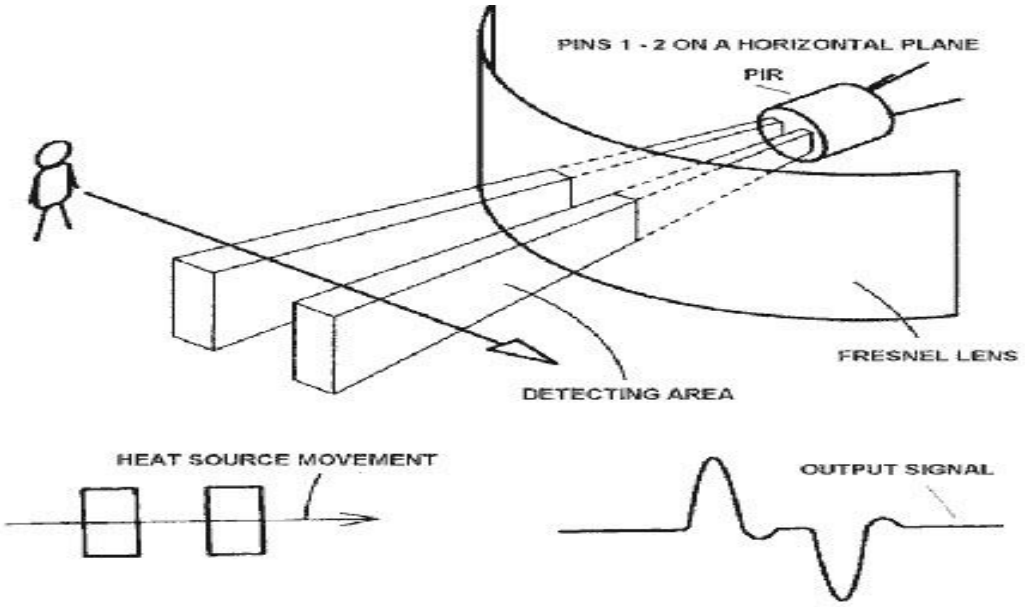


Figure 3.6: PIR sensor working

The PIR sensor itself has two slots in it, each slot is made of a special material that is sensitive to IR. The lens used here is not really doing much and so we see that the two slots can 'see' out past some distance (basically the sensitivity of the sensor). 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 passes by, 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.

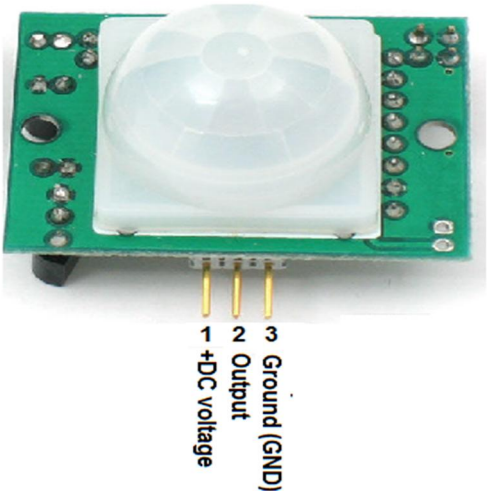


Figure 3.7:PIR sensor

To increase the detection range, Fresnel lens are used which condense large area into small area.

3.3.4 Light Dependent Resistor (LDR)

A Light Dependent Resistor (LDR) is also called a photo-resistor or a photoconductor. It is basically a photocell that works on the principle of photoconductivity. The passive component is basically a resistor whose resistance value decreases when the intensity of light decreases. The resistance is very high in darkness, almost high as 1MΩ but when there is light that falls on the LDR, the resistance is falling down to a few KΩ (10-20kΩ @ 10 lux, 2-4kOmega; @ 100 lux) depending on the model.

LDR Structure and Working:

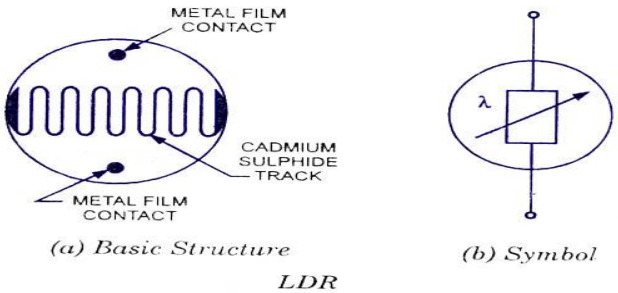


Figure 3.8: LDR structure and symbol

The snake like track shown below is the Cadmium Sulphide (CdS) film which also passes through the sides. On the top and bottom are metal films which are connected to the terminal

leads. It is designed in such a way as to provide maximum possible contact area with the two metal films. The structure is housed in a clear plastic or resin case, to provide free access to external light. As explained above, the main component for the construction of LDR is cadmium sulphide (CdS), which is used as the photoconductor and contains no or very few electrons when not illuminated. In the absence of light, it is designed to have a high resistance in the range of megaohms. As soon as light falls on the sensor, the electrons are liberated and the conductivity of the material increases. When the light intensity exceeds a certain frequency, the photons absorbed by the semiconductor give band electrons the energy required to jump into the conduction band. This causes the free electrons or holes to conduct electricity and thus dropping the resistance dramatically (< 1 Kiloohm).

Advantages:

LDR's are cheap and are readily available in many sizes and shapes. Practical LDRs are available in a variety of sizes and package styles, the most popular size having a face diameter of roughly 10 mm. They need very small power and voltage for its operation.

Disadvantages:

Highly inaccurate with a response time of about tens or hundreds of milliseconds.

3.3.5 Soil Moisture sensor:

It is very hectic for human to look after plants all the time, so soil moisture sensors are used to lessen the burden. Using this sensor, we can automate water sprinkler system depending on the soil moisture content.

Working:

The soil moisture sensor consists of two probes which are used to measure the volumetric content of water. The two probes allow the current to pass through the soil and then it gets the resistance value to measure the moisture value.

When there is more water, the soil will conduct more electricity which means that there will be less resistance. Therefore, the moisture level will be higher. Dry soil conducts electricity poorly, so when there will be less water, then the soil will conduct less electricity which means that there will be more resistance. Therefore, the moisture level will be lower.

The soil Moisture sensor FC-28 has four pins

- VCC: For power
- A0: Analog output
- D0: Digital output
- GND: Ground

Figure 3.9: Soil moisture sensor

Specifications:

Input Voltage	3.3 – 5V
Output Voltage	0 – 4.2V
Input Current	35mA
Output Signal	Both Analog and Digital

3.4 OPTICAL COUPLER:

An optical coupler, also called opto-isolator, is an electronic device which is designed to transfer electrical signals by using light waves in-order to provide coupling with electrical isolation between its input and output. The main purpose of an optocoupler is to prevent rapidly changing voltages or high voltages on one side of a circuit from distorting transmissions or damaging components on the other side of the circuit.

Working:

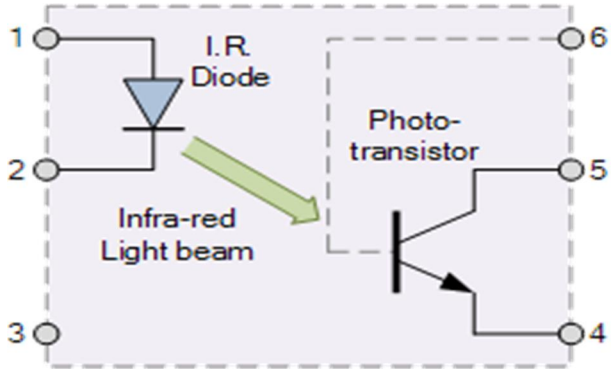


Figure 3.10: Optocoupler internal structure

Current from the source signal passes through the input LED which emits an infra-red light whose intensity is proportional to the electrical signal.

This emitted light falls upon the base of the photo-transistor, causing it to switch-ON and conduct in a similar way to a normal bipolar transistor.

The base connection of the photo-transistor can be left open (unconnected) for maximum sensitivity to the LEDs infrared light energy or connected to ground via a suitable external high value resistor to control the switching sensitivity making it more stable and resistant to false triggering by external electrical noise or voltage transients.

When the current flowing through the LED is interrupted, the infrared emitted light is cut-off, causing the photo-transistor to cease conducting. The photo-transistor can be used to switch current in the output circuit. The spectral response of the LED and the photo-sensitive device are closely matched being separated by a transparent medium such as glass, plastic or air. Since there is no direct electrical connection between the input and output of an optocoupler, electrical isolation up to 10kV is achieved.

HCPL-3120:

The HCPL-3120 gate drive optocouplers contain a GaAsP LED. The LED is optically coupled to an integrated circuit with a power output stage. It is ideally suited for driving power IGBTs and MOSFETs used in motor control inverted applications. The high operating voltage range of the output stage provides the drive voltages required by gate controlled devices.

The voltage and current supplied make it ideally suited for directly driving IGBTs with ratings up to 1200 V/100 A. For IGBTs with higher ratings, the HCPL-3120 series can be used to drive a discrete power stage which drives the IGBT gate. It has an insulation voltage

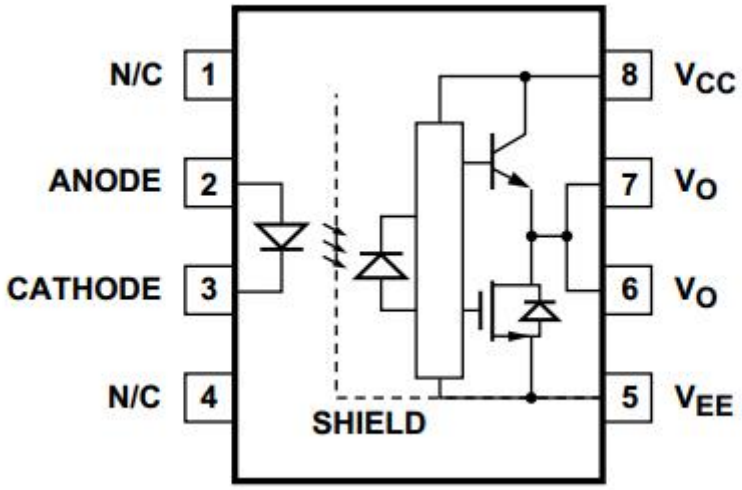


Figure 3.11: HCPL3120 IC

of VIORM = 630 V peak in the VDE 0884.

Features:

- 2.0 A Minimum Peak Output Current
- 15 kV/ms Minimum Common Mode Rejection (CMR) at VCM = 1500 V0.
- 5 V Maximum Low Level Output Voltage (VOL) Eliminates Need for Negative Gate Drive
- ICC = 5 mA Maximum Supply Current
- Under Voltage Lock-Out Protection (UVLO) with Hysteresis
- Wide Operating VCC Range: 15 to 30 Volts
- 500 ns Maximum Switching Speeds
- Industrial Temperature Range:-40 degree C to 100 degree C
- Safety Approval:

  UL Recognized - 3750 Vrms for 1 min.

  CSA Approval

  IEC/EN/DIN EN 60747-5-2 Approved: VIORM = 630 Vpeak for Option 060

- Options available are:

  60 = IEC/EN/DIN EN 60747-5-2,

VIORM = 630 V peak

300 = Gull Wing Surface Mount Option

500 = Tape and Reel Packaging Option

XXXE = Lead Free Option

Applications:

- IGBT/MOSFET Gate Drive
- AC/Brushless DC Motor Drives
- Industrial Inverter
- Switch Mode Power Supplies

3.5 MOSFET:

Field Effect Transistor whose Gate input is electrically insulated from the main current carrying channel is called an Insulated Gate Field Effect Transistor or IGFET. The most common type of insulated gate FET which is used in many different types of electronic circuits is called the Metal Oxide Semiconductor Field Effect Transistor or MOSFET for short.

The MOSFET (Metal Oxide Semiconductor Field Effect Transistor) transistor is a semiconductor device which is widely used for switching and amplifying electronic signals in the electronic devices. The MOSFET is a four-terminal device with source(S), gate (G), drain (D) and body (B) terminals. Gate electrode which is electrically insulated from the main semiconductor n-channel or p-channel by a very thin layer of insulating material usually silicon dioxide, commonly known as glass.

As the Gate terminal is isolated from the main current carrying channel "NO current flows into the gate" and just like the JFET, the MOSFET also acts like a voltage controlled resistor were the current flowing through the main channel between the Drain and Source is proportional to the input voltage. Also like the JFET, the MOSFETs very high input resistance can easily accumulate large amounts of static charge resulting in the MOSFET becoming easily damaged unless carefully handled or protected.

Working:

The working principle of MOSFET depends up on the MOS capacitor. The MOS capacitor is the main part. The semiconductor surface at below the oxide layer and between the drain and

source terminal can be inverted from p-type to n-type by applying a positive or negative gate voltages respectively. When we apply positive gate voltage the holes present beneath the oxide layer experience repulsive force and the holes are pushed downward with the substrate. The depletion region is populated by the bound negative charges, which are associated with the acceptor atoms. The positive voltage also attracts electrons from the n+ source and drain regions in to the channel. The electron reach channel is formed. Now, if a voltage is applied between the source and the drain, current flows freely between the source and drain gate voltage controls the electrons concentration the channel. Instead of positive if apply negative voltage a hole channel will be formed beneath the oxide layer.

Now, the controlling of source to gate voltage is responsible for the conduction of current between source and the drain. If the gate voltage exceeds a given value, called the threshold

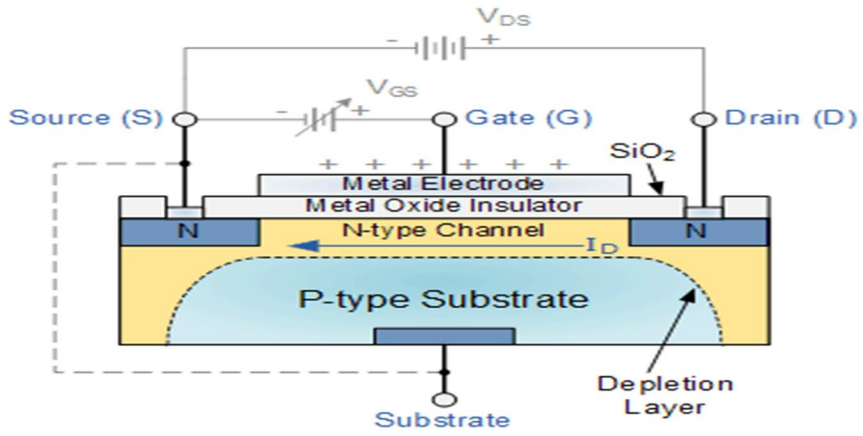


Figure 3.12: MOSFET Structure

voltage only then the conduction begins.

MOSFETs operates in 2 modes:

- Depletion Mode – the transistor requires the Gate-Source voltage, (V_{GS}) to switch the device "OFF". The depletion mode MOSFET is equivalent to a "Normally Closed" switch.
- Enhancement Mode – the transistor requires a Gate-Source voltage, (V_{GS}) to switch the device "ON". The enhancement mode MOSFET is equivalent to a "Normally Open" switch.
-

Types of MOSFET:

1. N-Channel.
2. P-Channel.

N- Channel MOSFET:

The N-Channel MOSFET has a N- channel region between source and drain It is a four terminal device such as gate, drain, source, body. This type of MOSFET the drain and source are heavily doped n+ region and the substrate or body is P- type. The current flows due to the negatively charged electrons. When we apply the positive gate voltage the holes present under the oxide layer pushed downward into the substrate with a repulsive force. The deflection region is populated by the bound negative charges which are associated with the acceptor atoms. The electrons reach channel is formed. The positive voltage also attracts electrons from the n+ source and drain regions into the channel. Now, if a voltage is applied between the drain and source the current flows freely between the source and drain and the gate voltage controls the electrons in the channel. Instead of positive voltage if we apply negative voltage a hole channel will be formed under the oxide layer.

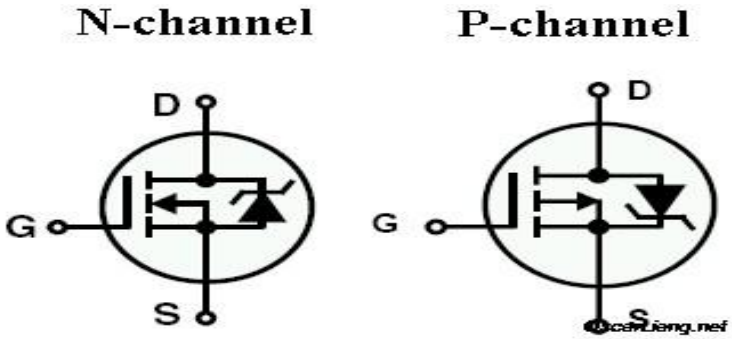


Figure 3.13: P and N channel MOSFETs

P-Channel MOSFET:

The P- Channel MOSFET has a P- Channel region between source and drain. It is a four terminal device such as gate, drain, source, body. The drain and source are heavily doped p+ region and the body or substrate is n-type. The flow of current is positively charged holes. When we apply the negative gate voltage, the electrons present under the oxide layer with are pushed downward into the substrate with a repulsive force. The deflection region populated by the bound positive charges which are associated with the donor atoms. The negative gate voltage also attracts holes from p+ source and drain region into the channel region.

IRF840:

8A, 500V, 0.850 Ohm, N-Channel Power MOSFET.

These power MOSFETs are designed for applications such as switching regulators, switching converters, motor drivers, relay drivers, and drivers for high power bipolar switching transistors requiring high speed and low gate drive power.

Features:

- 8A, 500V
- r DS(ON) = 0.850 Ω
- Single Pulse Avalanche Energy Rated
- SOA is Power Dissipation Limited
- Nanosecond Switching Speeds
- Linear Transfer Characteristics
- High Input Impedance

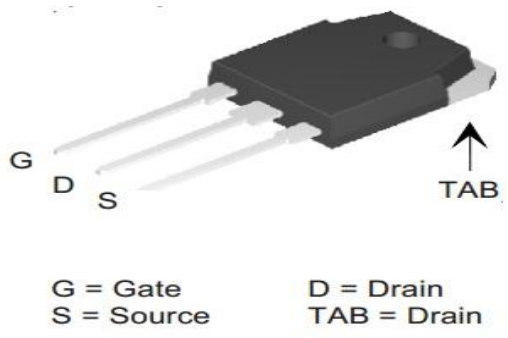


Figure 3.14: IRF 840

Absolute Maximum Ratings $T_C = 25^oC$, Unless Otherwise Specified

		IRF840	UNITS
Drain to Source Voltage (Note 1)	V_{DS}	500	V
Drain to Gate Voltage (R_{GS} = 20kΩ) (Note 1)	V_{DGR}	500	V
Continuous Drain Current	I_D	8.0	A
$T_C = 100^oC$	I_D	5.1	A
Pulsed Drain Current (Note 3)	I_{DM}	32	A
Gate to Source Voltage	V_{GS}	±20	V
Maximum Power Dissipation	P_D	125	W
Linear Derating Factor		1.0	W/^{o}C
Single Pulse Avalanche Energy Rating (Note 4)	E_{AS}	510	mJ
Operating and Storage Temperature	T_J, T_{STG}	-55 to 150	^{o}C
Maximum Temperature for Soldering			
Leads at 0.063in (1.6mm) from Case for 10s	T_L	300	^{o}C
Package Body for 10s, See Techbrief 334	T_{pkg}	260	^{o}C

3.6 NOT GATE:

The digital **Logic NOT Gate** is the most basic of all the logical gates and is sometimes referred to as an **Inverting Buffer** or simply a **Digital Inverter**. It "inverts" (complements) its input signal.

SN7404 (ACTIVE)Hex inverters:

- Six Hex Inverters in a 14-Pin DIP Package
- Outputs Directly Interface to CMOS, NMOS and TTL
- Large Operating Voltage Range
- Wide Operating Conditions

Pin layout:

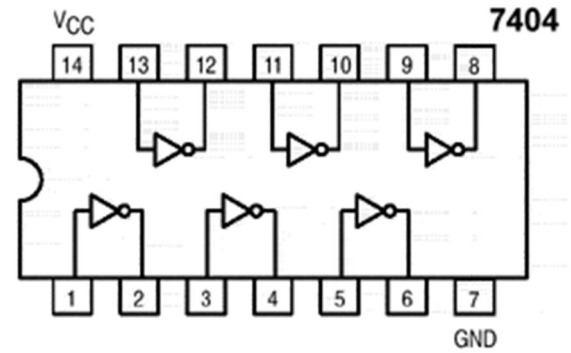


Figure 3.14: NOT gate

Absolute Maximum Ratings:

Supply Voltage	7V
Input Voltage	5.5V
Operating Free Air Temperature	07°C to +70°C
Storage Temperature Range	-65°C to +150°C

Specifications:

Symbol	Parameter	Min	Typ	Max	Units
Vcc	Supply Votage	4.75	5	5.25	V
Vih	HIGH Level Input Voltage	2			V
Vil	LOW Level Input Voltage			0.8	V
Ioh	HIGH Level Output Current			-0.4	mA
Iol	LOW Level Output Current			16	mA
Ta	Free Air Operating Temperature	0		70	°C

3.7 BLUETOOTH:

Bluetooth is a technology for wireless communication. It is designed to replace cable connections. Usually, it connects small devices like mobile phones, PDAs and TVs using a short-range wireless connection. And it uses the 2.45Ghz frequency band. The connection can be point-to-point or multipoint where the maximum range is 10 meters. The transfer rate of the data is 1Mbps (or a maximum of 2Mbps).

HC-05 module:

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. HC-05 is a more capable module that can be set to be either Master or Slave. This serial port bluetooth module is fully qualified **Bluetooth V2.0+EDR (Enhanced Data Rate)** 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses **CSR Bluecore 04**-External single chip Rluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature).

The module has two modes of operation, Command Mode where we can send AT commands to it and Data Mode where it transmits and receives data to another bluetooth module.

The Bluetooth module HC-05 is a MASTER/SLAVE module. By default, the setting is SLAVE. The (Master or Slave) role can be configured only by AT COMMANDS.

Slave module: cannot initiate a connection to another Bluetooth device, but can accept connections.

Master module: can initiate a connection to other devices.

Figure 3.15: Bluetooth Module

Hardware Features

- Typical -80dBm sensitivity
- Up to +4dBm RF transmit power
- Low Power 1.8V Operation ,1.8 to 3.6V I/O
- PIO control
- UART interface with programmable baud rate
- With integrated antenna
- With edge connector

Software Features

- Default Baud rate: 38400, Data bits:8, Stop bit:1, Parity:No parity, Data control: has.

Supported baud rate: 9600,19200,38400,57600,115200,230400,460800.

- Given a rising pulse in PIO0, device will be disconnected.
- Status instruction port PIO1: low-disconnected, high-connected;
- PIO10 and PIO11 can be connected to red and blue led separately. When master and slave

are paired, red and blue led blinks 1time/2s in interval, while disconnected only blue led blinks 2times/s.

- Auto-connect to the last device on power as default.

- Permit pairing device to connect as default.
- Auto-pairing PINCODE:"0000" as default
- Auto-reconnect in 30 min when disconnected as a result of beyond the range of connection.

Pin Description:

The HC-05 Bluetooth Module has 6pins. They are as follows:

ENABLE:

When enable is pulled LOW, the module is disabled which means the module will not turn on and it fails to communicate. When enable is left open or connected to 3.3V, the module is enabled i.e the module remains on and communication also takes place.

Vcc:

Supply Voltage 3.3V to 5V

GND:

Ground pin

TXD & RXD:

These two pins acts as an UART interface for communication

STATE:

It acts as a status indicator. When the module is not connected to / paired with any other bluetooth device, signal goes Low. At this low state, the led flashes continuously which denotes that the module is not paired with other device. When this module is connected to/paired with any other bluetooth device, the signal goes high. At this high state, the led blinks with a constant delay say for example 2s delay which indicates that the module is paired.

BUTTON SWITCH:

This is used to switch the module into AT command mode. To enable AT command mode, press the button switch for a second. With the help of AT commands, the user can change the parameters of this module but only when the module is not paired with any other BT device. If the module is connected to any other bluetooth device, it starts to communicate with that device and fails to work in AT command mode.

3.8 BLYNK APP

Imagine a prototyping board on your smartphone where you drag and drop buttons, sliders, displays, graphs and other functional widgets. And in a matter of minutes these widgets can control Arduino and get data from it.

How it works

Blynk works over the Internet. So, the one and only requirement is that your hardware can talk to the Internet. No matter what type of connection you choose - Ethernet, Wi-Fi or maybe this new ESP8266 everyone is talking about – Blynk libraries and example sketches will get you online, connect to Blynk Server and pair up with your smartphone.

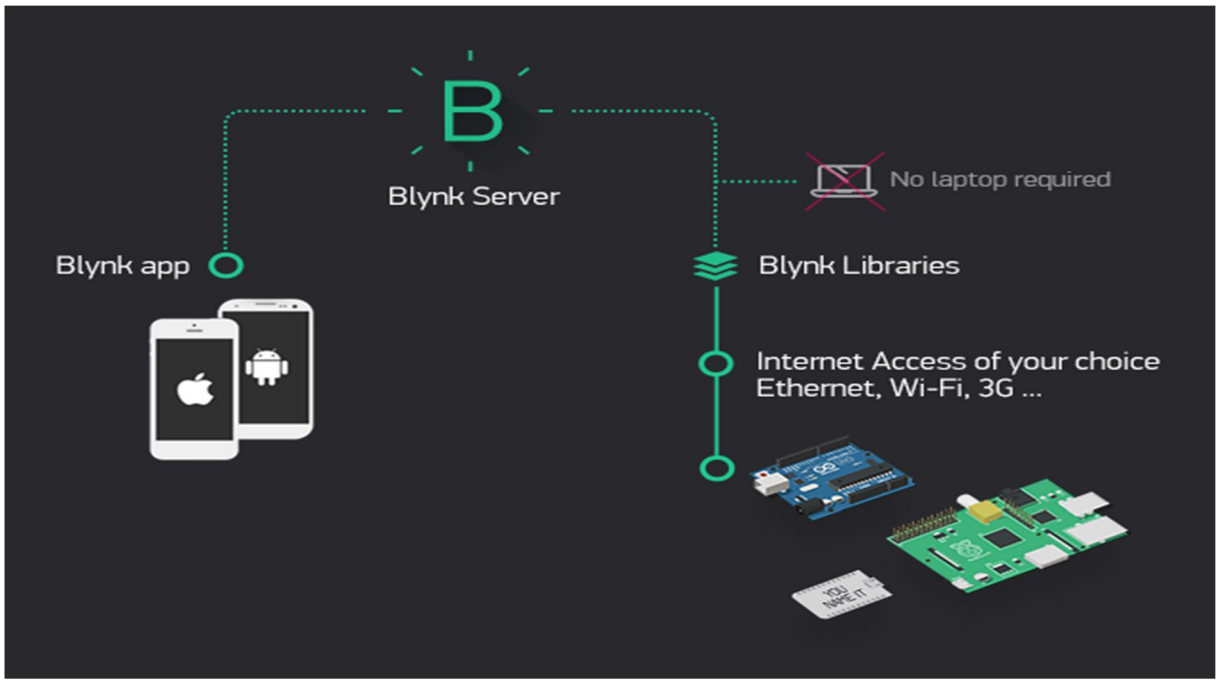


Figure 3.16 -Blynk app operation

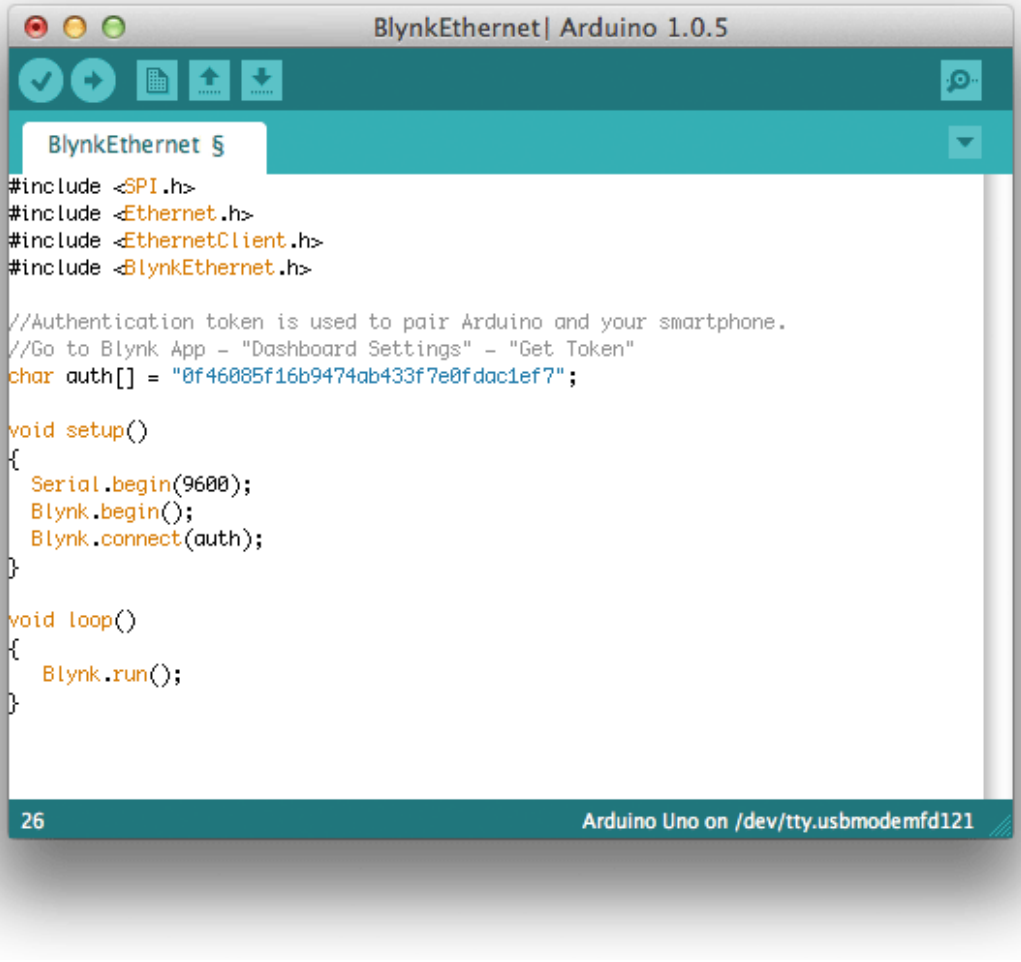


Figure 3.17-Blynk IOT coding

When designing Blynk, we really focused on simplifying things so that you could see your first results very quickly. However, if you are into writing more serious code, you'll have the full freedom in your hands.

Figure 3.18-Blynk app simplest set up

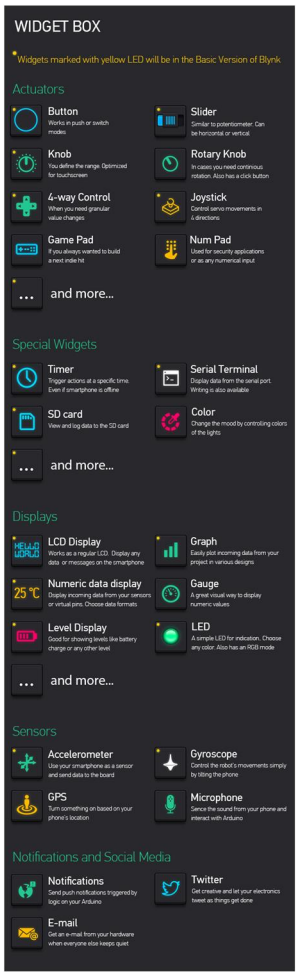


Figure 3.19 -Adding Blynk widgets.

3.9 TI CC3200 Board

The SimpleLink™ Wi-Fi® CC3200 LaunchPad™ development kit (with QFN-packaged device) is an evaluation development platform for the CC3200 wireless microcontroller (MCU), the industry's first single-chip programmable MCU with built-in Wi-Fi connectivity. The board features on-board emulation using FTDI and includes sensors for a full out-of-the-box experience. This board can be directly connected to a PC for use with development tools such as Code Composer Studio™ Cloud integrated development environment (IDE) and IAR Embedded Workbench.

This LaunchPad has driver support and a software development kit (SDK) with 40+ applications for Wi-Fi protocols, Internet applications and MCU peripheral examples.

Features

1. CC3200 Wi-Fi wireless microcontroller (MCU) in QFN package
2. Industry's first devices to be Wi-Fi CERTIFIED™ at the chip level by the Wi-Fi Alliance™
3. USB interface to PC for CCS/IAR using FTDI USB drivers
4. Flash update over the USB using SimpleLink Programmer
5. 20-pin connectors enables compatibility with Booster Packs with added functions (BoosterPack headers)
6. Standalone development platform featuring sensors, LEDs and push-buttons
7. Power from USB for the LaunchPad as well as external BoosterPack
8. Operates from 2 AA alkaline batteries
9. On-board antenna and U.FL connector selectable using a capacitor re-work
10. Supports 4 wire JTAG and 2 Wire SWD
11. GNU Debugger (GDB) support over Open On chip debugger (OpenOCD)

H bridge motor driver circuit:

The H-Bridge is designed to drive a motor clockwise and anticlockwise. To reverse a motor, the supply must be reversed and this is what the H-Bridge does. An H-Bridge can be made with SWITCHES, RELAYS, TRANSISTORS or MOSFETS.

Working of a H-bridge:

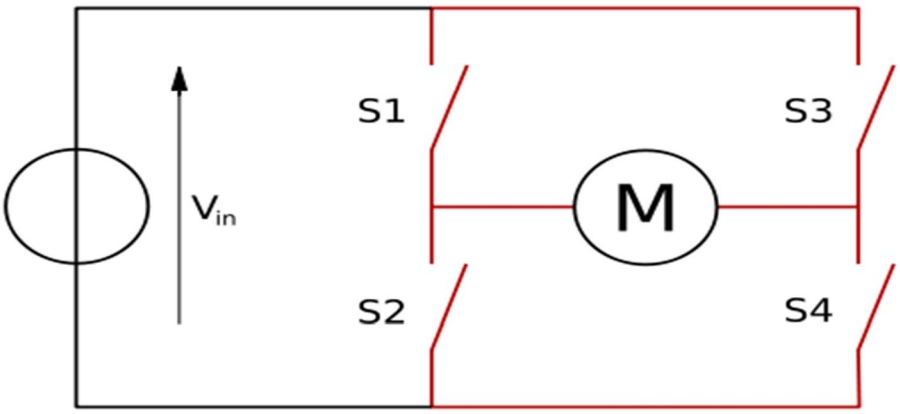


Figure 3.20: H Bridge circuit

In the given diagram, the arrow on the left points to the higher potential side of the input voltage of the circuit. Now if the switches S1 & S4 are kept in a closed position while the switches S2 & S3 are kept in a open position meaning that the circuit gets shorted across the switches S1 & S4. This creates a path for the current to flow, starting from the V input to switch S1 to the motor, then to switch S4 and then the exiting from the circuit. This flow of the current would make the motor turn in one direction. The direction of motion of the motor can be clockwise or anti-clockwise, this is because the rotation of the motor depends upon the connection of the terminals of the motor with the switches.

For simplicity, let's assume that in this condition the motor rotates in a clockwise direction. Now, when S3 and S2 are closed then and S1 and S4 are kept open then the current flows from the other direction and the motor will now definitely rotates in counter-clockwise direction

When S1 and S3 are closed and S2 and S4 are open then the 'STALL' condition will occur(The motor will break).

Stall Condition:

When the motor is applied positive voltage on both sides then the voltage from both the sides brings the motor shaft to a halt

The IC used in this project for implementing H-bridge is L293D.

L293D:

L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D IC. Dual H-bridge Motor Driver integrated circuit (IC).

L293 Pin diagram:

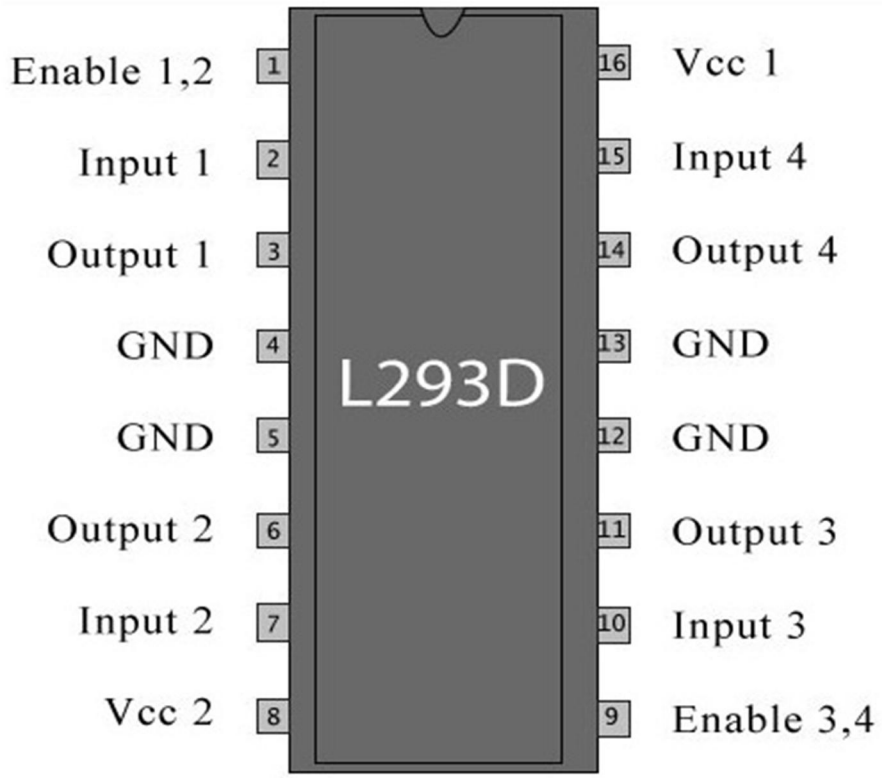


Figure 3.21: L293D IC

Features:

- Wide Supply-Voltage Range: 4.5 V to 36 V
- Separate Input-Logic Supply
- Internal ESD Protection
- High-Noise-Immunity Inputs
- Output Current 1 A Per Channel (600 mA for L293D)
- Peak Output Current 2 A Per Channel (1.2 A for L293D)
- Output Clamp Diodes for Inductive Transient Suppression (L293D)

CHAPTER 4

AC LAMP DIMMER CIRCUIT

We have used AC chopper circuit for dimming R-loads which generally includes tube-lights and bulbs. The circuit is as shown below. Two IRF840 MOSFETs are used in anti-parallel which is in series with the load. Thea gate signal Vgs across Gate and source is to given to the mosfet to switch it on. A fixed frequency square wave of 2 KHz with Vmax=12 V is given across gate and source. Sources of both the IRFs are shorted as well as the gate pin.

For positive half cycle first MOSFET conducts and the anti-parallel diode across the second MOSFET gives the way for current to flow. Similarly during negative half cycle the second MOSFET conducts as it is forward biased and the anti-parallel diode across first MOSFET gives current a path to flow hence finishing a complete cycle.

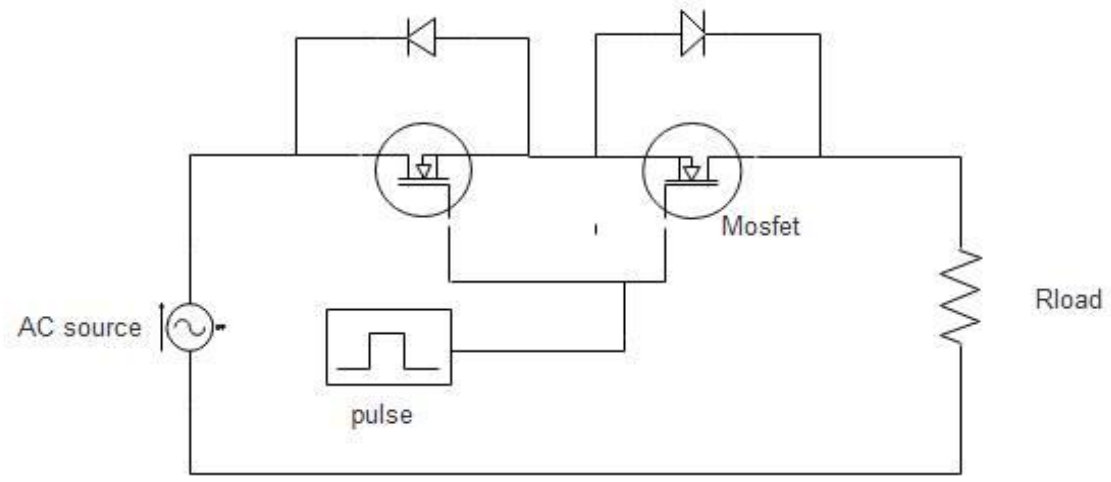
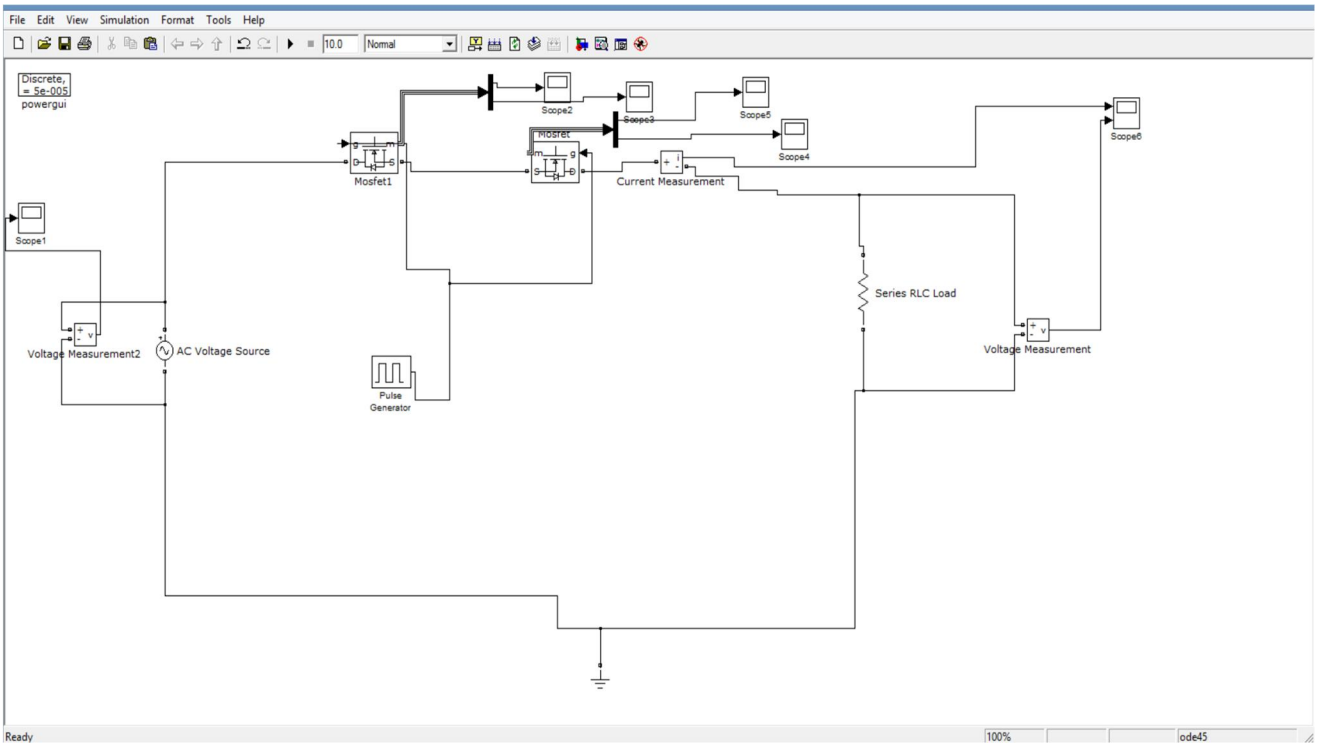


Figure 4.1: AC voltage controller for R load

The pulse is generated using Arduino analogwrite signal. It generates a 2KHz square wave of max voltage of 5V. But as the gate signal required for MOSFET should be 12-15v,we need to regulate the voltage. For this purpose we use optocouplers. It serves the purpose of both isolation and voltage regulation. The buffer circuit used and optocoupler description is provided in preceding chapter.

The computer simulation is carried out to check for the desired output. The block diagram used is shown below.



In this model gate pulse was given directly unlike the practical situation were gate voltage from optocoupler is applied across Gate and source.Output waveforms are as follows(output voltage and current):

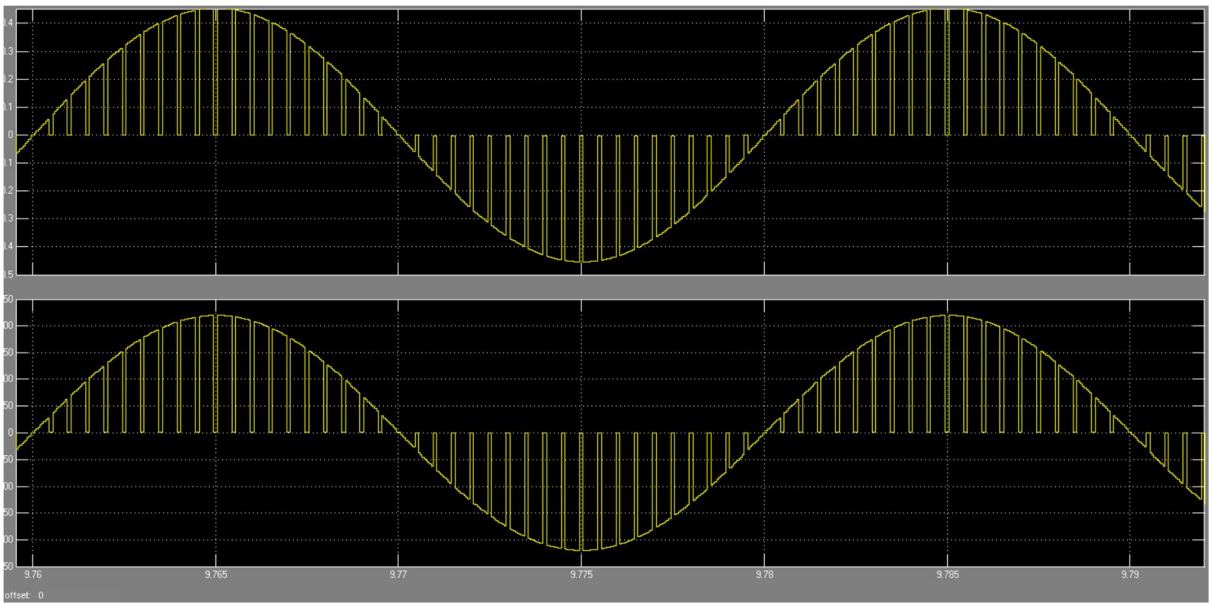


Figure 4.2: simulation result for D=0.8

Duty cycle=0.8

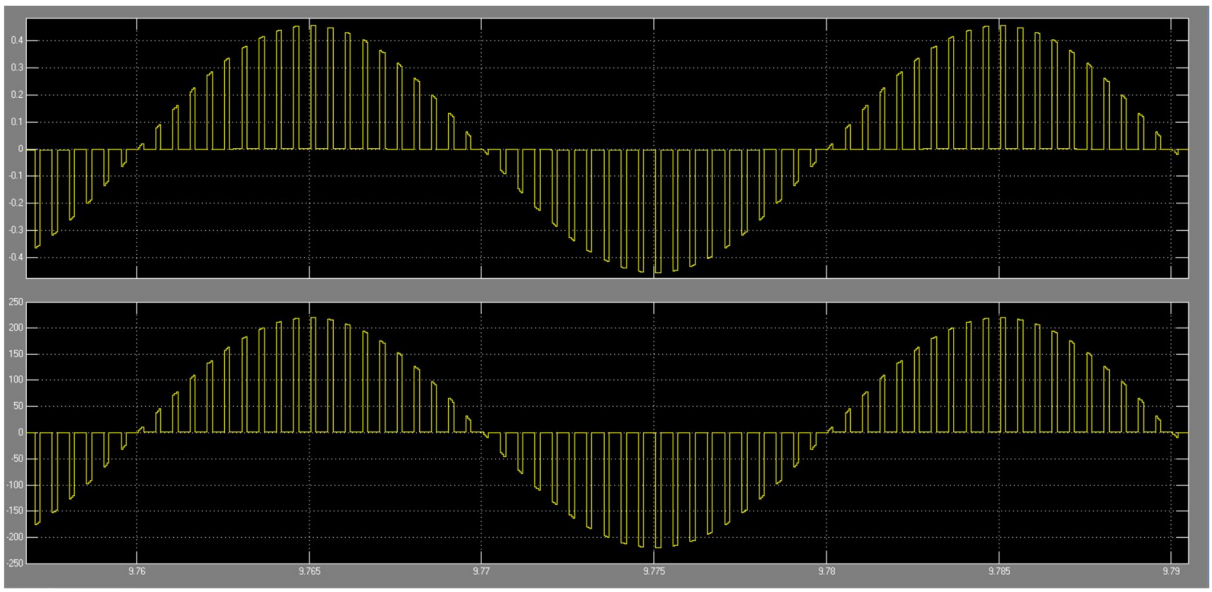


Figure 4.3: simulation result for D=0.25

Duty cycle=0.25

After verifying the waveforms by simulation, circuit was ready to be implemented practically. Connections were made according to the circuit diagram. Verifying results theoretically is very different from implementing it practically. Here are some practical problems faced by us while implementing the circuit:

1)Always check whether Arduino output on CRO and not just on DMM as the value of Vmax is of more importance.

2)Input to optocoupler should be given through a high resistance value, otherwise high currents might flow inside Arduino and it may get damaged.

3)+Vcc and -VEE across pin 8 and pin 5 should be more then 15V otherwise it won't work, so we have to use two 9 V batteries in series.

4)DON'T use single stranded wire for power circuit even not for shorting two sources,it will definitely burn whereas it works just fine with the gate circuit.

5)If you are using intensity control for tube lights it will dim only till a particular limit after which it will completely switch off.

Keeping these precautions in mind circuit was implemented. For testing the circuit input was given through serial monitor. Code for the same is as follows(in Arduino 1.6.12):

```
int ledPin=11;
void setup()
{
Serial.begin(9600);
}

void loop ()
{

if (Serial.available()) {
```

```
int ser = Serial.read(); //read serial as a character

//NOTE because the serial is read as “char” and not “int”, the read value must be compared to character numbers

//hence the quotes around the numbers in the case statement


switch (ser)

{

case '0' :

analogWrite(ledPin, 0);

break;


case '1':

analogWrite(ledPin, 64);

break;


case '2' :

analogWrite(ledPin, 128);

break;


case '3' :

analogWrite(ledPin, 192);

break;


case '4' :

analogWrite(ledPin, 255);
```

```
break;
}
}
```

Pins 3,5,6,9,10,11 can be used for generating PWM signals. In this case 11th pin is used.

The command analogWrite is used for the same. The second quantity in the analogWrite command depicts the duty cycle. For example for 255 duty is 100% similarly for 128 it is 50% and the rest is self-explanatory. Input is given through computer(serial monitor and hence intensity of bulb changed accordingly).

Now for connecting this circuit to a mobile app through Bluetooth module the following code has to be implemented:

```
char data = 0;                //Variable for storing received data
void setup()
{
  Serial.begin(9600);         //Sets the data rate in bits per second (baud) for serial data transmission


   pinMode(11, OUTPUT);
    digitalWrite(11, LOW);
}
void loop()
{
  if(Serial.available() > 0)  // Send data only when you receive data:
  {
    data = Serial.read();      //Read the incoming data and store it into variable data
    Serial.print(data);        //Print Value inside data in Serial monitor
    Serial.print("\n");        //New line
```

```
   if(data == 'A' || data == 'a')           //Checks whether value of data is equal to 1
     analogWrite(11,0);  //If value is 1 then LED turns ON
   if(data == 'B' || data== 'b')       //Checks whether value of data is equal to 0
     analogWrite(11,64);   //If value is 0 then LED turns OFF
 if(data == 'C' || data == 'c')           //Checks whether value of data is equal to 1
     analogWrite(11, 128);  //If value is 1 then LED turns ON
  if(data == 'D' || data== 'd')       //Checks whether value of data is equal to 0
     analogWrite(11, 192);   //If value is 0 then LED turns OFF


      if(data == 'E' || data== 'e')           //Checks whether value of data is equal to 1
     analogWrite(11, 255);  //If value is 1 then LED turns ON
    //Checks whether value of data is equal to 0
    // analogWrite(11, 255);   //If value is 0 then LED turns OFF
  }
}
```

This code is responsible for discrete open loop control of Domestic R-Loads through Mobile-Applications.

The mobile application takes input from user as single character. Depending on that our code will change the intensity of light.

CLOSED LOOP CONTROL OF LIGHT USING LDR

Details about LDR and it's working has been mentioned in the previous chapters. It basically changes it's resistance depending upon light. Using this property we can measure the light intensity of a room at any point of time. Once we know the how much light is available from alternative sources we can decide upon the intensity of lamp. Circuit used for incorporating LDR control system into the AC chopper circuit:

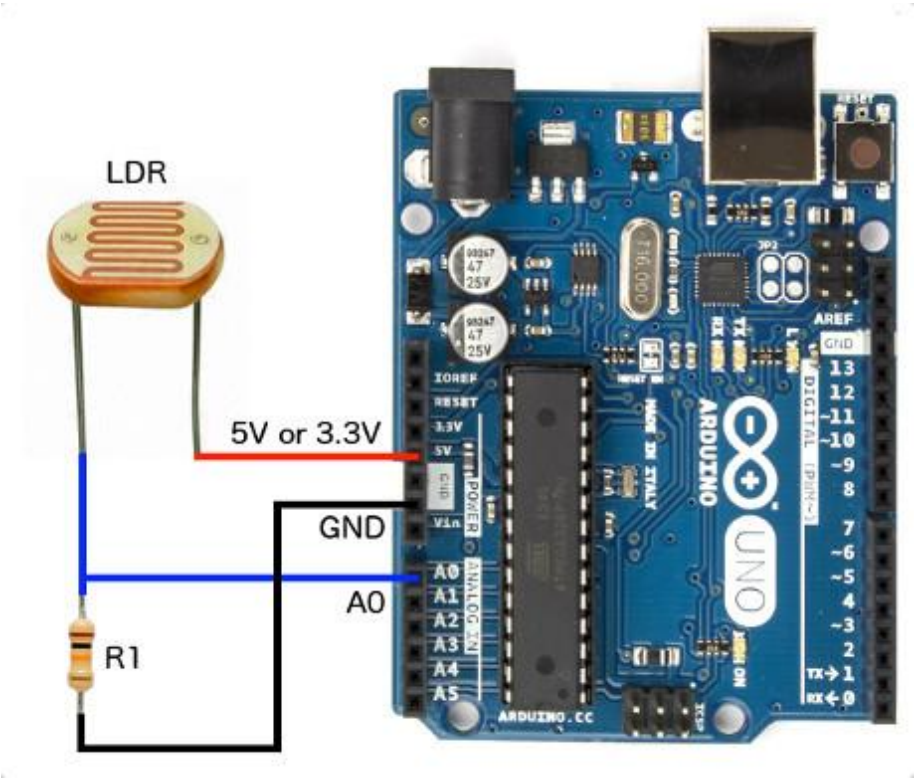


Figure 4.5 : LDR Circuit

On using this circuit we get an analogue input inside the microcontroller. When light intensity is maximum numerical input is 1000 and when light intensity is minimum it drops to 0. Using this data we had to monitor the duty cycle of the MOSFETs.

Using straight line interpolation we arrive on the equation:

Duty=(1- ldr_sensorvalue/1000)*255;

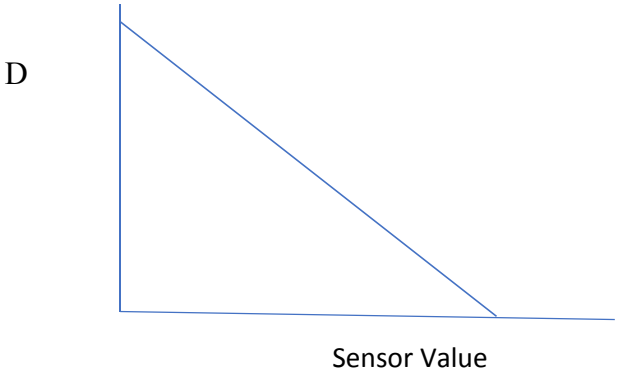


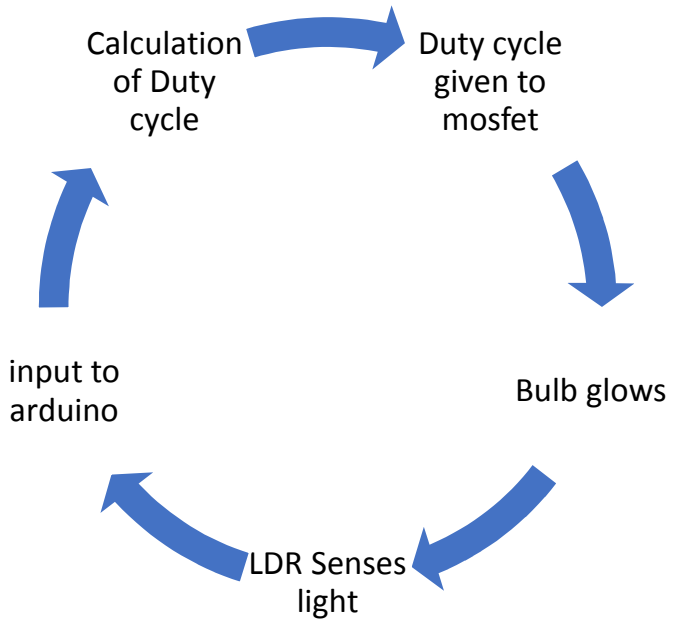
Figure 4.6: Graph for D vs Sensor Value

Code used for this integration:

```
int ledPin = 11;

double duty1;

int duty;

int i=0;

int sensorPin = A0; // select the input pin for ldr

double sensorValue = 0; // variable to store the value coming from the sensor

void setup()

{

Serial.begin(9600);

//Serial.println("connection started, waiting instructions…n0 = Offn1 = 25%n2 =50%n3 = 75%n4 = 100%");

}


void loop ()

{


sensorValue = analogRead(sensorPin); // read the value from the sensor

Serial.println(sensorValue); //prints the values coming from the sensor on the screen
```

```
duty1=(1-sensorValue/1000)*255;

Serial.println(duty1);

duty=duty1;

Serial.println(duty);

analogWrite(ledPin,duty);

delay(100);


}
```

This gives a continuous closed control of light. Following flowchart will make the process more clear:



Although this circuit gives a good control over light intensity, there are methods to do this task. We can use 2 or more LDR's, first situated nearby to the lamp and second fixed near the window so that we can get separate intensities. Main aim is to segregate the two intensities which makes the calculation much more accurate.

The main advantage of using LDR closed loop control is that energy is saved as it minimizes the unnecessary extra lighting. Secondly this can be used for many other applications like switching on garden lights or outdoor lights automatically after sunset.

CHAPTER-5

SWITICHING OF DOMESTIC APPLIANCES

This chapter illustrates the creation of a virtual switch inside a mobile phone for control of domestic loads for example light, fan, heater, chargers etc. Although this is just a luxury service and doesn't serve anything more than a remote, but it can be more than handy if we use a GSM or Wifi module through which we can control all our domestic loads from any part of the world. This also fulfils security issues as well as saves energy.

Relays are used to implement these practically. A 5 V signal is given through Arduino to the coil circuit of relay and the main circuit is connected between common and N0. So as soon the relay receives the signal from Arduino it closes the switch and the bulb glows. Circuit used is shown below.

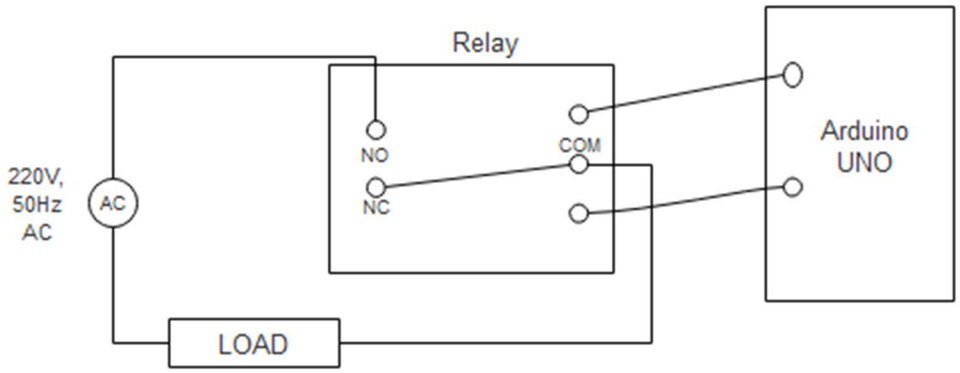


Figure 5.1: Relay circuit for operating 230 V devices

The relay structure was explained in the previous chapters. Some precautions have to be kept in mind. Firstly, we should measure the resistance across the coil terminals, and calculate current through it. If current is greater than 20 mA we should connect a resistance in parallel to limit the current through the Arduino for safe operation.

Code used is as follows:

```
char data = 0;              //Variable for storing received data
void setup()
{
  Serial.begin(9600);   //Sets the data rate in bits per second (baud) for serial data transmission
//Sets digital pin 11 as output pin
   pinMode(11, OUTPUT);
    digitalWrite(11, LOW);

}
void loop()
{
  if(Serial.available() > 0)  // Send data only when you receive data:
```

```
  {
    data = Serial.read();      //Read the incoming data and store it into variable data
    Serial.print(data);        //Print Value inside data in Serial monitor
    Serial.print("\n");        //New line
    if(data == 'A')            //Checks whether value of data is equal to 1
      digitalWrite(11,HIGH);  //If value is 1 then LED turns ON
    if(data == ‘a’)       //Checks whether value of data is equal to 0
      digitalWrite(11,LOW);   //If value is 0 then LED turns OFF
}
}
```

Signal is sent through Bluetooth module HC-05.

This is how the interface looks like on the user end i.e on mobile devices. Many such devices can be controlled through single interface

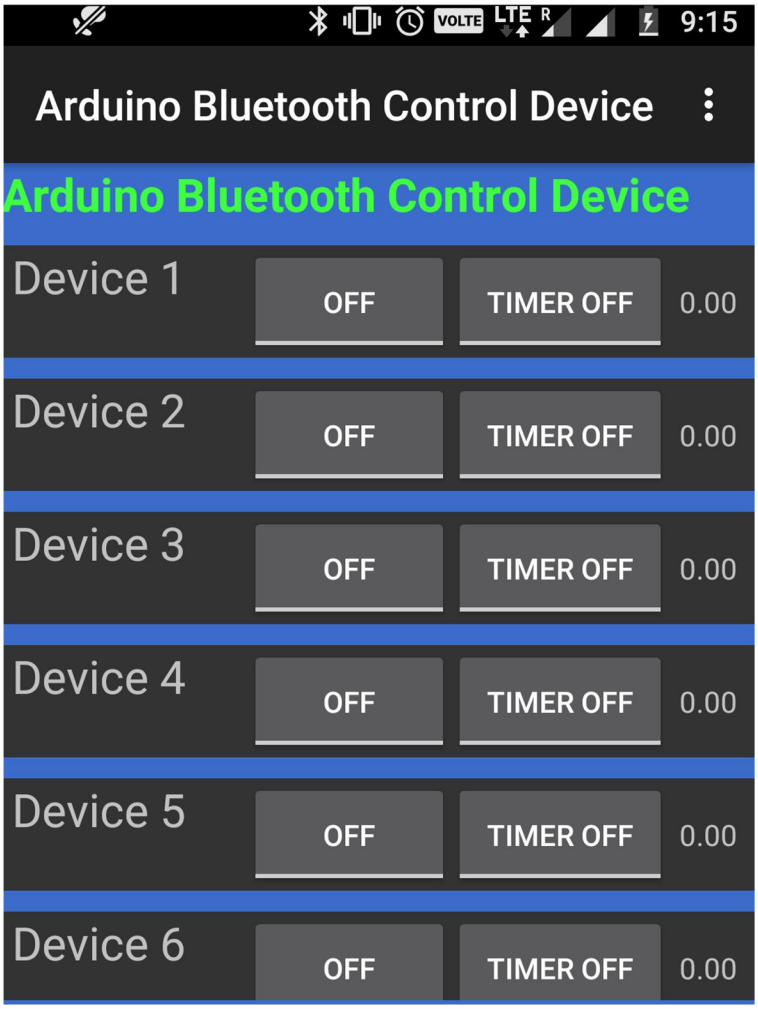


Figure 5.2: Mobile App Interface

CHAPTER 6

FAN MOTOR SPEED CONTROL

Conventional method of controlling speed of fan discretely is through triac circuit in which a resistance pot (regulator) is varied to fire the triac circuit.

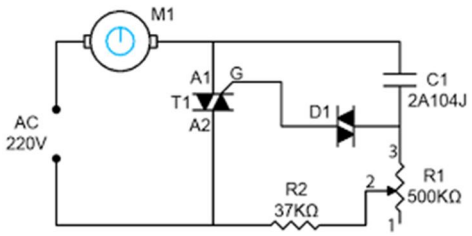


Figure 6.1: Triac circuit used for fan speed control

The general circuit is as shown above. Firing pulse is adjusted through the pot resistance.

For automating it we have to do two things, firstly create gate pulses through micro-controllers so that it can be controlled through a Mobile App. Secondly we need to go for continuous control as it will be helpful for closed loop control also.

We have used four MOSFETs in this circuit with anti-parallel diodes on them. As motor is considered as an RLE circuit it needs a freewheeling path whenever the voltage across the load is zero. Inductor doesn't allow sudden change in current, so if use the normal two MOSFET circuit, which we used for lamp load , that wouldn't have a freewheeling path whenever there is no supply and hence voltage spikes would be there which causes damage to the circuit. In order to provide a freewheeling path two MOSFETs are connected in parallel to the load. The gate signals for these 'auxiliary MOSFET's' are designed very carefully. There seems to be some connection between the two gate signals, doesn't it? Lets name the Main Mosfet gate signal G1 and auxiliary Mosfet gate signal G2. When G1 is on current is suppose to flow through load. Hence G2 is off. When G1 is off ,i.e the source is isolated from the circuit, load needs a freewheeling path for current before it becomes zero. Hence G2 has to be on at that time.

Therefore we arrive at a simple conclusion that G2=NOT(G1).

Hence we need an NOT gate for implementing the circuit.

The motor used in a fan is a single phase induction motor which can be equivalently assumed as an R-L-E circuit. Circuit used is shown below:

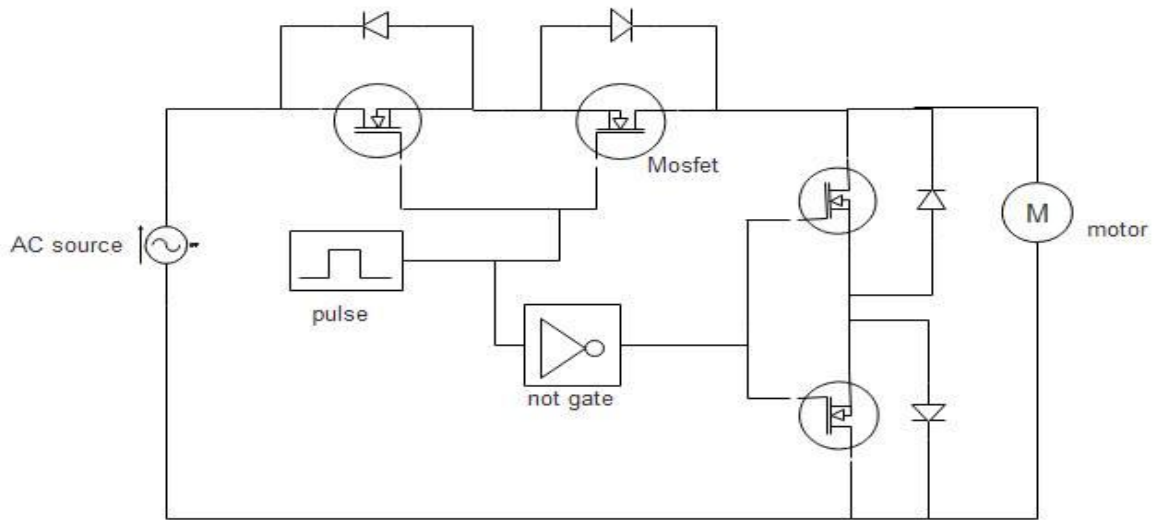


Figure 6.2: Circuit Diagram of AC dimmer for RLE load

The pulses given are similar to that of the lamp load, just the hardware part has changed. Just for convenience the code used is:

Code:

```
int ledPin=11;

void setup()

{

Serial.begin(9600);

}


void loop ()

{


if (Serial.available()) {

int ser = Serial.read(); //read serial as a character




//NOTE because the serial is read as “char” and not “int”, the read value must be compared to character numbers

//hence the quotes around the numbers in the case statement


switch (ser)

{

case '0' :

analogWrite(ledPin, 0);
```

```
break;

case '1':
analogWrite(ledPin, 64);
break;

case '2' :
analogWrite(ledPin, 128);
break;

case '3' :
analogWrite(ledPin, 192);
break;

case '4' :
analogWrite(ledPin, 255);
break;
}
}
```

Pins 3,5,6,9,10,11 can be used for generating PWM signals. In this case 11^{th} pin is used.

The command analogWrite is used for the same. The second quantity in the analogWrite command depicts the duty cycle. For example for 255 duty is 100% similarly for 128 it is 50% and the rest is self-explanatory. Input is given through computer(serial monitor and hence intensity of bulb changed accordingly).

Now for connecting this circuit to a mobile app through Bluetooth module the following code has to be implemented:

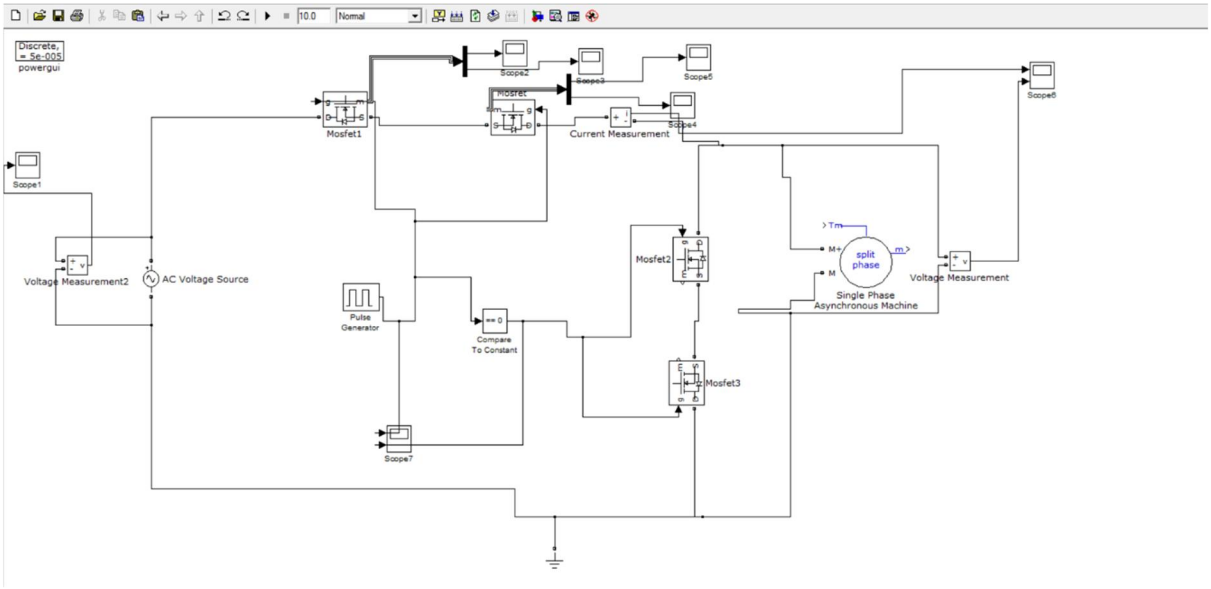
```
char data = 0;                //Variable for storing received data
void setup()
{
  Serial.begin(9600);       //Sets the data rate in bits per second (baud) for serial data transmission


   pinMode(11, OUTPUT);
    digitalWrite(11, LOW);
}
void loop()
{
  if(Serial.available() > 0)  // Send data only when you receive data:
  {
    data = Serial.read();      //Read the incoming data and store it into variable data
    Serial.print(data);        //Print Value inside data in Serial monitor
    Serial.print("\n");        //New line
    if(data == 'A' || data == 'a')           //Checks whether value of data is equal to 1
      analogWrite(11,0);  //If value is 1 then LED turns ON
    if(data == 'B' || data== 'b')       //Checks whether value of data is equal to 0
      analogWrite(11,64);   //If value is 0 then LED turns OFF
 if(data == 'C' || data == 'c')           //Checks whether value of data is equal to 1
      analogWrite(11, 128);  //If value is 1 then LED turns ON
```

```
  if(data == 'D' || data== 'd')       //Checks whether value of data is equal to 0
     analogWrite(11, 192);   //If value is 0 then LED turns OFF


      if(data == 'E' || data== 'e')            //Checks whether value of data is equal to 1
     analogWrite(11, 255);  //If value is 1 then LED turns ON
    //Checks whether value of data is equal to 0
    // analogWrite(11, 255);   //If value is 0 then LED turns OFF


  }
}
```

This is code for discrete control of speed of motor using mobile app.

Before implementing the model was tested on MATLAB.

The Simulink model is:



The output(voltage) was as expected:

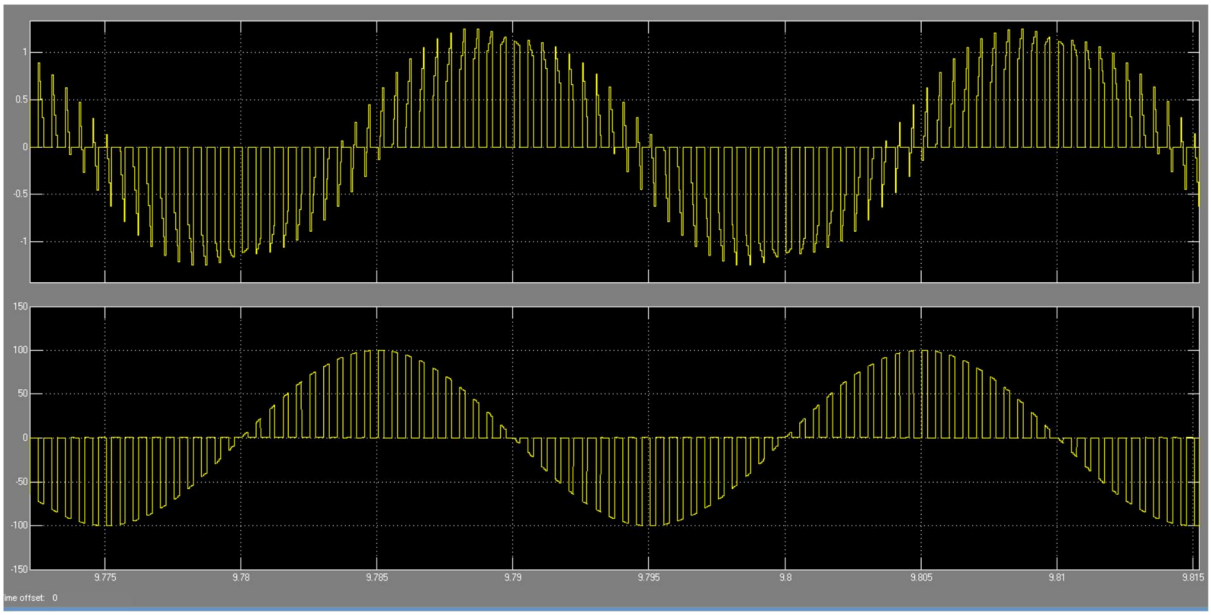
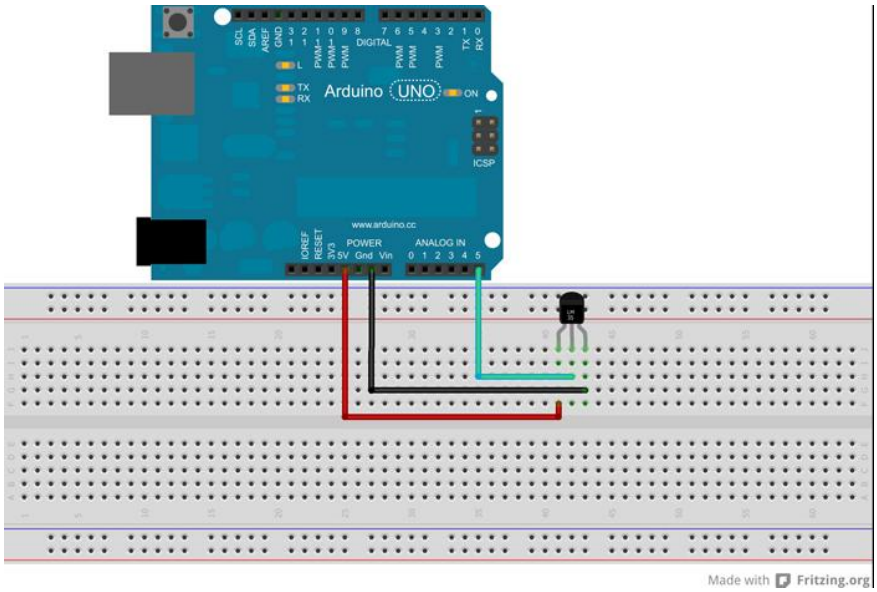


Figure 6.3: Simulation results

The above is current and below is voltage. Current looks somewhat distorted as it was simulated in discrete mode, but the voltages are without spikes as desired.

CONTINOUS FAN MOTOR CONTROL USING LM-35 TEMPRETURE SENSOR

Temperature sensor is used to measure the temperature of any room and that value is fed back to Arduino for calculation of speed of motor. Details of working of LM35 has been mentioned in preceding chapters. Motor to be controlled here can be either a fan motor or a compressor of a centralized Air conditioning system. The circuit used for measuring tempreture:



Code used for doing the same:

```
Int val;
int tempPin = 1;

void setup()
{
```

```
Serial.begin(9600);
}
void loop()
{
val = analogRead(tempPin);
float mv = ( val/1024.0)*5000;
float cel = mv/10;
float farh = (cel*9)/5 + 32;

Serial.print("TEMPRATURE = ");
Serial.print(cel);
Serial.print("*C");
Serial.println();
delay(1000);

/* uncomment this to get temperature in farenhite
Serial.print("TEMPRATURE = ");
Serial.print(farh);
Serial.print("*F");
Serial.println();


*/
}
```

As we get the temperature value we can design a control logic for motor control. This will vary from place to place and person to person. So for example let us assume that comfort temperature being 25 degrees. Logic Being:

If(realtemp>25)

Duty=0.6+(realtemp-25)/100

If(realtemp<25)

Duty=0.6-(realtemp-25)/100

If(realtemp=25)

Duty=0.6

That completes the logic for closed loop control.

CHAPTER-7

MOTION SENSOR USING TWO ULTRASONIC SENSORS

Although we can sense movement quite accurately using PIR sensor, but the only disadvantage it has that it cannot detect the direction of movement. So we are using two ultrasonic sensors to detect the direction of movement. Working of ultrasonic sensors are described in previous chapters. As ultrasonic sensors also tell the distance from the obstacle we can also use this data for security purposes.

It's working is quite simple, two ultrasonic sensors are placed one after the other physically on top the door. Let outside door ultrasonic be U1 and inside door ultrasonic be U2. If U1 senses an obstacle before U2 someone is going out of the room and similarly if U2 senses an obstacle before U1 someone is coming inside the room. This is the complete logic behind this idea for using ultrasonic sensors. The circuit assembled is as shown:

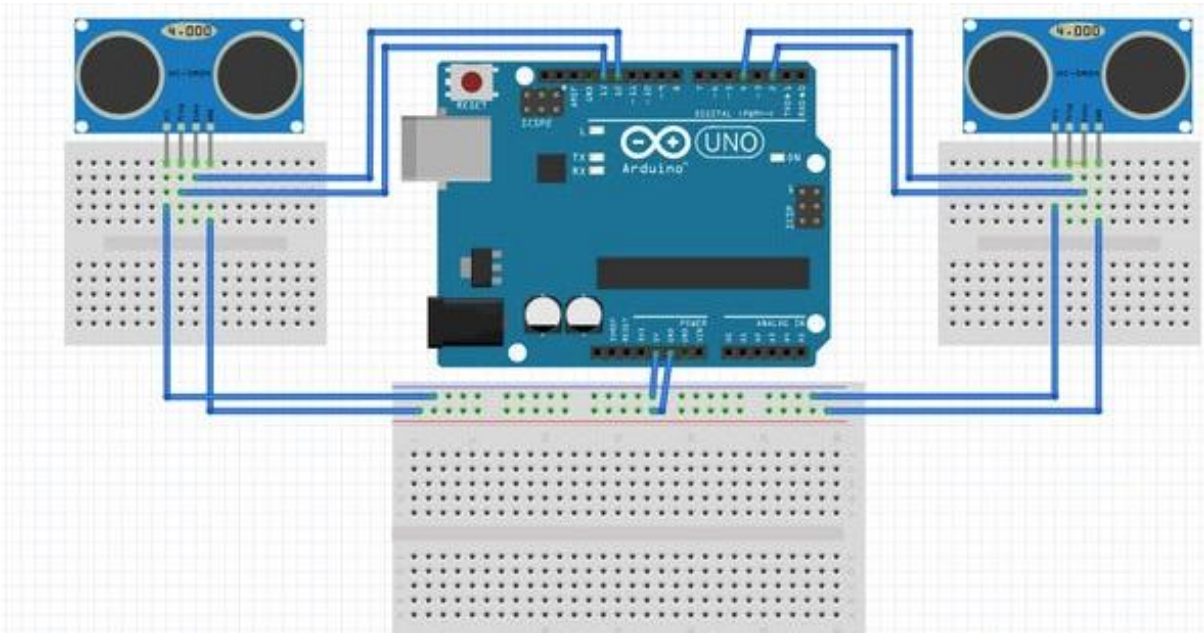


Figure 7.1 : Circuit diagram for Motion sensor

Code used in Arduino IDE is:

```
#define trigPin 12

#define echoPin1 11

#define echoPin2 12

int Buzzer = 8;

int c=0;

//int k=0;

//int p=0;

void setup() {

Serial.begin (9600);

pinMode(trigPin, OUTPUT);

pinMode(echoPin1, INPUT);

pinMode(echoPin2,INPUT);
```

```
}


void loop() {
  int duration1,duration2, distance1,distance2;// put your main code here, to run repeatedly:int duration, distance;
digitalWrite(trigPin, LOW);
delayMicroseconds(100);
digitalWrite(trigPin, HIGH);
duration1 = pulseIn(echoPin1, HIGH);
duration2 = pulseIn(echoPin2, HIGH);
distance1 = (duration1/2)/29.1;
distance2 = (duration2/2)/29.1;
//if (distance >= 200 || distance <= 0){
//Serial.println("no object detected");
if(distance1>0 && distance2>0)
{
  if(distance1<70)
  c++;
  if(distance2<70)
  c--;

}
//k=distance1;
//p=distance2;
Serial.print(distance1);
```

```
Serial.print(" ");

Serial.print(distance2);

Serial.print(" ");

Serial.print(c);

Serial.print(" ");

Serial.println(" ");

delay(500);

}
```

We trigger the both the ultrasonic sensors at the same time and get two different inputs from two echo pins. Logic here is if number of people in a room is zero for say 10 sec then all the appliances will automatically switch off.

CHAPTER 8

Load prioritization

Loads have priorities depending on the surrounding conditions (like temperature, light intensity etc.) and on the needs of the user. In some cases, Load shedding of least priority loads should be done in order to stabilize and ensure the reliable supply to the remaining part of the system. For proper load shedding, a proper load prioritization system need to be present (which prioritizes the loads depending on above mentioned parameters).

Reasons for load prioritization:

- With growing population and growing economy, the need for electricity has been increased. The present capacity fails to meet the demand, resulting in an unstable system. To meet the demand, the loads need to be prioritized (i.e., shutting down the least priority loads). This way the number of operational loads of a household can be increased, without having to increase the demand. This also assures the reliability of the system.
- To avoid complete shutdown of loads:
  When supply fails to meet the demand, shutdown of all the loads may occur (tripping of central circuit breaker). This may cause great inconvenience. So, we need to shed

some of least priority loads for ensuring the uninterrupted operation of certain important loads.

- Reducing the electricity bill:
  The cost of electricity depends on the amount of its usage and on the intensity of its usage. The demand is determined as the highest measured intensity within a certain period. Many electricity utilities offer financial incentives to reduce demand, particularly during the winter and the peak of summer. Load shedding is a mechanism to help manage the way electricity is used, to reduce this peak demand, significantly reducing utility costs.
- Prioritized Back-up Power supply:
  Though some of the back-up supplies can supply power to all the loads, they may exhaust readily. This may again lead to shutdown of all the loads. So, to make the system habitat even during the prolonged power outages, there is a need to prioritize as to which loads need to be operated.

Load prioritization:

In this project, we considered three loads i.e., a lamp, water pump and an air-conditioner.

Components Used:

12V Relay- for switching purpose.

LM35(temperature sensor)

Light Dependent Resistor(LDR)- for measuring light intensity.

12V DC motor- (representing pump load).

LED- (representing lamp).

Resistors – 100 Kohm (in the LDR circuit).

Algorithm:

Here loads are prioritized depending on the inputs from the sensors. In this algorithm, we have considered three cases depending on the extent to which water tank is filled.

Case-1: The water tank is empty.

Here the maximum priority is given to the pump load over air conditioner. Now the light can be switched on or off depending on the surroundings. If the light intensity is sufficiently high (in our case sensorvalue >900), the light is switched off, else it is switched on.

Case-2: The water tank is half filled.

Here both the water pump and the air conditioner has equal priority. So, in this case we consider an additional parameter to set the priority i.e., temperature. If the temperature of the room is low (in our case, temperature<), then the water pump is given highest priority (switched on) as there won't be much need of air conditioner in a cool room. If the temperature is high, the air conditioner is given highest priority (switched on). And the lamp load follows the same logic as in above case.

Case-3: The water tank is filled completely.

Both the air conditioner and the lamp are switched. And pump is switched off.

The System operation is automatic (to temporarily shed electrical use). This also reduces the burden on the user in addition to having above mentioned advantages.

Code for load prioritization:

```
int sensorPin = A5; // select the input pin for ldr

float tempn=25;

int sensorValue = 0;
```

```
int data;

int temp;

int val;

int tempPin =A0;

void setup() {

 Serial.begin(9600);

pinMode(12,OUTPUT);//fan

pinMode(13,OUTPUT);//water pump

pinMode(10,OUTPUT);//light


digitalWrite(10,HIGH);

}


void loop() {


  sensorValue = analogRead(sensorPin); // read the value from the sensor

Serial.println(sensorValue); //prints the values coming from the sensor on the screen

val = analogRead(tempPin);

float mv = ( val/1024.0)*5000;

float cel = mv/10;

float farh = (cel*9)/5 + 32;


Serial.print("TEMPRATURE = ");

Serial.print(cel);

Serial.print("*C");

Serial.println();
```

```
delay(1000);


 if(Serial.available() > 0)  // Send data only when you receive data:
 {
  data = Serial.read();
  temp=Serial.read();//Read the incoming data and store it into variable data
  //Serial.print(data);       //Print Value inside data in Serial monitor
  //Serial.print("\n");


  if( data=='0')
   { digitalWrite(13,HIGH);
     digitalWrite(12,LOW);


     if(sensorValue > 900)
       digitalWrite(10,LOW);
     else digitalWrite(10,HIGH);
      }


   if(data=='1')
   {
    if(cel>tempn)
    {digitalWrite(12,HIGH);
     digitalWrite(13,LOW);}


     else
     { digitalWrite(13,HIGH);
```

```
    digitalWrite(12,LOW);}



   if(sensorValue > 900)
       digitalWrite(10,LOW);
     else digitalWrite(10,HIGH);

   }

   if(data=='2')
    {

        digitalWrite(12,HIGH);
     digitalWrite(13,LOW);
     digitalWrite(10,HIGH);

    }
  }
}
```

CHAPTER 9

PIR motion sensor based corridor lighting system

PIR sensors have numerous applications in different fields such as automatic switching operation of outdoor lights, lift lobby, common staircases, automatic switching operation of garden lights based on the presence of a human being, for covered parking area, automatic door operating system in shopping malls, and so on. In this project, we discuss the use of PIR sensor for automatic corridor lighting.

PIR motion sensor based corridor lighting system:

If any human passes through the corridor, then the sensor generates output pulses. These pulses are sent to the microcontroller (Arduino in this project) which is used to control the operation of light (switch on or off). This light load is controlled Arduino by giving appropriate pulses to the input and enable pins.

By adjusting the delay time, we can select how long the light stays on after activation & thus stops the wastage of electricity.

Implementation:

Components Required:

- Arduino UNO
- PIR sensor
- LED of any color

Connecting PIR sensors to a microcontroller is simple. The PIR acts as a digital output so all you need to do is listen for the pin to flip high (detected) or low (not detected).

Wiring:

Power the PIR with 5V and connect ground to ground. Then connect the output to a digital pin.

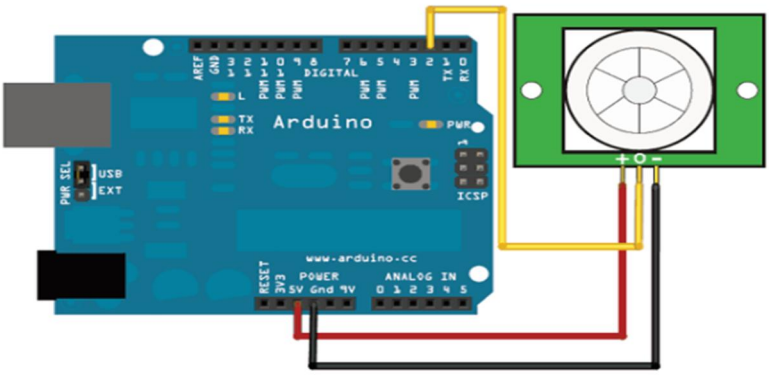


Figure 9.1: Connections for PIR sensor

Code:

```
int ledPin = 13;                // choose the pin for the LED
int inputPin = 2;               // choose the input pin (for PIR sensor)
int pirState = LOW;             // we start, assuming no motion detected
int val = 0;                    // variable for reading the pin status

void setup() {
  pinMode(ledPin, OUTPUT);      // declare LED as output
  pinMode(inputPin, INPUT);     // declare sensor as input
```

```
  Serial.begin(9600);
}

void loop(){
  val = digitalRead(inputPin);  // read input value
  if (val == HIGH) {            // check if the input is HIGH
    digitalWrite(ledPin, HIGH);  // turn LED ON
    if (pirState == LOW) {
      // we have just turned on
      Serial.println("Motion detected!");
      // We only want to print on the output change, not state
      pirState = HIGH;
    }
  } else {
    digitalWrite(ledPin, LOW); // turn LED OFF
    if (pirState == HIGH){
      // we have just turned of
      Serial.println("Motion ended!");
      // We only want to print on the output change, not state
      pirState = LOW;
    }
  }
}
```

Using PIR Sensor, considerable energy can be saved by switching off the lights when the space is not in use. Savings are huge in larger facilities.

CHAPTER 10

SMART GARDEN

An Arduino can convert your favorite pots into self-watering planters, keeping your plants from drying out and reducing the time you spend watering. Self-watering system is ideal for people frequently on vacation, and takes the guesswork out of watering.

This is a simple arduino project for a soil moisture sensor that will light up a LED at a certain moisture level. It uses Arduino UNO microcontroller board. Two wires placed in the soil pot form a variable resistor, whose resistance varies depending on soil moisture. This variable resistor is connected in a voltage divider configuration, and Arduino collects a voltage proportional to resistance between the 2 wires.

Insert the 2 probes (wires, pcb) in the dry soil and measure the resistance value and then pour water and measure it again. Now we have resistance values of both the dry soil and wet soil. Here we consider mid value for implementing the logic.

Dry soil:

Wet soil:

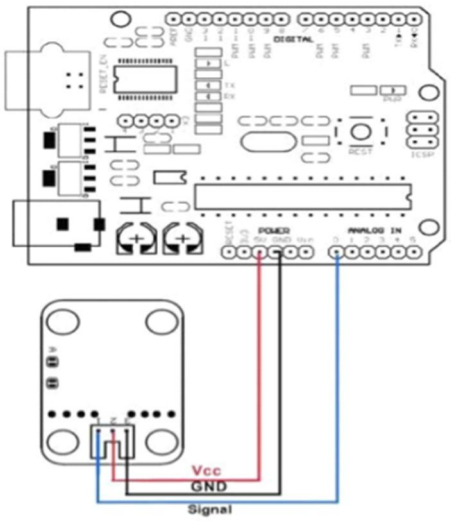
Mid resistance value:

Implementation:

Components:

- Arduino UNO.
- Soil moisture sensor.
- Analog sensor cable.

Wiring:



Arduino	Soil Moisture sensor
A0	S (pin 3)
5V	VCC (pin 1)
GND	GND (pin 2)

For this sensor no extra circuit is not required to construct so the data pin of soil moisture sensor which is pin 3 is directly connected with arduino uno's analog I/O pin. In this project this pin is connected with arduino uno's analog pin A0. The reason behind using analog I/O pin is because the sensor provides analog voltage as output.

Algorithm:

When the sensor output is less than the mid resistance value, then it gives alert(red LED glows) indicating dry soil. Else when the sensor output is greater than the mid resistance value, then it gives alert indicating wet profile (green LED glows).

Arduino pins:

red LED— D13

Green LED—D12

Sensor Pin—A0

Code:

```
int GLED= 13; // Wet Indicator at Digital PIN D13
int RLED= 12; // Dry Indicator at Digital PIN D12
int SENSE= 0; // Soil Sensor input at Analog PIN A0
int value= 0;
void setup() {
  Serial.begin(9600);
  pinMode(GLED, OUTPUT);
  pinMode(RLED, OUTPUT);
  Serial.println("SOIL MOISTURE SENSOR");
  Serial.println("-----------------------------");
}
void loop() {
  value= analogRead(SENSE);
  value= value/10;
  Serial.println(value);
```

```
  if(value<50)
  {
    digitalWrite(GLED, HIGH);
  }
  else
  {
    digitalWrite(RLED,HIGH);
  }
  delay(1000);
  digitalWrite(GLED,LOW);
  digitalWrite(RLED, LOW);
}
```

As the output of the sensor is an analog value, it can be used for various applications. The total range of resistance from dry to wet soil, can be divided into any number of groups indicating different soil profiles (Ex. for identifying three types of soils: dry, humid, watery).

When moisture content is high we don't need to activate the water sprinkler whereas when it is low when need to switch on the water sprinkler. That's how it's automated.

Summary and Conclusions

Being able to monitor your house and the control your house appliances wirelessly without any distance limitations is the main aim of this project. This can be then applied to more wider areas such as controlling an automated factory! Which makes day-to-day jobs easier & that's the ultimate goal. When we talk about home automation & IOT(Internet of things) what we are really talking about is things that have never been digital for example Doors, windows, lights etc. And we are connecting them to the internet to communicate and control them wirelessly.The limitation of wireless control using IOT based system is limitless as long as you are connected to the internet.

Your control system should work for you and make life easier. It should provide a level of comfort and enjoyment that meets your needs. And this will also will be use full to old aged/especially able people as appliances can be controlled by merely a touch. It is safe because there is no chance of getting electric shock. We hope to add more innovative Ideas and Implement them on the next semester.

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