

**MANUAL AND AUTOMATIC CONTROL OF APPLIANCES BASED
ON INTEGRATION OF WSN AND IOT
TECHNOLOGY**

Submitted in partial fulfillment of the requirements for the award of Bachelor of
Engineering Degree in Electronics and Communication Engineering

by

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**DEPARTMENT OF ELECTRONICS AND COMMUNICATION
ENGINEERING
SCHOOL OF ELECTRICAL AND ELECTRONICS ENGINEERING**

SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY (DEEMED TO BE UNIVERSITY)
Accredited with Grade “A” by NAAC
JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

MARCH 2021



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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of ADUSUMALLI NISHANTH (37130009) and ANNAA PRAVEEN (37130028) who carried out the project entitled “**MANUAL AND AUTOMATIC CONTROL OF APPLIANCES BASED ON INTEGRATION OF WSN AND IOT TECHNOLOGY**” under our supervision from December 2020 to March 2021.

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DECLARATION

We, **ADUSUMALLI NISHANTH (37130009)** and **ANNAA PRAVEEN (37130028)** hereby declare that the Project Report entitled “**MANUAL AND AUTOMATIC CONTROL OF APPLIANCES BASED ON INTEGRATION OF WSN AND IOT TECHNOLOGY**” done by us under the guidance of **Dr.S .KARTHIKEYAN** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electronics and Communication Engineering.

1)

2)

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**SIGNATURE OF THE
CANDIDATES**

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ABSTRACT

According to the Internet of Things, the future home, the so-called Smart Home, will be a seamless integration of physical smart objects, interfacing among them and with the surrounding environment. Moreover, nowadays, mobile devices are used to manage many aspects of people's lives, the capability to control and manage Smart Homes through them will become a primary requirement. The project aim is to design a highly secured multi-way home automation system that allows the user to control all the electric and electronic devices from any Smartphone. This project implementation includes the features like the Camera based security alert, Light and Fan control, Fire alert and Garden maintenance. The sensors are connected with the Arduino to send the sensors status to that mail. The Arduino is used for interfacing with the sensor and Ethernet is also connected with Arduino to get ip from Ethernet port.

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LIST OF ABBREVIATIONS

IOT -Internet of Things

PCA -Principal Component Analysis

UMAD -Universal Mobile Application Development

DTMF -Dual Tone Multi Frequency

IDE -Integrated Development Environment

PMW -Pulse Width Modulation

SPDT -Single Pole Double Throw

DPDT -Dual Pole Double Throw

GaN -Gallium Nitride

PIR -Passive Infrared Sensors

NC -Normally Closed

LDR -Light Dependent Resistors

LED -Light Emitting Diode

CHAPTER-1

INTRODUCTION

INTRODUCTION:

Nowadays, home security system is a crucial issue. Indeed, this system is to ensure properties and loves ones is always safe and protected. For the past few years, it is important to have a solid security system for home, which can secure in the most ideal and safe way. Many countries are step by step deployed home security system. The important part of any home security system is the person identification to enter and exit the house. Previously, people use the traditional method for their home security system. The traditional security system relies on the use of external things such as key, password and ID card to gain access. However, due to some limitation, biometric takes place to deliver such a promising security system. The biometric is a unique and quantifiable parameter for individual recognition. Biometric system required the used of specialized hardware such as fingerprint scanner, palm print scanner, DNA analyzer and etc. Furthermore, this specific machine required the target to touch the hardware to acquire data of human unique features. Biometric technology is viewed as a standout among the most secure verification system accessible, by giving a more elevated amount of security than conventional method. Face recognition is the most famous method in biometric technology besides fingerprint characteristics. This is due to more stability as face contains more features. Besides, it is considered highly secure as face cannot be stolen, borrowed or forge in order to enter the house. Face recognition is likely the most natural approach to perform biometric verification between individuals. Face detection is the first step of the face recognition system.

CHAPTER-2

LITERATURE

SURVEY

IoT based facial recognition door access control home security system using raspberry pi

Author: A. R. Syafeeza¹ , M. K. Mohd Fitri Alif² , Y. Nursyifaa Athirah³ , A. S. Jaafar⁴ , A. H. Norihan⁵ , M. S. Saleha⁶

The home security system has become vital for every house. Previously, most doors can be open by using traditional ways, such as keys, security cards, password or pattern. However, incidents such as a key loss has led to much worrying cases such as robbery and identity fraud. This has become a significant issue. To overcome this problem, face recognition using deep learning technique was introduced and Internet of Thing (IoT) also been used to perform efficient door access control system. Raspberry Pi is a programmable small computer board and used as the main controller for face recognition, youth system and locking system. The camera is used to capture images of the person in front of the door. IoT system enables the user to control the door access.

1. IOT based Facial Recognition Door Access Control Home Security System **Author: Anjali Patel, Ashok Verma**

This idea deals with the idea of secure locking automation utilizing IOT for door unlocking system to provide essential security to our homes, bank lockers and related control operations and security caution through the GSM module. It uses an image capturing technique in an embedded system based on raspberry pi server system. RPi (Raspberry pi) controls the video camera for catching it for turning on a relay for door unlocking. The module contains a secured face recognizer for automatic door unlocking. The camera catches the facial picture and compares it with the image which is stored in the database. If the picture is found in the database then the door lock opens otherwise it will produce a SMS that an unknown person is trying to gain access.

2. Home Security System and Door Access Control Based on Face Recognition **Author: R. Manjunatha¹, Dr. R. Nagaraja²**

Smart security system has become indispensable in modern daily life. The proposed security system has been developed to prevent robbery in highly secure areas like home environment with lesser power consumption and more reliable standalone security device for both Intruder detection and for door security. The door access control is implemented by using face recognition technology, which grants access to only authorized people to enter that area. The face recognition and detection process is implemented by principal component analysis (PCA) approach and instead of using

sensor devices intruder detection is achieved by performing image processing on captured video frames of data, and calculating the difference between the previously captured frame with the running frames in terms of pixels in the captured frames.

Universal Mobile Application Development (UMAD) On Home Automation” Marathwada Mitra Mandal’s Institute of Technology, University of Pune, India Network and Complex Systems ISSN 2224-610X (Paper) ISSN 2225-0603 (Online)Vol 2, No.2, 2012

Author: Amul Jadhav, S. Anand, Nilesh Dhangare, K.S. Wagh

At present scenario the market is flooded with many cell phones compatibility issues intended with Operating System and hardware's, so the applications are not made in a manner to suite large mass. Till now the applications made were targeted to a particular Operating System only which restricted there usability. With the limitations of above in mind there is a need of a universal mobile application development (UMAD) platform. So that an application can be developed in a universal XML format which can be easily ported to any other mobile devices. This paper presents the design and implementation of the Home automation system on one of the Operating System and creation of a unique XML document that can be placed over the server which can be adapted by any other mobile device without any platform issues. The XML format which controls the layout of the screen remains common, only the part which needs to be coded on every platform is the downloading of the XML file from the server and parsing it. This reduces a lot of coding effort as the design part is coded only once, and the same file can be used by every other platform. We have taken Home Automation system as our application, in which all the household devices such as Bulb, Fan, and AC etc. all are controlled by a smartphone which is connected to a server containing the XML file via an internet connection. Every change made by the user on the smartphone affects the data in the XML file of server, which thus helps in continuous updating of data and all other users get an updated Graphical User Interface. We have taken Home Automation as one of our application, but the same principle can be implemented in any other applications like Mobile Themes, Games etc.

CHAPTER-3

MATERIALS AND

METHODS

3.1 EXISTING SYSTEM:

- The existing methods for the automation of home are Bluetooth, ZigBee, GSM based technology. The system requires an intrusive and expensive wired installation and the use of a high end PC. A home control network using hand gestures
- The controller uses a glove to relay hand gestures to the system. A phone based remote controller for home and office automation. The system differs in that all communications occur over a fixed telephone line and not over the Internet. The system can be accessed using any telephone that supports dual tone multiple frequency (DTMF).
- The existing system of our project didn't use Internet of things concept to control the home appliances. This is suitable for modern technologies to control devices wherever you located in the world.
- So, we are moving to the IOT technology as proposed system in our project for the home automation.

3.2 DRAWBACKS:

- Home automation is normally done by using ir remote , bluetooth, rf technology
- While controlling through this technology within in a smart distance only
- And some of the IOT home automation is done by using apache server but it is also having some kind of issue device have to connect within a network
- We can't able control the devices remotely, Mobility is not possible
- Not suitable for modern technologies and Hard to implement and maintenance
- Hard to replacement, Human error

3.3 PROPOSED SYSTEM:

- The proposed system designed for security purpose and to monitor the basically consists of Arduino module and sensor.
- Arduino is connected to the internet through Modulator Demodulator (MODEM) interface to control the devices.
- When the human is entered into the home, the PIR sensor is detected it send to the respective task to controller like turn on light and fan.
- We can control home electrical devices such as bulb, fan and motor through the Internet of Things (IOT).
- The metal detector is used for the detecting metal for detects thief. If any unknown person came in to the detector range it will intimates to the home owners.
- And then water level sensor is used for the detecting the level of the water available in the water tank.
- LDR is used to turn on the lights on night time and turn off the lights on day time automatically

3.4 ADVANTAGES:

- We control the devices wherever you located in the world
- Remote monitoring and control is suitable for modern technologies
- More Reliability than the existing method
- Easy to implement and maintenance

3.5 BLOCK DIAGRAM:

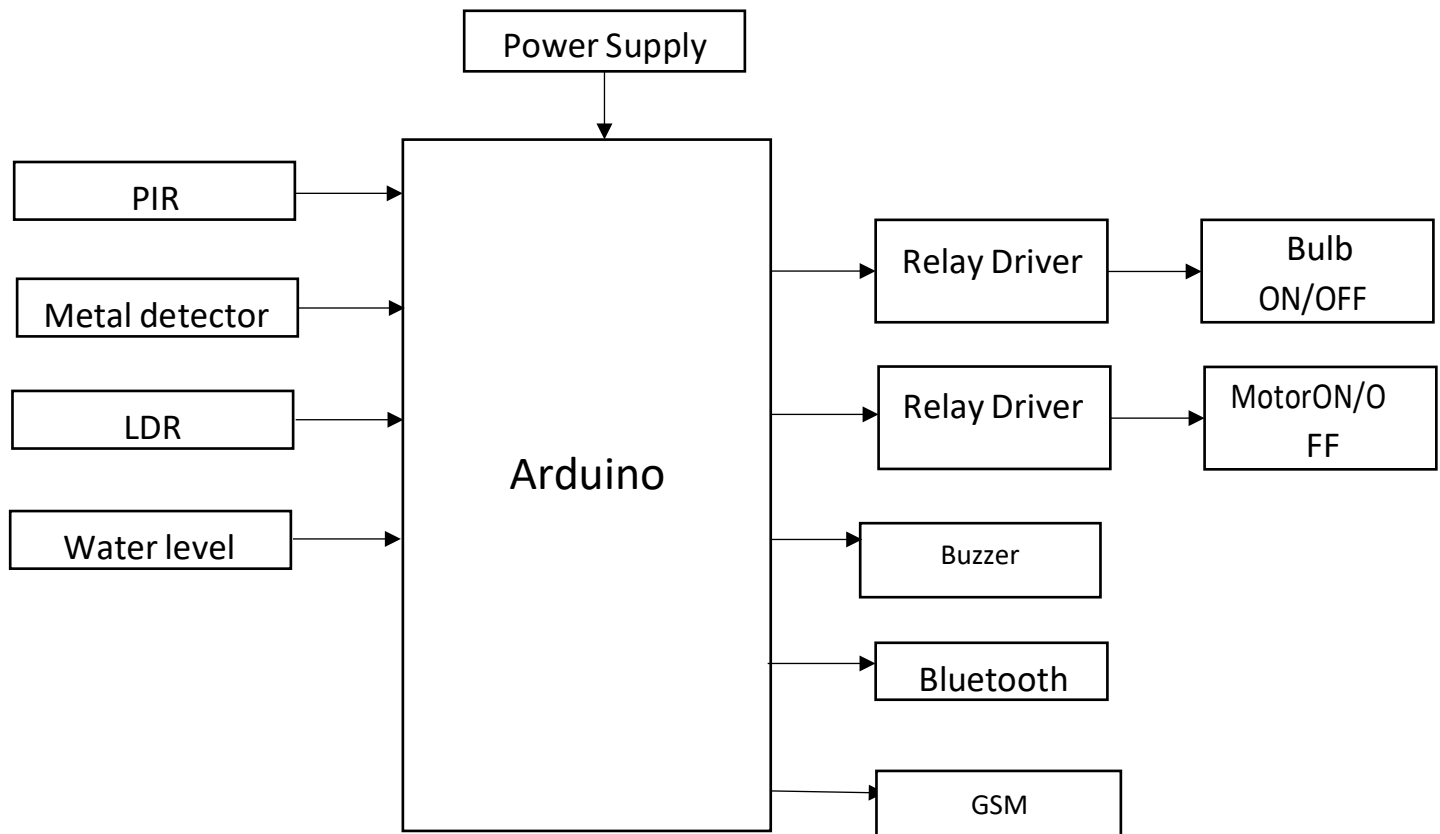


Fig 3.1 block diagram

3.6 HARDWARE REQUIRED:

- ▯ Arduino uno
- ▯ Relay
- ▯ Power supply
- ▯ PIR
- ▯ Metal detector
- ▯ LDR Sensor
- ▯ Water level sensor
- ▯ Buzzer
- ▯ GSM

3.7 HARDWARE IMPLEMENTATION: EMBEDDED SYSTEMS

Overview of embedded systems

An embedded system is a special-purpose computer system designed to perform one or a few dedicated functions, often with real-time computing constraints. It is usually embedded as part of a complete device including hardware and mechanical parts. In contrast, a general-purpose computer, such as a personal computer, can do many different tasks depending on programming. Embedded systems have become very important today as they control many of the common devices we use.

Since the embedded system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product, or increasing the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale.

Physically, embedded systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants. Complexity varies from low, with a single microcontroller chip, to very high with multiple units, peripherals and networks mounted inside a large chassis or enclosure.

In general, "embedded system" is not an exactly defined term, as many systems have some element of programmability. For example, Handheld computers share some elements with embedded systems — such as the operating systems and microprocessors which power them

— but are not truly embedded systems, because they allow different applications to be loaded and peripherals to be connected.

Embedded systems provide several functions

Monitor the environment; embedded systems read data from input sensors.

This data is then processed and the results displayed in some format to a user or users

Control the environment; embedded systems generate and transmit commands for actuators.

Transform the information; embedded systems transform the data collected in some meaningful way, such as data compression/decompression

Although interaction with the external world via sensors and actuators is an important aspect of embedded systems, these systems also provide functionality specific to their applications. Embedded systems typically execute applications such as control laws, finite state machines, and signal processing algorithms. These systems must also detect and react to faults in both the internal computing environment as well as the surrounding electromechanical systems.

There are many categories of embedded systems, from communication devices to home appliances to control systems. Examples include;

Communication devices

e.g.: modems, cellular phones Home Appliances

e.g.: CD player, VCR, microwave oven Control Systems

e.g.: Automobile anti-lock braking systems, robotics, and satellite control

Block diagram of an embedded system:

An embedded system usually contains an embedded processor.

Many appliances that have a digital interface -- microwaves, VCRs, cars -- utilize embedded systems. Some embedded systems include an operating system. Others are very specialized resulting in the entire logic being implemented as a single program. These systems are embedded into some device for some specific purpose other than to provide general purpose computing . A typical embedded system is shown in Fig 3.1

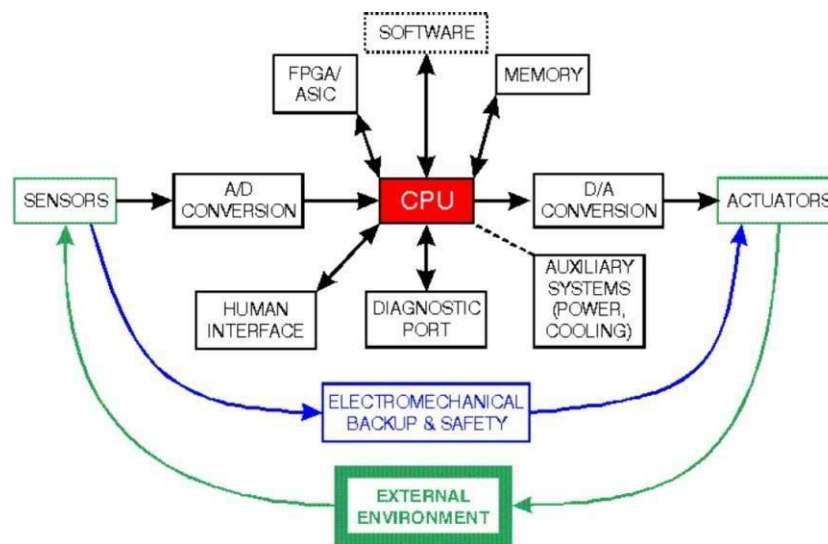


Fig 3.2 Block diagram of a typical embedded system

CHARACTERISTICS OF EMBEDDED SYSTEMS:

Embedded systems are characterized by a unique set of characteristics. Each of these characteristics imposed a specific set of design constraints on embedded systems designers. The challenge to designing embedded systems is to conform to the specific set of constraints for the application.

APPLICATION SPECIFIC SYSTEMS:

Embedded systems are not general-purpose computers. Embedded system designs are optimized for a specific application. Many of the job characteristics are known before the hardware is designed. This allows

the designer to focus on the specific design constraints of a well-defined application. As such, there is limited user reprogrammability. Some embedded systems, however, require the flexibility of reprogrammability. Programmable DSPs are common for such applications.

REACTIVE SYSTEMS:

As mentioned earlier, a typical embedded systems model responds to the environment via sensors and control the environment using actuators. This requires embedded systems to run at the speed of the environment. This characteristic of embedded system is called “reactive”. Reactive computation means that the system (primarily the software component) executes in response to external events. External events can be either periodic or aperiodic. Periodic events make it easier to schedule processing to guarantee performance. Aperiodic events are harder to schedule. The maximum event arrival rate must be estimated in order to accommodate worst case situations. Most embedded systems have a significant reactive component. One of the biggest challenges for embedded system designers is performing an accurate worst case design analysis on systems with statistical performance characteristics (e.g., cache memory on a DSP or other embedded processor). Real time system operation means that the correctness of a computation depends, in part, on the time at which it is delivered. Systems with this requirement must often design to worst case performance. But accurately predicting the worst case may be difficult on complicated architectures. This often leads to overly pessimistic estimates erring on the side of caution. Many embedded systems have a significant requirement for real time operation in order to meet external I/O and control stability requirements. Many real-time systems are also reactive systems.

DISTRIBUTED SYSTEMS:

A common characteristic of an embedded system is one that consists of communicating processes executing on several CPUs or ASICs which are connected by communication links. The reason for this is economy. Economical 4 8-bit microcontrollers may be cheaper than a 32-bit processors. Even after adding the cost of the communication links, this approach may be preferable. In this approach, multiple processors are usually required to handle multiple time-critical tasks. Devices under control of embedded systems may also be physically distributed.

HETEROGENEOUS ARCHITECTURES:

Embedded systems often are composed of heterogeneous architectures (Fig 1.2). They may contain different processors in the same system solution. They may also be mixed signal systems. The combination of I/O interfaces, local and remote memories, and sensors and actuators makes embedded system design truly unique. Embedded systems also have tight design constraints, and heterogeneity provides better design flexibility.

POWER SUPPLY:

All electronic circuits works only in low DC voltage, so we need a power supply unit to provide the appropriate voltage supply for their proper functioning .This unit consists of transformer, rectifier, filter & regulator. AC voltage of typically 230volts rms is connected to a transformer voltage down to the level to the desired ac voltage. A diode rectifier that provides the full wave rectified voltage that is initially filtered by a simple

capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation . A regulator circuit can use this dc input to provide dc voltage that not only has much less ripple voltage but also remains the same dc value even the dc voltage varies somewhat, or the load connected to the output dc voltages changes.

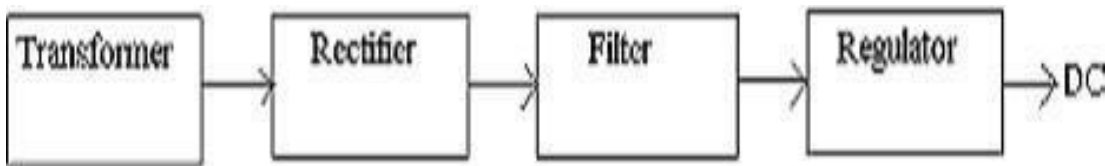


Fig 3.3 General Block of Power Supply Unit

TRANSFORMER:

A transformer is a static piece of which electric power in one circuit is transformed into electric power of same frequency in another circuit. It can raise or lower the voltage in the circuit, but with a corresponding decrease or increase in current. It works with the principle of mutual induction. In our project we are using a step down transformer to providing a necessary supply for the electronic circuits. Here we step down a 230volts ac into 12volts ac.

RECTIFIER:

A dc level obtained from a sinusoidal input can be improved 100% using a process called full wave rectification. Here in our project for full wave rectification we use bridge rectifier. From the basic bridge configuration we see that two diodes(say D2 & D3) are conducting while the other two diodes (D1 & D4) are in off state during the period $t = 0$ to $T/2$. Accordingly for the negative cycle of the input the conducting diodes

are D1 & D4 .Thus the polarity across the load is the same.

In the bridge rectifier the diodes may be of variable types like 1N4001, 1N4003, 1N4004, 1N4005, 1N4007 etc... can be used. But here we use 1N4007, because it can withstand up to 1000v.

FILTERS:

In order to obtain a dc voltage of 0 Hz, we have to use a low pass filter. So that a capacitive filter circuit is used where a capacitor is connected at the rectifier output & a dc is obtained across it. The filtered waveform is essentially a dc voltage with negligible ripples & it is ultimately fed to the load.

REGULATORS:

The output voltage from the capacitor is more filtered & finally regulated. The voltage regulator is a device, which maintains the output voltage constant irrespective of the change in supply variations, load variations & temperature changes. Here we use fixed voltage regulator namely LM7805. The IC LM7805 is a +5v regulator which is used for microcontroller.

FEATURES AND DESCRIPTION OF REGULATORS

- Output Current up to 1A
- Output Voltages of 5, 6, 8, 9, 10, 12, 15, 18, 24V
- Thermal Overload Protection

- Short Circuit Protection

Output Transistor Safe Operating Area Protection

CHAPTER-4

HARDWARE

DESIGN

4.1 ARDUINO INTRODUCTION

Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board – you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro- controller into a more accessible package.

What does it do?

The Arduino hardware and software was designed for artists, designers, hobbyists, hackers, newbies, and anyone interested in creating interactive objects or environments. Arduino can interact with buttons, LEDs, motors, speakers, GPS units, cameras, the internet, and even your smart-phone or your TV! This flexibility combined with the fact that the Arduino software is free, the hardware boards are pretty cheap, and both the software and hardware are easy to learn has led to a large community of users who have contributed code and released instructions for a **huge** variety of Arduino-based projects.

For everything from robots and a heating pad hand warming blanket to honest fortune-telling machines, and even a Dungeons and Dragons dice-throwing gauntlet, the Arduino can be used as the brains behind almost any electronics project.

What's on the board?

There are many varieties of Arduino boards (explained on the next page) that can be used for different purposes. Some boards look a bit different from the one below, but most Arduino have the majority of these components in common

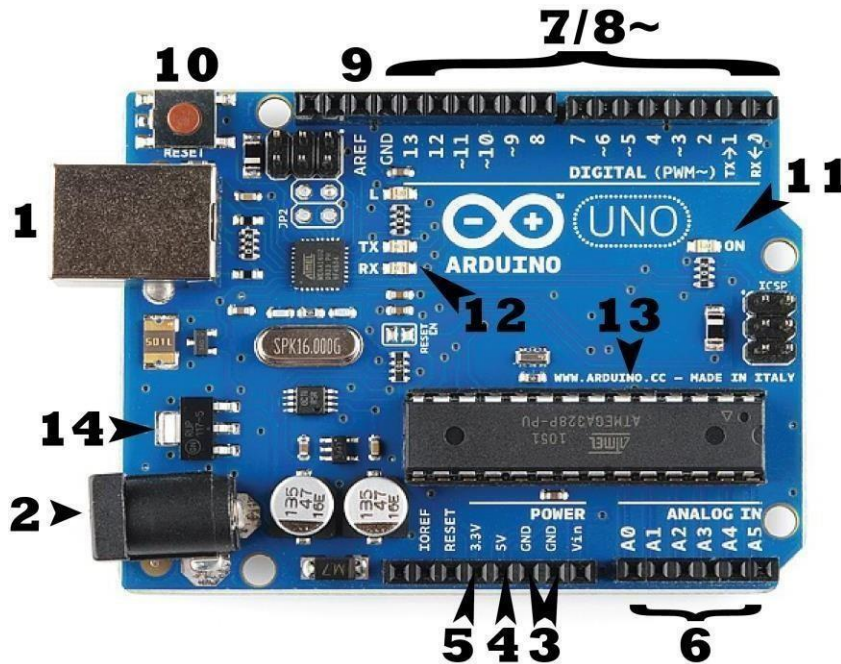


Fig 4.1 arduino

Power (USB / Barrel Jack)

Every Arduino board needs a way to be connected to a power source. The Arduino UNO can be powered from a USB cable coming from your computer or a wall power supply that is terminated in a barrel jack. In the picture above the USB connection is labelled **(1)** and the barrel jack is labelled.

NOTE: Do NOT use a power supply greater than 20 Volts as you will overpower (and thereby destroy) your Arduino. The recommended voltage for most Arduino models is between 6 and 12 Volts.

Pins (5V, 3.3V, GND, Analog, Digital, PWM, AREF)

The pins on your Arduino are the places where you connect wires to

construct a circuit (probably in conjunction with a breadboard and some wire. They usually have black plastic 'headers' that allow you to just plug a wire right into the board. The Arduino has several different kinds of pins, each of which is labelled on the board and used for different functions.

- **GND (3):** Short for 'Ground'. There are several GND pins on the Arduino, any of which can be used to ground your circuit.
- **5V (4) & 3.3V (5):** As you might guess, the 5V pin supplies 5 volts of power, and the 3.3V pin supplies 3.3 volts of power. Most of the simple components used with the Arduino run happily off of 5 or 3.3 volts.
- **ANALOG (6):** The area of pins under the 'Analog In' label (A0 through A5 on the UNO) are Analog In pins. These pins can read the signal from an analog sensor (like a temperature sensor) and convert it into a digital value that we can read.
- **DIGITAL (7):** Across from the analog pins are the digital pins (0 through 13 on the UNO). These pins can be used for both digital input (like telling if a button is pushed) and digital output (like powering an LED).
- **PWM (8):** You may have noticed the tilde (~) next to some of the digital pins (3, 5, 6, 9, 10, and 11 on the UNO). These pins act as normal digital pins, but can also be used for something called Pulse-Width Modulation (PWM). We have a tutorial on PWM, but for now, think of these pins as being able to simulate analog output (like fading an LED in and out).
- **AREF (9):** Stands for Analog Reference. Most of the time you can leave this pin alone. It is sometimes used to set an external reference voltage (between 0 and 5Volts) as the upper limit for the analog input pins.

RESET BUTTON

Just like the original Nintendo, the Arduino has a reset button **(10)**. Pushing it will temporarily connect the reset pin to ground and restart any

code that is loaded on the Arduino. This can be very useful if your code doesn't repeat, but you want to test it multiple times.

POWER LED INDICATOR

Just beneath and to the right of the word "UNO" on your circuit board, there's a tiny LED next to the word 'ON' **(11)**. This LED should light up whenever you plug your Arduino into a power source. If this light doesn't turn on, there's a good chance something is wrong. Time to re-check your circuit!

TX RX LEDs

TX is short for transmit, RX is short for receive. These markings appear quite a bit in electronics to indicate the pins responsible for serial communication. In our case, there are two places on the Arduino UNO where TX and RX appear – once by digital pins 0 and 1, and a second time next to the TX and RX indicator LEDs **(12)**. These LEDs will give us some nice visual indications whenever our Arduino is receiving or transmitting data (likewhen we're loading a new program onto the board).

MAIN IC

The black thing with all the metal legs is an IC, or Integrated Circuit **(13)**. Think of it as the brains of our Arduino. The main IC on the Arduino is slightly different from board type to board type, but is usually from the AT mega line of IC's from the ATMEL company. This can be important, as you may need to know the IC type (along with your board type) before loading up a new program from the Arduino software. This information can

usually be found in writing on the top side of the IC. If you want to know more about the difference between various IC's, reading the datasheets is often a good idea.

VOLTAGE REGULATOR

The voltage regulator **(14)** is not actually something you can (or should) interact with on the Arduino. But it is potentially useful to know that it is there and what it's for. The voltage regulator does exactly what it says – it controls the amount of voltage that is let into the Arduino board. Think of it as a kind of gatekeeper; it will turn away an extra voltage that might harm the circuit. Of course, it has its limits, so don't hook up your Arduino to anything greater than 20 volts.

The Arduino Family

Arduino makes several different boards, each with different capabilities. In addition, part of being open source hardware means that others can modify and produce derivatives of Arduino boards that provide even more form factors and functionality. If you're not sure which one is right for your project, check this guide for some helpful hints. Here are a few options that are well-suited to someone new to the world of Arduino

ARDUINO UNO (R3)

The Uno is a great choice for your first Arduino. It's got everything you need to get started, and nothing you don't. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a USB

connection, a power jack, a reset button and more. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

RELAY:

A relay is an electrically operated switch. 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 relays have two switch positions and they are double throw (changeover) switches. Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical.

The coil of a relay passes a relatively large current, typically 30mA for a 12V relay, but it can be as much as 100mA for relays designed to operate from lower voltages. Most ICs (chips) cannot provide this current and a transistor is usually used to amplify the small IC current to the larger value required for the relay coil. The maximum output current for the popular 555 timer IC is 200mA so these devices can supply relay coils directly without amplification.

Relays are usually SPDT or DPDT but they can have many more sets of switch contacts, for example relays with 4 sets of changeover contacts are readily available. Most relays are designed for PCB mounting but you can solder wires directly to the pins providing you take

care to avoid melting the plastic case of the relay. The animated picture shows a working relay with its coil and switch contacts. You can see a lever on the left being attracted by magnetism when the coil is switched on. This lever moves the switch contacts. There is one set of contacts (SPDT) in the foreground and another behind them, making the relay DPDT.

The relay's switch connections are usually labeled COM, NC and NO:

- **COM** = Common, always connect to this, it is the moving part of the switch.
- **NC** = Normally Closed, COM is connected to this when the relay coil is **off**.
- **NO** = Normally Open, COM is connected to this when the relay coil is **on**.

LEVEL MEASUREMENT:

In industry, liquids such as water, chemicals, and solvents are used in various processes. The amount of such liquid stored can be found by measuring level of the liquid in a container or vessel. The level affects not only the quantity delivered but also pressure and rate of flow in and out of the container. Level sensors detect the level of substances like liquids, slurries, granular materials, and powders. The substance to be measured can be inside a container or can be in its natural form (e.g. a river or a lake). The level measurement can be either continuous or point values.

Wide spectrum of sensors is available in the market and commonly, they are classified based on the specific application of the sensor. Sensor used for measuring humidity is termed as humidity sensor, the one used

for measurement of pressure is called pressure sensor, sensor used for measurement of displacement is called position sensor and so on though all of them may be using the similar sensing principle. In a similar fashion, the sensor used for measurement of fluid levels is called a level sensor.

Quite obvious from its name, level sensors are used to measure the level of the free-flowing substances. Such substances include liquids like water, oil, slurries, etc as well as solids in granular/powder form (solids which can flow). These substances tend to get settled in the container tanks due to gravity and maintain their level in rest state. Level sensors measure their level against a pre-set reference.

They are important not only in nuclear plants but in lot many applications. Every car, truck and motorcycle is equipped with a fuel level sensor to measure the amount of gasoline left in the fuel tank. In addition, there are sensors for level measurement of engine oil, brake / power steering fluid, cooling water, windshield cleaning liquid, etc. Industrial applications include liquid level sensing in water treatment tanks, transport and storage tanks, in the petrochemical industry for liquids such as petrol, etc. Liquid level measurement is important in household applications for devices such as automated coffee machines, water dispensers, juice squeezers, water evaporators, steamers, fridges and freezers, boilers, heating systems, dishwashers, washing machines, steam irons, etc

In short, level sensors are one of the very important sensors and play

very important role in variety of consumer/ industrial applications. As with other type of sensors, level sensors are available or can be designed using variety of sensing principles. Selection of an appropriate type of sensor suiting to the application requirement is very important.

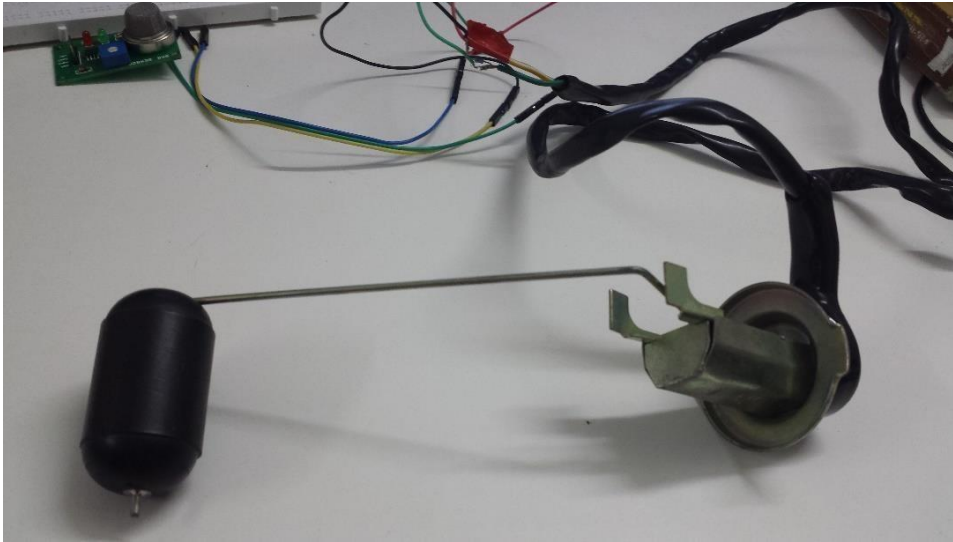


Fig 4.2continuous and point level sensors

Continuous level sensors measure the level to determine the exact amount of substance in a continuous manner.

Point-level sensors indicate whether the substance is above or below the sensing point. This is essential to avoid overflow or emptying of tanks and to protect pumps from dry run.

From the application point of view the considerations are:

- Price
- Accuracy
- Response rate

- Ease of calibration
- Physical size and mounting of the instrument
- Monitoring or control of continuous or discrete levels

Level measurements are broadly classified in two groups:

- Direct methods
- Indirect methods

In direct methods, the level is indicated directly by means of simple mechanical devices. The measurement is not affected by changes in material density. Few examples are:

- Dip Stick
- Resistance Tapes
- Sight Glass
- Floats
- Ultrasonic
- Radar

In Indirect methods, the level is converted in a measurable signal using a suitable transducer. Change in the material affects the measurement. A corrective factor must be used in recalibrating the instrument. Few examples are:

- Hydrostatic head methods
- Load cell
- Capacitance
- Conductivity

APPLICATIONS:

Level Probes are used for measuring level of

1. Liquids
2. Powdered and granular solids
3. Liquid metals at very high temperature
4. Liquefied gases at very low temperature

DISADVANTAGES:

Light density materials under 20 lb/ft³ and materials with particle sizes exceeding 1/2 in. in diameter can be a problem due to their very low dielectric constants (caused by the large amount of air space between particles).

4.2 PIR MOTION SENSOR

A PIR detector is a motion detector that senses the heat emitted by a living body. These are often fitted to security lights so that they will switch on automatically if approached. They are very effective in enhancing home security systems.

The sensor is passive because, instead of emitting a beam of light or microwave energy that must be interrupted by a passing person in order to “sense” that person, the PIR is simply sensitive to the infrared energy emitted by every living thing. When an intruder walks into the detector’s field of vision, the detector “sees” a sharp increase in infrared energy.

A PIR sensor light is designed to turn on when a person approaches, but will not react to a person standing still. The lights are designed this way. A moving person exhibits a sudden change in infrared energy, but a slower change is emitted by a motionless body. Slower changes are also caused by gradual fluctuations in the temperature of the environment. If the light were sensitive to these slower changes, it would react to the sidewalk cooling off at night, instead of the motion of a burglar.

If you have a PIR light, you may notice that it is more sensitive on cold days than on warm days. This is because the difference in temperature between the ambient air and the human body is greater on cold days, making the rise in temperature easier for the sensor to detect. This has drawbacks, though; if the sensor is too sensitive, it will pick up things you don't want it to such as the movement of small animals.

Passive infrared sensor is an electronic device, which measures infrared light radiating from objects in its field of view. PIRs are often used in the construction of PIR-based motion detectors. Apparent motion is detected when an infrared source with one

temperature, such as a human, passes in front of an infrared source with another temperature, such as a wall.

All objects emit what is known as black body radiation. This energy is invisible to the human eye but can be detected by electronic devices designed for such a purpose. The term 'Passive' in this instance means the PIR does not emit energy of any type but merely accepts incoming infrared radiation.

Infrared radiation enters through the front of the sensor, known as the sensor face. At the core of a PIR is a solid state sensor or set of sensors, made from approximately 1/4 inches square of natural or artificial pyroelectric materials, usually in the form of a thin film, out of gallium nitride (GaN), caesium nitrate (CsNO_3), polyvinyl fluorides, derivatives of phenylpyrazine, and cobalt phthalocyanine. (See pyroelectric crystals.) Lithium tantalate (LiTaO_3) is a crystal exhibiting both piezoelectric and pyroelectric properties.

The sensor is often manufactured as part of an integrated circuit and may consist of one (1), two (2) or four (4) 'pixels' of equal areas of the pyroelectric material. Pairs of the sensor pixels may be wired as opposite inputs to a differential amplifier. In such a configuration, the PIR measurements cancel each other so that the average temperature of the field of view is removed from the electrical signal; an increase of IR energy across the entire sensor is self-cancelling and will not trigger the device. This allows the device to resist false indications of change in the event of being exposed to flashes of light or field-wide illumination. (Continuous bright light could still saturate the sensor materials and

render the sensor unable to register further information.)

At the same time, this differential arrangement minimizes common-mode interference; this allows the device to resist triggering due to nearby electric fields. However, a differential pair of sensors cannot measure temperature in that configuration and therefore this configuration is specialized for motion detectors.

In a PIR-based motion detector, the PIR sensor is typically mounted on a printed circuit board, which also contains the necessary electronics required to interpret the signals from the chip. The complete circuit is contained in a housing, which is then mounted in a location where the sensor can view the area to be monitored. Infrared energy is able to reach the sensor through the window because the plastic used is transparent to infrared radiation (but only translucent to visible light). This plastic sheet prevents the introduction of dust and insects, which could obscure the sensor's field of view.

PIR sensors allow you to sense motion, almost always used to detect whether a human has moved in or out of the sensors range. They are small, inexpensive, low-power, easy to use and don't wear out. For that reason they are commonly found in appliances and gadgets used in homes or businesses. They are often referred to as PIR, "Passive Infrared", "Pyroelectric", or "IR motion" sensors.

PIR sensors are more complicated than many of the other sensors explained in these tutorials (like photocells, FSRs and tilt switches) because there are multiple variables that affect the sensors input and output. To begin explaining how a basic sensor works, we'll use this rather nice diagram (if anyone knows where it originates plz let me know).

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.

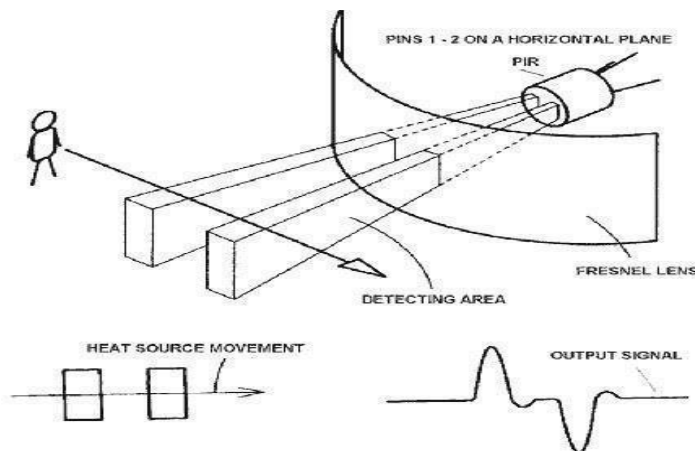


Fig 4.3 PIR SENSOR working

The PIR Sensor

The IR sensor itself is housed in a hermetically sealed metal can to improve noise/temperature/humidity immunity. There is a window made of IR-transmissive material (typically coated silicon since that is very easy to come by) that protects the sensing element. Behind the window are the two balanced sensors.

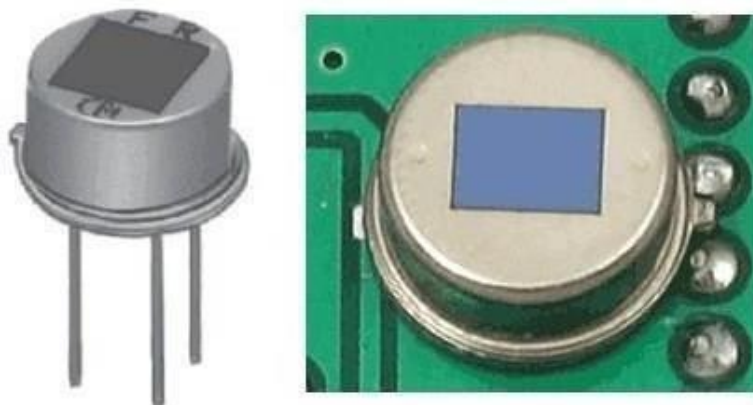


Fig 4.4 PIR SENSOR hardware

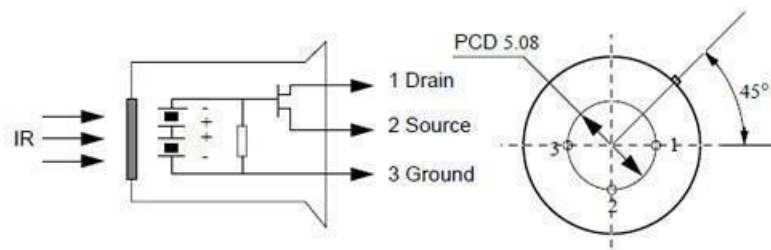


Fig 4.5 PIR SENSOR sensing the movement

This image shows the internal schematic. There is actually a JFET inside (a type of transistor) which is very low-noise and buffers the extremely high impedance of the sensors into something a low-cost chip (like the BIS0001) can sense.

Lenses

PIR sensors are rather generic and for the most part vary only in price and sensitivity. Most of the real magic happens with the optics. This is a pretty good idea for manufacturing: the PIR sensor and circuitry is fixed and costs a few dollars. The lens costs only a few cents and can change the breadth, range, sensing pattern, very easily.

In the diagram up top, the lens is just a piece of plastic, but that means that the detection area is just two rectangles. Usually we'd like to have a detection area that is much larger. To do that, we use such as those found in a camera: they condense a large area (such as a landscape) into a small one (on film or a CCD sensor). For reasons that will be apparent soon, we would like to make the PIR lenses small and thin and moldable from cheap plastic, even though it may add distortion. For this reason the sensors are actually

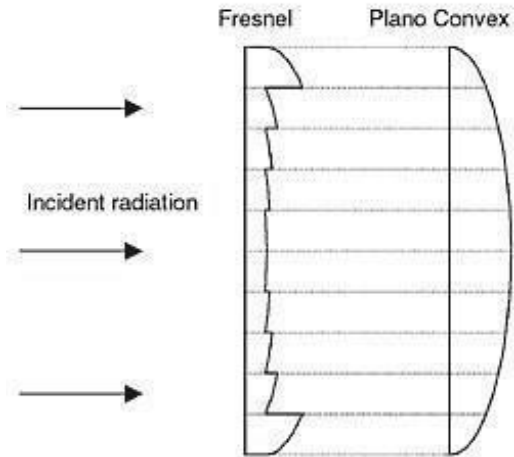


Fig 4.6 incident of light in PIR SENSOR

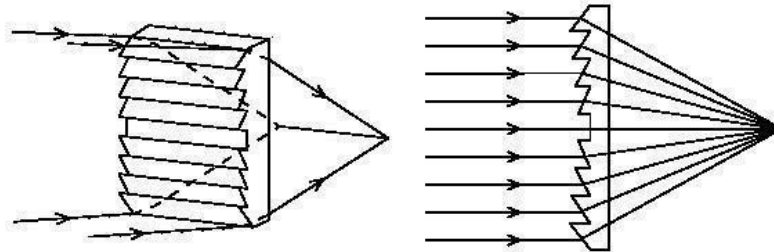


fig 4.7: The Fresnel lens condenses light, providing a larger range of IR to the sensor.

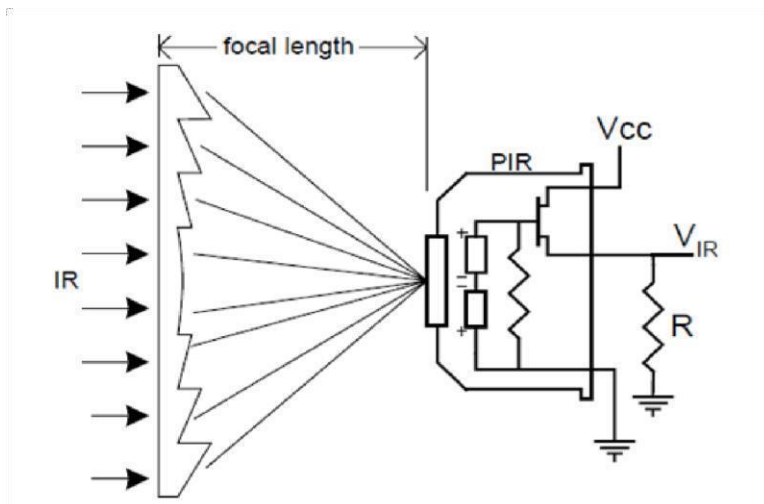


Fig 4.8: internal working of PIR SENSOR

OK, so now we have a much larger range. However, remember that we actually have two sensors, and more importantly we don't want two really

big sensing-area rectangles, but rather a scattering of multiple small areas. So what we do is split up the lens into multiple sections, each section of which is a fresnel lens.



Fig 4.9 multiple facet-sections



Fig 4.10 This macro shot shows the different Fresnel lenses in each facet!

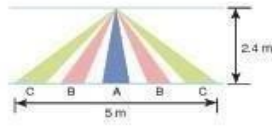
The different faceting and sub-lenses create a range of detection areas, interleaved with each other. That's why the lens centers in the facets above are 'inconsistent' - every other one points to a different half of the PIR sensing element

Ceiling Mount

Top View

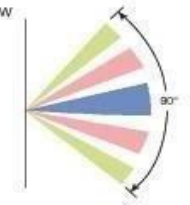


Side View



Wall Mount

Top View



Side View

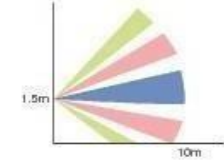


fig 4.11 angles of PIR

Connecting to a PIR

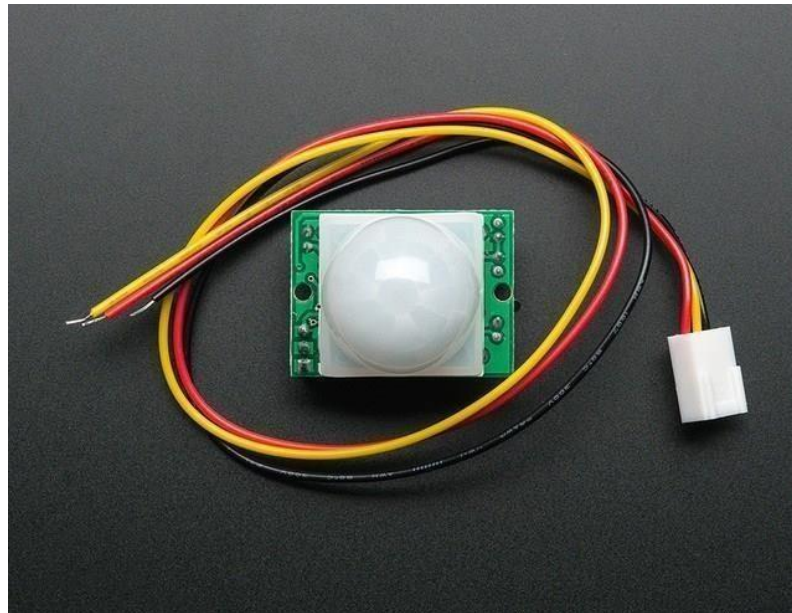


Fig 4.12:connecting to PIR

Most PIR modules have a 3-pin connection at the side or bottom. The pinout may vary between modules so triple-check the pinout! It's often silkscreened on right next to the connection (at least, ours is!) One pin will be ground, another will be signal and the final one will be power. Power is usually 3-5VDC input but may be as high as 12V. Sometimes

larger modules don't have direct output and instead just operate a relay in which case there is ground, power and the two switch connections.

The output of some relays may be 'open collector' - that means it requires a pullup resistor. If you're not getting a variable output be sure to try attaching a 10K pullup between the signal and power pins.

An easy way of prototyping with PIR sensors is to connect it to a breadboard since the connection port is 0.1" spacing. Some PIRs come with header on them already, the one's from adafruit have a straight 3-pin header on them for connecting a cable

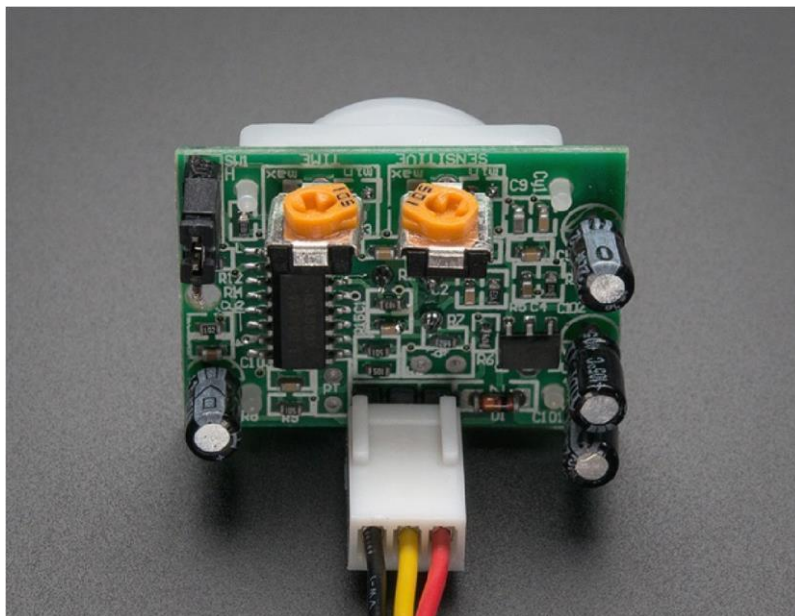


Fig 4.13 wire connected to PIR

For our PIR's the red cable is + voltage power, black cable is - ground power and yellow is the signal out. Just make sure you plug the cable in as shown above! If you get it backwards you won't damage the PIR but it won't work.

TESTING A PIR

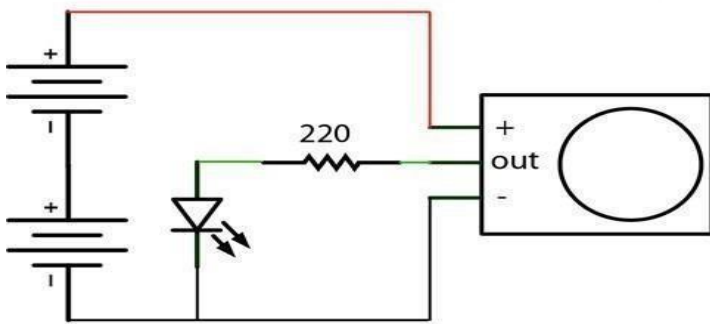


Fig 4.14 testing a PIR

Now when the PIR detects motion, the output pin will go "high" to 3.3V and light up the LED!

Once you have the breadboard wired up, insert batteries and wait 30-60 seconds for the PIR to 'stabilize'. During that time the LED may blink a little. Wait until the LED is off and then move around in front of it, waving a hand, etc, to see the LED light up.

RETRIGGERING:

There's a couple options you may have with your PIR. First up we'll explore the 'Retriggering' option.

Once you have the LED blinking, look on the back of the PIR sensor and make sure that the jumper is placed in the **L** position as shown below.

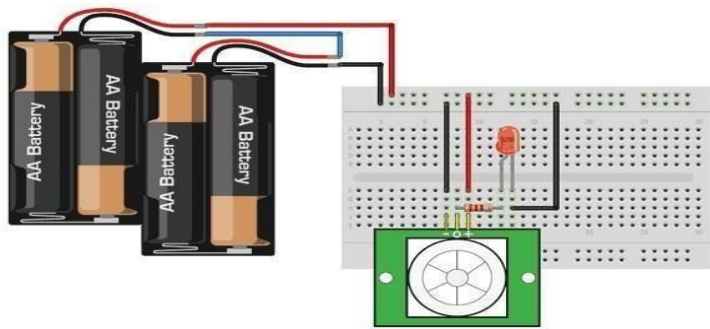


fig 4.15 bread board test

Now set up the testing board again. You may notice that when connecting up the PIR sensor as above, the LED does not stay on when moving in front of it but actually turns on and off every second or so. That is called "non- retriggering".

Now change the jumper so that it is in the **H** position. If you set up the test, you will notice that now the LED *does* stay on the entire time that something is moving. That is called "retriggering".

For most applications, "retriggering" (jumper in H position as shown below) mode is a little nicer.

If you need to connect the sensor to something edge-triggered, you'll want to set it to "nonretriggering" (jumper in L position).

Changing sensitivity

The Adafruit PIR has a trimpot on the back for adjusting sensitivity. You can adjust this if your PIR is too sensitive or not sensitive enough - clockwise makes it more sensitive.

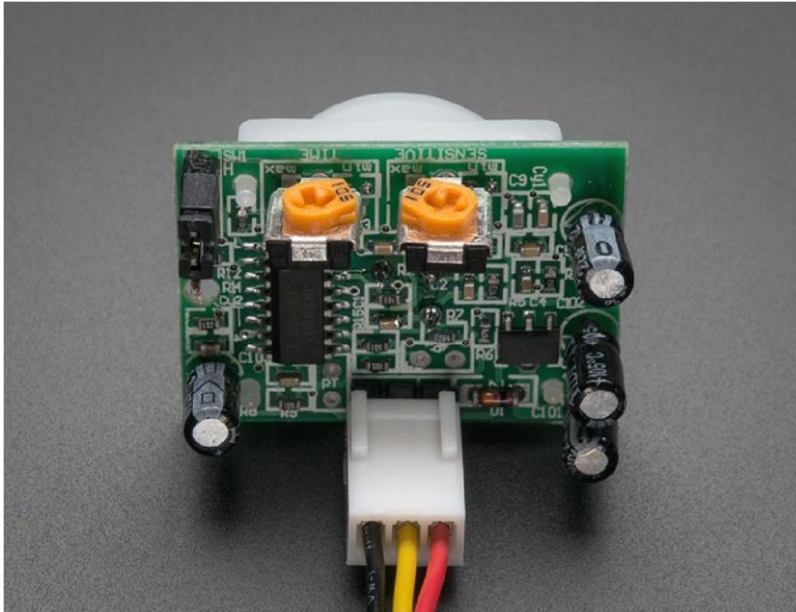


Fig 4.16 Changing Pulse Time and Timeout Length

There are two 'timeouts' associated with the PIR sensor. One is the "**Tx**" timeout: how long the LED is lit after it detects movement - this is easy to adjust on Adafruit PIR's because there's a potentiometer.

The second is the "**Ti**" timeout which is how long the LED is guaranteed to be off when there is no movement. This one is not *easily* changed but if you're handy with a soldering iron it is within reason.

Tx = The time duration during which the output pin (Vo) remains high after triggering.
Ti = During this time period, triggering is inhibited. See timing charts for details.

$Tx \approx 24576 \times R_{10} \times C_6$; **$Ti \approx 24 \times R_9 \times C_7$** . (ref to schematic)

First, lets take a look at the BISS datasheet again

On Adafruit PIR sensors, there's a little trim potentiometer labeled **TIME**. This is a 1 Megaohm adjustable resistor which is added to a 10K series resistor. And **C6** is 0.01uF so **$Tx = 24576 \times (10K + R_{time}) \times 0.01\mu F$**

If the Rtime potentiometer is turned all the way down counter-clockwise (to 0 ohms) then

$Tx = 24576 \times (10K) \times 0.01\mu F = 2.5$ seconds (approx)

If the Rtime potentiometer is turned all the way up clockwise to 1 Megaohm then

$Tx = 24576 \times (1010K) \times 0.01\mu F = 250$ seconds (approx)

If RTime is in the middle, that'd be about 120 seconds (two minutes)

so you can tweak it as necessary. For example if you want motion from someone to turn on a fan for a minimum of 1 minute, set the Rtime potentiometer to about 1/4 the way around.

OPERATION OF PIR SENSOR:

A few mechanisms have been used to focus the distant infrared energy onto the sensor surface. The window may have Fresnel lenses molded into it. Alternatively, sometimes PIR sensors are used with plastic segmented parabolic mirrors to focus the infrared energy; when mirrors are used, the plastic window cover has no Fresnel lenses molded into it. A filtering window (or lens) may be used to limit the wavelengths to 8-14 micrometers, which is most sensitive to human infrared radiation (9.4 micrometers being the strongest).

The PIR device can be thought of as a kind of infrared 'camera', which remembers the amount of infrared energy focused on its surface. Once power is applied to the PIR the electronics in the PIR shortly settle into a quiescent state and energize a small relay. This relay controls a set of electrical contacts, which are usually connected to the detection input of an alarm control panel. If the amount of infrared energy focused on the sensor changes within a configured time period, the device will switch the state of the alarm output relay. The alarm output relay is typically a "normally closed (NC)" relay; also known as a "Form B" relay.

A person entering the monitored area is detected when the infrared energy emitted from the intruder's body is focused by a Fresnel lens or a mirror segment and overlaps a section on the chip, which had previously been looking at some much cooler part of the protected area. That portion of the chip is now much warmer than when the intruder wasn't there. As the intruder moves, so does the hot spot on the surface of the chip. This moving hot spot causes the electronics connected to the chip to de-energize the relay, operating its contacts, thereby activating the detection input on the alarm control panel. Conversely, if an intruder were to try to defeat a PIR perhaps

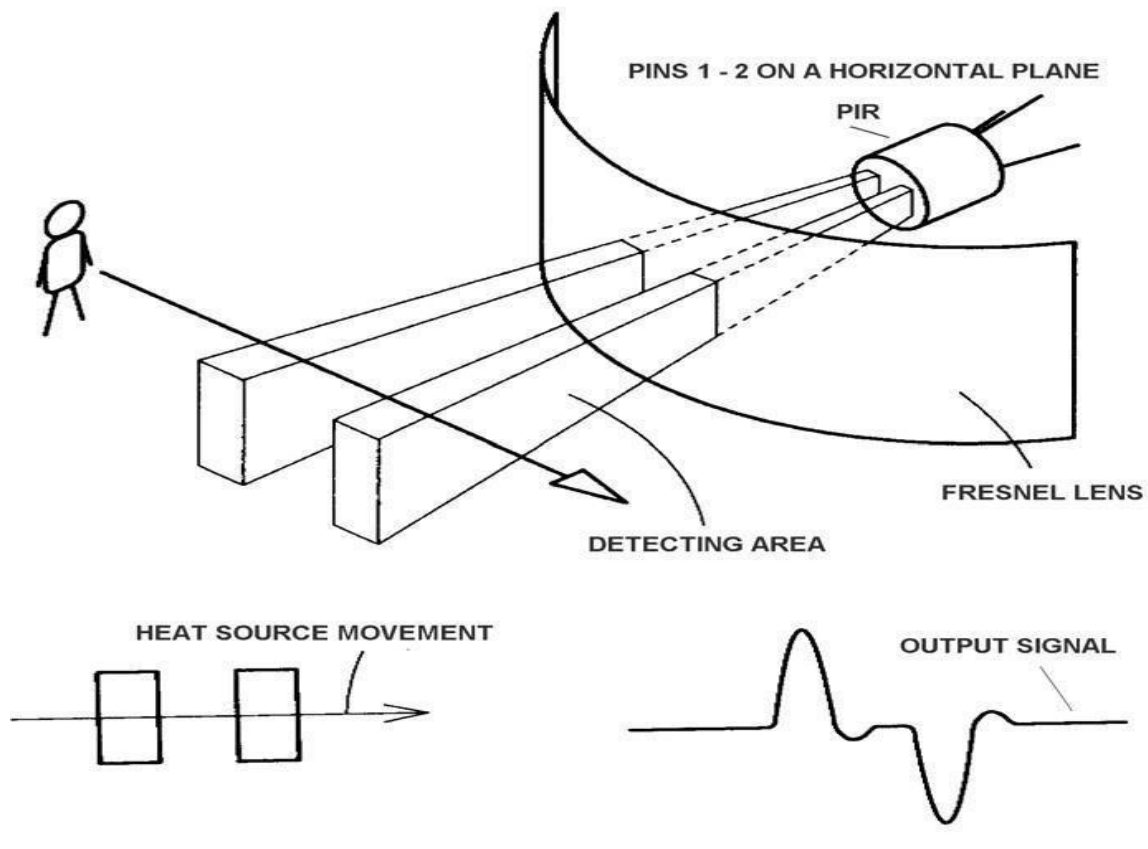


Fig 4.17 operation of PIR SENSOR

By holding some sort of thermal shield between himself and the PIR, a corresponding 'cold' spot moving across the face of the chip will also cause the relay to de-energize unless the thermal shield has the same temperature as the objects behind it.

Manufacturers recommend careful placement of their products to prevent false alarms. They suggest mounting the PIRs in such a way that the PIR cannot 'see' out of a window. Although the wavelength of infrared radiation to which the chips are sensitive does not penetrate glass very well, a strong infrared source (a vehicle headlight, sunlight reflecting from a vehicle window) can overload the chip with enough infrared energy to fool the electronics and cause a false (non-intruder caused) alarm. A person moving on the other side of the glass however would not be 'seen' by the PIR.

They also recommended that the PIR not be placed in such a position that an HVAC vent would blow hot or cold air onto the surface

of the plastic, which covers the housing's window. Although air has very low emissivity (emits very small amounts of infrared energy), the air blowing on the plastic window cover could change the plastic's temperature enough to, once again, fool the electronics.

PIRs come in many configurations for a wide variety of applications. The most common used in home security systems has numerous Fresnel lenses or mirror segments and has an effective range of about thirty feet. Some larger PIRs are made with single segment mirrors and can sense changes in infrared energy over one hundred feet away from the PIR. There are also PIRs designed with reversible orientation mirrors, which allow either broad coverage (110° wide) or very narrow 'curtain' coverage.

PIRs can have more than one internal sensing element so that, with the appropriate electronics and Fresnel lens, it can detect direction. Left to right, right to left, up or down and provide an appropriate output signal

4.3 METAL DETECTOR:

How Do Metal Detectors Work?

Metal detectors work by transmitting an electromagnetic field from the search coil into the ground. Any metal objects (targets) within the electromagnetic field will become energised and retransmit an electromagnetic field of their own. The detector's search coil receives the retransmitted field and alerts the user by producing a target response. Minelab metal detectors are capable of discriminating between different target types and can be set to ignore unwanted targets.

1. CONTROL BOX

The control box contains the detector's electronics. This is where the transmit signal is generated and the receive signal is processed and converted into a target response.

2. SEARCH COIL

The detector's search coil transmits the electromagnetic field into the ground and receives the return electromagnetic field from a target.

3. TRANSMIT ELECTROMAGNETIC FIELD (*visual representation only - blue*)

The transmit electromagnetic field energises targets to enable them to be detected.

4. TARGET

A target is any metal object that can be detected by a metal detector. In this example, the detected target is treasure, which is a good (accepted) target.

5. UNWANTED TARGET

Unwanted targets are generally ferrous (attracted to a magnet), such as nails, but can also be non-ferrous, such as bottle tops. If the metal detector is set to reject unwanted targets then a target response will not be produced for those targets.

6. RECEIVE ELECTROMAGNETIC FIELD (*visual representation only - yellow*)

The receive electromagnetic field is generated from energised targets and is received by the search coil.

7. TARGET RESPONSE (*visual representation only - green*)

When a good (accepted) target is detected the metal detector will produce an audible response, such as a beep or change in tone. Many Minelab detectors also provide a visual display of target information such as an ID number or 2 dimensional display.

KEY DETECTING CONCEPTS

Frequency

The frequency of a metal detector is one of the main characteristics that determines how well targets can be detected. Generally, a single frequency detector that transmits at a high frequency will be more sensitive to small targets and a single frequency detector that transmits at low frequencies will give more depth on large targets. Minelab's single frequency technologies are VLF and VFLEX.

Minelab's world-leading BBS, FBS, MPS and new revolutionary Multi-IQ technologies transmit multiple frequencies simultaneously and are therefore sensitive to small and deep large targets at the same time.

Ground

B

alance

Ground Balance is a variable setting that increases detection depth in mineralised ground. This ground may contain salts, such as in wet beach sand or fine iron particles, such as in red earth. These minerals

respond to a detector's transmit field in a similar way that a target does. Due to the much larger mass of the ground compared to a buried target, the effect of mineralisation can easily mask small targets. To correct this the Ground Balance setting removes the responding ground signals, so you clearly hear target signals and are not distracted by ground noise.

There are three main types of Ground Balance:

- 1. Manual Ground Balance** – Manually adjust the Ground Balance setting, so the minimum amount of ground signal is heard.
- 2. Automatic Ground Balance** – The detector automatically determines the best Ground Balance setting. This is quick, simple and more accurate than a manually set Ground Balance.
- 3. Tracking Ground Balance** – The detector continuously adjusts the Ground Balance setting while detecting. This ensures that the Ground Balance setting is always correct.

Minelab detectors use exclusive advanced technologies for superior ground balancing capabilities that cannot be matched by any other detectors.

Discrimination

Discrimination is a metal detector's ability to identify buried targets based on their conductive and/or ferrous properties. By accurately identifying a buried target you can decide to dig it up or consider it as junk and continue searching. Minelab detectors produce target identification (Target ID) numbers and/or Target Tones to indicate the type of target that has been detected.

There are four main types of discrimination in Minelab detectors:

- 1. Variable discrimination** – The simplest type of discrimination which uses a control knob to adjust the level of discrimination.
- 2. Iron Mask/Iron Reject** – Used mostly with gold prospecting detectors to ignore iron junk.

3. **Notch discrimination** – Allows specific target types to be accepted or rejected.

4. **Smartfind** – The most advanced form of discrimination. Target IDs are plotted based on both ferrous and conductive properties on a two dimensional (2D) display. Individual segments or larger areas of the display can be shaded to reject unwanted targets.

DETECTION DEPTH FACTORS

The most common question about metal detectors is ‘How deep do they go?’

The simple answer is "as deep as the diameter of the coil". So detectors with larger coils will detect deeper.

However, detection depth also depends upon detector technology and many environmental factors. A more complex answer usually starts with ‘It depends...’ The depth that a metal detector can detect a target depends on a number of factors:



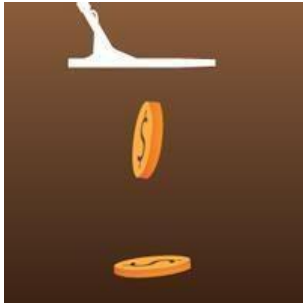
Target Size

Large targets can be detected deeper than small targets.



Target Shape

Circular shapes like coins and rings can be detected deeper than long thin shapes like nails.



Target Orientation

A horizontal coin (e.g. lying flat) can be detected deeper than a vertical coin (e.g. on edge).



Target Material

High conductive metals (e.g. silver) can be detected deeper than low conductive metals (e.g. lead or gold).

Fig 4.18 target of metal detector

MULTI-IQ: ALL METALS, ALL SOILS, ALL THE TIME

INTRODUCING MULTI-IQ:

Multi-IQ is Minelab's latest major technology innovation and can be considered as combining the performance advantages of both FBS and VFLEX in a new fusion of technologies. It isn't just a rework of single frequency VLF, nor is it merely another name for an iteration of BBS/FBS.

Multi-IQ achieves a high level of **target ID accuracy at depth** much better than any single frequency detector can achieve, including switchable single frequency detectors that claim to be multi-frequency. When Minelab use the term "multi-frequency" we mean "simultaneous" – i.e. more than one frequency is transmitted, received AND processed concurrently. This enables maximum target sensitivity across all target types and sizes, while minimising ground noise (especially in saltwater). There are presently only a handful of detectors from Minelab and other manufacturers that can be classed as true multi-frequency, all of which have their own advantages and disadvantages.

How does Multi-IQ compare to BBS/FBS?

Multi-IQ uses a different group of fundamental frequencies than BBS/FBS to generate a wide-band multi-frequency transmission signal that is more sensitive to high frequency targets and slightly less sensitive to low frequency targets. Multi-IQ uses the latest high-speed processors and advanced digital filtering techniques for a much faster recovery speed than BBS/FBS technologies. Multi-IQ copes with saltwater and beach conditions almost as well as BBS/FBS, however BBS/FBS still have an advantage for finding high conductive silver coins in all conditions.

With Multi-IQ, we can derive much greater target ID accuracy and increased detecting performance, especially in 'difficult' ground. In 'mild' ground, single frequency may perform adequately, BUT depth and stable ID's will be limited by ground noise; whereas the Multi-IQ simultaneous multi-frequency will achieve maximum depth with a very stable target signal. In 'strong' ground, single frequency will not be able to effectively separate the target signal, giving decreased results; whereas Multi-IQ will still detect at depth, losing a minimal amount of target accuracy, as shown in this diagram.

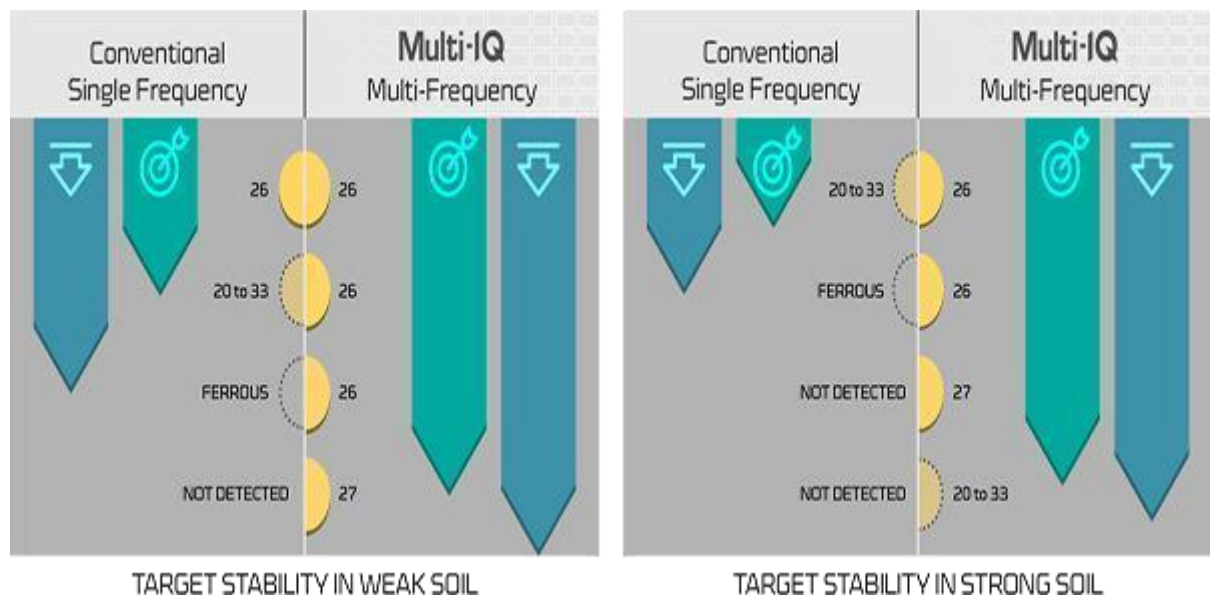


Fig 4.19 target stability

“How many simultaneous frequencies?” you may ask, wondering if this is a critical parameter. Minelab has been carrying out detailed investigations into this in recent years. Just as you can colour in a map with many colours, the minimum number to differentiate between adjacent countries is only four. Similar to the map problem, it's perhaps not the maximum number of frequencies needed to achieve an optimum result, but the minimum number that is more interesting. When it comes to frequencies in a detector, how the frequencies are

combined AND processed is now more important than how many frequencies, for achieving even better results.

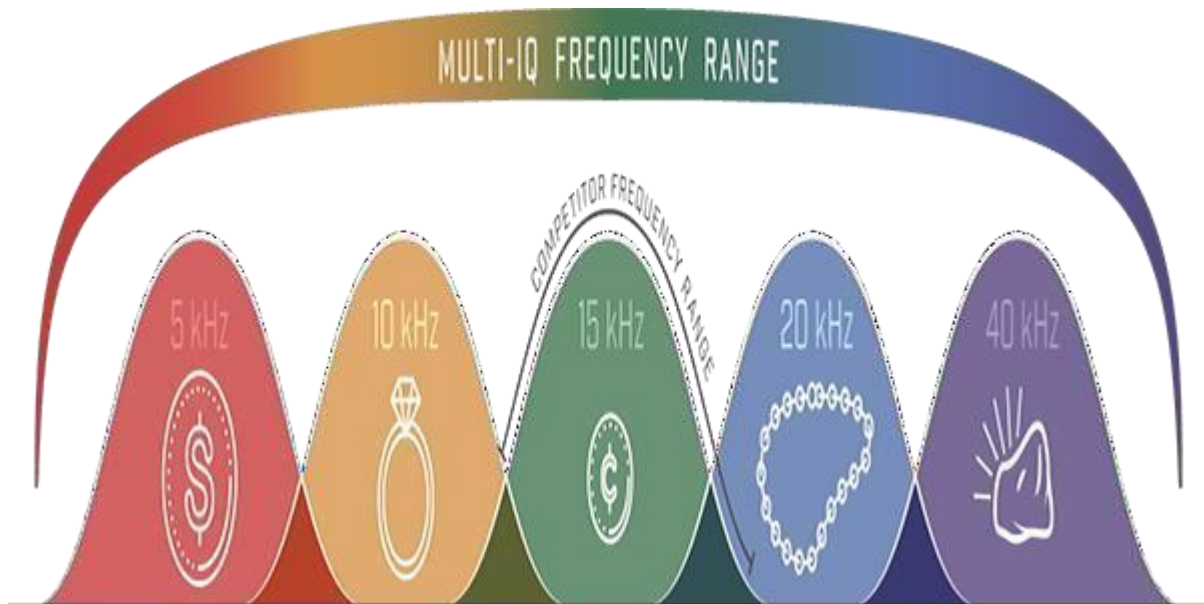


fig 4.20 frequency range

The Multi-IQ frequency range shown on this chart applies to both the EQUINOX series & VANQUISH series detectors, in all models. There is no direct link between the individual single frequencies shown in the diagram and the frequencies used in Multi-IQ.

The above diagram demonstrates the typical sensitivity range of single frequency detectors, as compared with the full-spectrum sensitivity provided by Multi-IQ. Whilst a detector operating at 5kHz will be sensitive to high conductors, such as large silver targets, that same detector will be particularly unresponsive to small gold nuggets (low conductors). Conversely, a detector running at 40kHz has high sensitivity for small gold, and much less sensitivity to large silver. Multi-IQ is highly sensitive to all targets across the frequency range.

4.4LDR – Light Dependent Resistors Circuit and Working Principle

The controlling of lights and home appliances is generally operated and maintained manually on several occasions. But the process of appliances controlling may cause wastage of power due to the carelessness of human beings or unusual circumstances. To overcome this problem we can use the light-dependent resistor circuit for controlling the loads based on the intensity of light. An LDR or a photo resistor is a device that is made up of high resistance semiconductor material. This article gives an overview of what is LDR, light- dependent resistor circuit and its working.

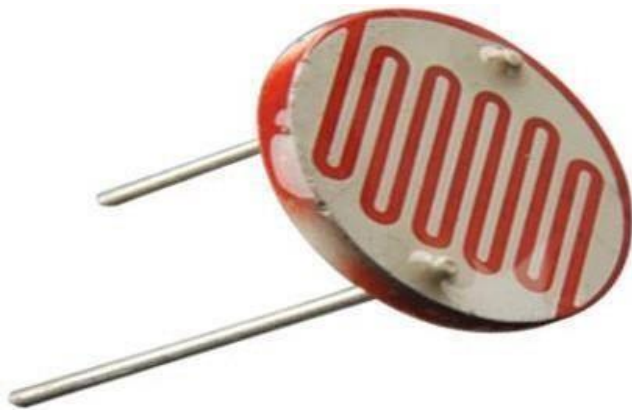


Fig 4.21 Light Dependent Resistor

Construction of an LDR

The construction of an LDR includes a light-sensitive material that is placed on an insulating substrate like as ceramic. The material is placed in a zigzag shape in order to get the required power rating and resistance. The area of zigzag separates the metal placed areas into two regions.

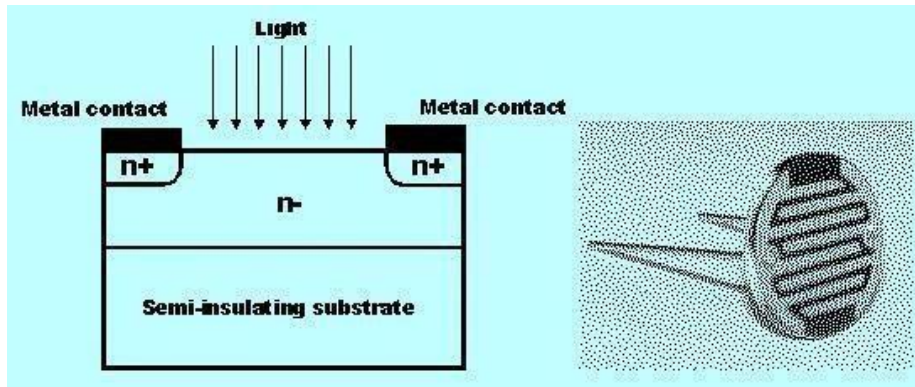


Fig 4.22 Construction of an LDR

Where the Ohmic contacts are made either on the sides of the area. The resistances of the contacts must be as less as possible to make sure that the resistance, mainly varies due to the light effect only. The use of lead & cadmium materials is avoided as they are injurious to the environment.

Working Principle of Light Dependent Resistor

The working principle of an LDR is photo conductivity that is nothing but an optical phenomenon. When the light is absorbed by the material then the conductivity of the material reduces. When the light falls on the LDR, then the electrons in the valence band of the material are eager to the conduction band. But, the photons in the incident light must have energy superior than the band gap of the material to make the electrons jump from one band to another band (valance to conduction).

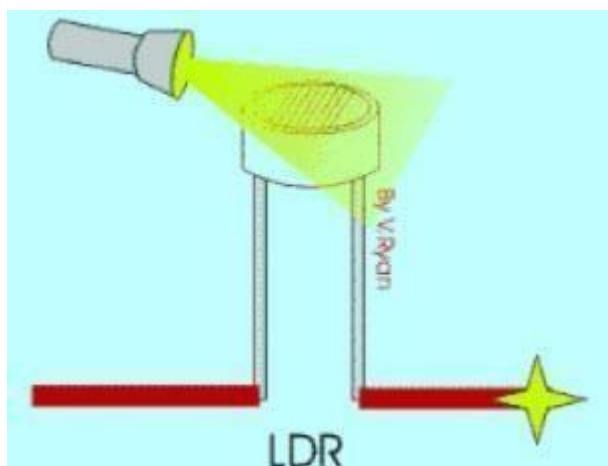


Fig 4.23 LDR Working Principle

Hence, when light having ample energy, more electrons are excited to

the conduction band which grades in a large number of charge carriers. When the effect of this process and the flow of the current starts flowing more, the resistance of the device decreases.

Light Dependent Resistor Circuit

The circuit of LDR is an electronic circuit built with LDR, relay, Darlington pair, diode, & resistors shown in the below circuit diagram. A voltage supply is given to the load

The required DC voltage of the LDR circuit is supplied from a bridge rectifier circuit or a battery. This circuit changes the AC supply into a DC. The bridge rectifier circuit uses a step-down transformer to step-down the voltage from 230v into 12v. The diodes are connected in the form of a bridge used to alter the AC voltage into DC. The voltage regulator is used to change the 12v DC-6v DC, and then, this DC voltage is supplied to the entire circuit. A 230v AC supply for both the bridge rectifier and the load is to be kept continuously for continuous operation of the light sensor circuit.

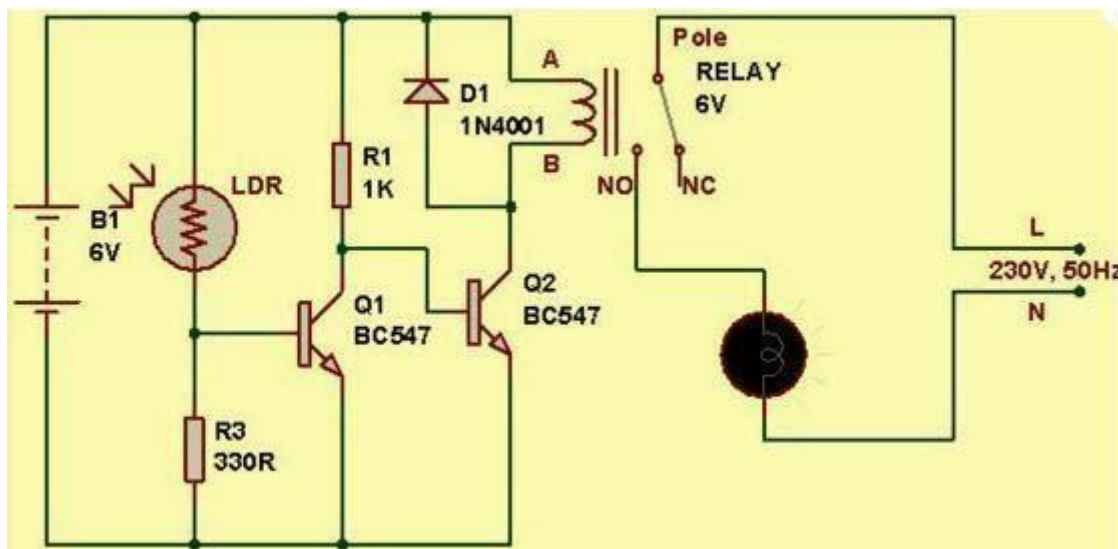


Fig 4.24 Light Dependent Resistor Circuit Diagram

In the morning time, this sensor has a low resistance around 100Ω. Thus, the power supply flows through the LDR & ground through the variable resistor and resistor as shown in the above light sensor circuit. This is due to the resistance offered by the light-dependent resistor in the daytime or when the light falls on the LDR, then it is less compared to the resistance of the remaining part of the sensor circuit. We are alert of the principle of current, that the flow of current always flows in

the path of low resistance.

Therefore, the relay coil does not get sufficient supplies to get strengthened. Hence, the light is switched off in the daylight. In the same way, during the nighttime, the resistance of the LDR increases to a high value ($20M\Omega$). Thus, due to the high resistance of the resistor, the flow of current is low or almost zero. Now, the flow of current through the low-resistance lane such that it increases the base voltage of the Darlington pair to reach more than 1.4v. As the Darlington pair transistor is triggered, the relay coil acquires enough supply to get energized, and hence, the light switches in the night time.

Applications of LDR:

Light-dependent resistors are simple and low-cost devices. These devices are used where there is a need to sense the presence and absence of light is necessary. These resistors are used as light sensors and the applications of LDR mainly include alarm clocks, street lights, light intensity meters, burglar alarm circuits. For a better understanding of this concept, here we have explained one project namely; power conserving of intensity controlled street lights using LDR.

Power Conserving of Intensity Controlled Street Lights using LDR

Nowadays, lightening-up of highways is done through HID lamps but, the energy consumption of these lights is high as well as there is no particular mechanism to turn on/off the lights from sunrise to sunset. To overcome this problem, here is an alternative method using LEDs i.e. power conserving of intensity controlled street lights using LDR.

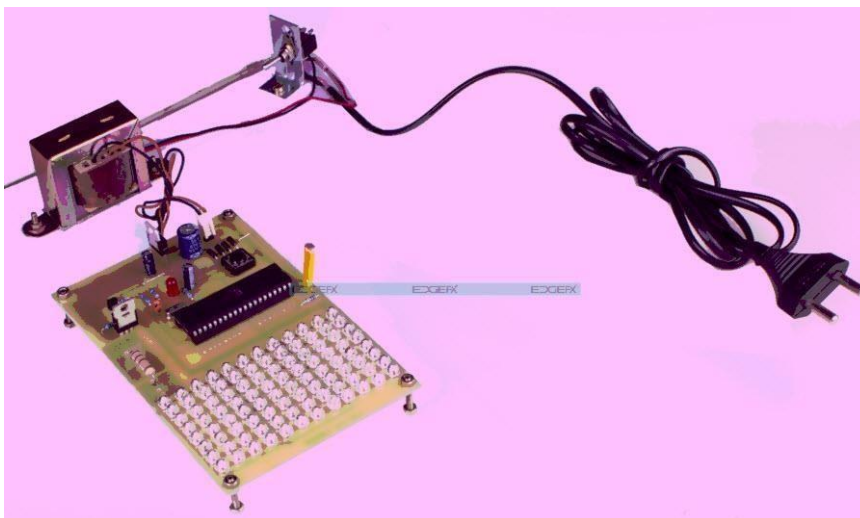


Fig 4.25 Intensity Controlled Street Light using LDR

The proposed system is built to overcome the drawback of the present day of HID lamps. The proposed system determines the usage of light-emitting diodes as a light source and its adjustable intensity control according to the requirement. These lights consume less power, as well as the life span of these lights, which is more compared to conventional HID lamps.

The most important feature of this project is, the light intensity can be controlled according to the necessity during night time, which is not possible in HID lamps. An LDR is used to detect the light and the resistance of the LDR drastically reduces according to the light in the day time, which forms as an i/p signal to the controller.

A bunch of LEDs is used to make a street light and the microcontroller using in the project is preprogrammed with instructions that control the light intensity based on the Pulse width modulation signals generated. The light intensity is

kept high during the night time, and as the traffic on the roads tends to fall in peak hours; the intensity also falls gradually till morning. Finally, the LED lights get turned off in the morning at 6 am and continues again at 6 pm in the evening. This process will continue.

Furthermore, this project can be developed by mixing it with a solar panel, which changes the intensity of the solar to the equivalent voltage and solar energy is used to feed the lights on highways.

Thus, this is all about the working principle of the light-dependent resistor and LDR circuit diagram and its applications. We hope that you have got a better concept through this article. Furthermore, any queries regarding this article or electrical and electronics projects, please give your feedback in the comment section below. Here is a question for you, what is the function of an LDR?

Photo Credits:

- LED Construction sarutech
- LDR Working Principle technologystudent
- LDR wordpress

4.5 Bluetooth Module HC-05

- It is used for many applications like wireless headset, game controllers, wireless mouse, wireless keyboard and many more consumer applications.
- It has range up to <100m which depends upon transmitter and receiver, atmosphere, geographic & urban conditions.
- It is IEEE 802.15.1 standardized protocol, through which one can build wireless Personal Area Network ([PAN](#)). It uses frequency-hopping spread spectrum ([FHSS](#)) radio technology to send data over air.
- It uses serial communication to communicate with devices. It communicates with microcontroller using serial port (USART).

HC-05 Bluetooth Module

- HC-05 is a Bluetooth module which is designed for wireless communication. This module can be used in a master or slave configuration.

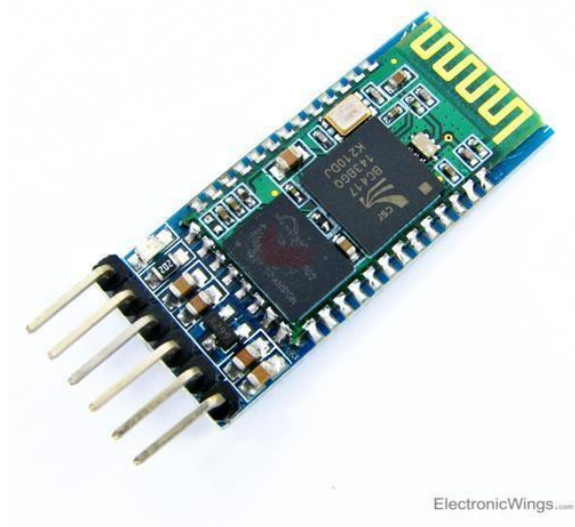


Fig 4.26 HC-05 Bluetooth Module

Pin Description



Fig 4.27 pin description

Bluetooth serial modules allow all serial enabled devices to communicate with each other using Bluetooth.

It has 6 pins,

1. **Key/EN:** It is used to bring Bluetooth module in AT commands mode. If Key/EN pin is set to high, then this module will work in command mode. Otherwise by default it is in data mode. The default baud rate of HC-05 in command mode is 38400bps and 9600 in data mode.

HC-05 module has two modes,

1. **Data mode:** Exchange of data between devices.
 2. **Command mode:** It uses AT commands which are used to change setting of HC-05. To send these commands to module serial (USART) port is used.
2. **VCC:** Connect 5 V or 3.3 V to this Pin.
3. **GND:** Ground Pin of module.
 4. **TXD:** Transmit Serial data (wirelessly received data by Bluetooth module transmitted outserially on TXD pin)
 5. **RXD:** Receive data serially (received data will be transmitted wirelessly by Bluetooth module).
6. **State:** It tells whether module is connected or not.

HC-05 module Information

- HC-05 has red LED which indicates connection status, whether the Bluetooth is connected or not. Before connecting to HC-05 module this red LED blinks continuously in a periodic manner. When it gets connected to any other Bluetooth device, its blinking slows down to two seconds.
- This module works on 3.3 V. We can connect 5V supply voltage as well since the module has on board 5 to 3.3 V regulator.
- As HC-05 Bluetooth module has 3.3 V level for RX/TX and microcontroller can detect 3.3 V level, so, no need to shift transmit level of HC-05 module. But we need to shift the transmit voltage level from microcontroller to RX of HC-05 module.

Bluetooth communication between Devices

E.g. Send data from Smartphone terminal to HC-05 Bluetooth module and see this data on PC serial terminal and vice versa.

To communicate smartphone with HC-05 Bluetooth module, smartphone requires Bluetooth terminal application for transmitting and receiving data. You can find Bluetooth terminal applications for android

and windows in respective app. store.

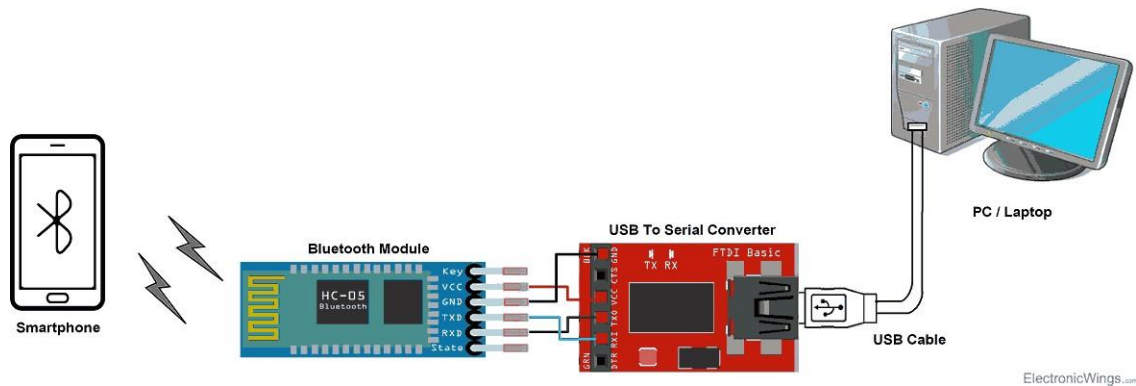


Fig 4.28 Bluetooth Module Serial Interface

So, when we want to communicate through smartphone with HC-05 Bluetooth module, connect this HC-05 module to the PC via serial to USB converter.

Before establishing communication between two Bluetooth devices, 1st we need to pair HC-05 module to smartphone for communication.

Pair HC-05 and smartphone:

1. Search for new Bluetooth device from your phone. You will find Bluetooth device with "HC-05" name.
2. Click on connect/pair device option; default pin for HC-05 is 1234 or 0000.

After pairing two Bluetooth devices, open terminal software (e.g. Teraterm, Realterm etc.) in PC, and select the port where we have connected USB to serial module. Also select default baud rate of 9600 bps.

In smart phone, open Bluetooth terminal application and connect to paired device HC-05.

It is simple to communicate, we just have to type in the Bluetooth terminal application of smartphone. Characters will get sent wirelessly to Bluetooth module HC-05. HC-05 will automatically transmit it serially to the PC, which will appear on terminal. Same way we can send data from PC to smartphone.

Command Mode

- When we want to change settings of HC-05 Bluetooth module like change password for connection, baud rate, Bluetooth device's name etc.
- To do this, HC-05 has AT commands.
- To use HC-05 Bluetooth module in AT command mode, connect "Key" pin to High(VCC).
- Default Baud rate of HC-05 in command mode is 38400bps.
- Following are some AT command generally used to change setting of Bluetooth module.
- To send these commands, we have to connect HC-05 Bluetooth module to the PC via serial to USB converter and transmit these command through serial terminal of PC.
-

Command	Description	Response
AT	Checking communication	OK
AT+PSWD=XXXX	Set Password e.g. AT+PSWD=4567	OK
AT+NAME=XXXX	Bluetooth Device Name e.g. AT+NAME=MyHC-05	OK
AT+UART=Baud rate, stop bit, parity bit	Change Baud rate e.g. AT+UART=9600,1,0	OK
AT+VERSION?	Respond version no. of Bluetooth module	+Version: XX OK e.g. +Version: 2.0 20130107 OK
AT+ORGL	Full detail of setting done by manufacturer	Parameters: device type, module mode, serial parameter, passkey, etc.

Table 4.1 Bluetooth models

4.6 WATER LEVEL SENSOR:

Principle:

When the water reaches the tip of the ultrasonic sensor the motor turns off. It is useful for saving the water

CONDITION 1: Water not available When the tank is empty there is no conductive path so the transistor base emitter region will not have sufficient biasing voltage hence it remains in cut off region and the output across its collector will be V_c approximately 4.2v. As in this case the microcontroller is used in the active low region (which means it considers 0-2 volts for HIGH and 3-5 volts for LOW) now the output of transistor which is 4.2v approximately will be considered as LOW by the microcontroller and hence the default value given by microcontroller to the seven segment display is 1 which indicates as the tank is empty.

CONDITION 2: Water full When the tank becomes full, the probe gets the conductive path through water and the corresponding transistor gets into conduction whose output given to microcontroller with this input microcontroller not only displays the level in seven segment display but also activates the continuous buzzer by which user can understand that tank is full and can switch off the motor and save water



Fig 4.30 water level sensor

4.6 ARDUINO UNO AND ITS PROGRAMMING

Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board.

Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone, or they can be communicate with software running on your computer. The boards can be assembled by hand or purchased preassembled; the open-source IDE can be downloaded for free.

The Arduino programming language is an implementation of Wiring, a similar physical computing platform, which is based on the Processing multimedia programming environment

Overview

The Arduino microcontroller is an easy to use yet powerful single board computer that has gained considerable traction in the hobby and professional market. The Arduino is open-source, which means hardware is reasonably priced and development software is free. This guide is for students in ME 2011, or students anywhere who are confronting the Arduino for the first time. For advanced Arduino users, prowl the web; there are lots of resources.

This guide covers the Arduino Uno board (Spark fun DEV-09950, \$29.95), a good choice for students and educators. With the Arduino board, you can write programs and create interface circuits to read switches and other sensors, and to control motors and lights with very little effort. Many of the pictures and drawings in this guide were taken from the documentation on the

This is what the Arduino board looks like.

fig 4.31 *arduino board*



The Duemilanove board features an Atmel ATmega328 microcontroller operating at 5 V with 2 Kb of RAM, 32 Kb of flash memory for storing programs and 1 Kb of EEPROM for storing parameters. The clock speed is 16 MHz, which translates to about executing about 300,000 lines of C source code per second. The board has 14 digital I/O pins and 6 analog input pins. There is a USB connector for talking to the host computer and a DC power jack for connecting an external 6-20 V power source, for example a 9 V battery, when running a program while not connected to the host computer. Headers are provided for interfacing to the I/O pins using 22g solid wire or header connectors.

The Arduino programming language is a simplified version of C/C++. If you know C, programming the Arduino will be familiar. If you do not know C, no need to worry as only a few commands are needed to perform useful functions.

An important feature of the Arduino is that you can create a control program on the host PC, download it to the Arduino and it will run automatically. Remove the USB cable connection to the PC, and the program will still run from the top each time you push the reset button. Remove the battery and put the Arduino board in a closet for six months. When you reconnect the battery, the last program you stored will run. This means that you connect the board to the host PC to develop and debug your program, but once that is done, you no longer need the PC to run the program.

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, 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.

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.

Summary:

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) of which 0.5 KB used by

bootloader SRAM 2 KB (ATmega328)

EEPROM 1 KB (ATmega328)

Clock Speed 16 MHz

Pin Configuration

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wall- wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the

voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The power pins are as follows:

- **VIN.** The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- **5V.** this pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board.
- **3V3.** A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- **GND.** Ground pins.
- **IOREF.** This pin on the Arduino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs for working with the 5V or 3.3V.

Memory

The ATmega328 has 32 KB (with 0.5 KB used for the bootloader). It

also has 2 KB of SRAM and 1 KB of EPROM.

Input and Output

Each of the 14 digital pins on the Uno can be used as an input or output, using `pinMode()`, `digitalWrite()`, and `digitalRead()` functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kohms. In addition, some pins have specialized functions:

- **Serial: 0 (RX) and 1 (TX).** Used to receive (RX) and Transmit (TX) TTL serial data.

These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.

- **External Interrupts: 2 and 3.** These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the `attachInterrupt()` function for details.
- **PWM: 3, 5, 6, 9, 10, and 11.** Provide 8-bit PWM output with the `analogWrite()` function.
- **SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK).** These pins support SPI communication using the SPI library.
- **LED: 13.** There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Uno has 6 analog inputs, labeled A0 through A5, each of which

provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though it is possible to change the upper end of their range using the AREF pin and the analog Reference () function. Additionally, some pins have specialized functionality:

- **TWI: A4 or SDA pin and A5 or SCL pin.** Support TWI communication using the Wire library.

There are a couple of other pins on the board:

- **AREF.** Reference voltage for the analog inputs. Used with analog Reference ().

Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

Communication

Microcontrollers depend on a host computer for developing and compiling programs. The software used on the host computer is known as an integrated development environment, or IDE. For the Arduino, the development environment is based on the open source Processing platform (www.processing.org) which is described by its creators as a “programming language and environment for people who want to program images, animation, and interactions.” The Arduino programming language leverages an open source project known as Wiring (wiring.org.co). The Arduino language is based on good old-fashioned C. If you are unfamiliar with this language, don’t worry; it’s not hard to learn, and the Arduino IDE provides some feedback when you make mistakes in your programs.

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on

digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A Software Serial library allows for serial communication on any of the Uno's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation for details. For SPI communication, use the SPI library.

As you go through the list of programming statements available in the Arduino IDE (choose Help->Reference), you might think there isn't much power for doing things like running servos, operating stepper motors, reading potentiometers, or displaying text on an LCD. Like most any language based on C, the Arduino supports the notion of "libraries" code.

Repositories that extend core programming functionality. Libraries let you re-use code without having to physically copy and paste it into all your programs. The standard Arduino software installation comes with several libraries you may use, and you can download others from the Arduino support pages and from third-party websites that publish Arduino library code. A good example of a library you'll use with the Robot and likely many other robot projects is

Servo. This library allows you to connect one or more hobby R/C servos

to the Arduino's digital I/O pins. The Servo library comes with the standard Arduino installation package Library-

>Servo. This adds the line `#include <Servo.h>`

Which tells the Arduino IDE that you wish to include the Servo library in your sketch. With the functionality of the library now available to you, you can use its various functions to control one or more servos. For example, you can use the write function to rotate a servo to a specific position, from 0 to 180 degrees. The following code

```
myServo.write(90);
```

Moves a servo to its midpoint, or 90 degree position. Structurally, Arduino sketches are very straightforward and are pretty easy to read and understand. The Arduino program contains two main parts: setup () and loop (). These are programming functions that do what their names suggest: setup () sets up the Arduino hardware, such as specifying which I/O lines you plan to use, and whether

They are inputs or outputs. The loop () function is repeated endlessly when the Arduino is operating.

Arduino IDE (Integrated development environment) is used to write the program and dump into the Arduino board

ARDUINO SOFTWARE:

1. Open Arduino IDE as shown below

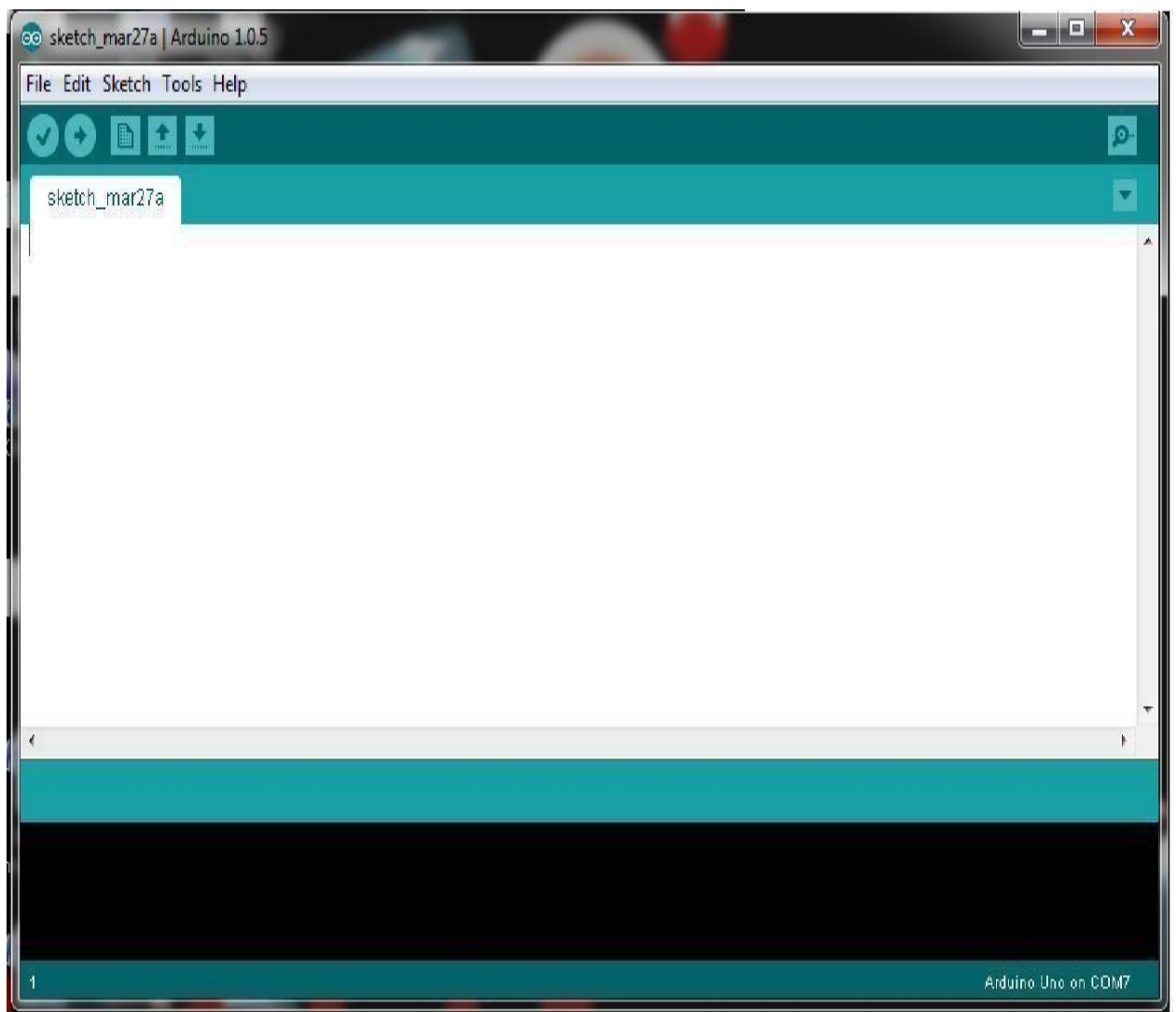


Fig 4.32 open IDE

2. Select the COM Port from tool

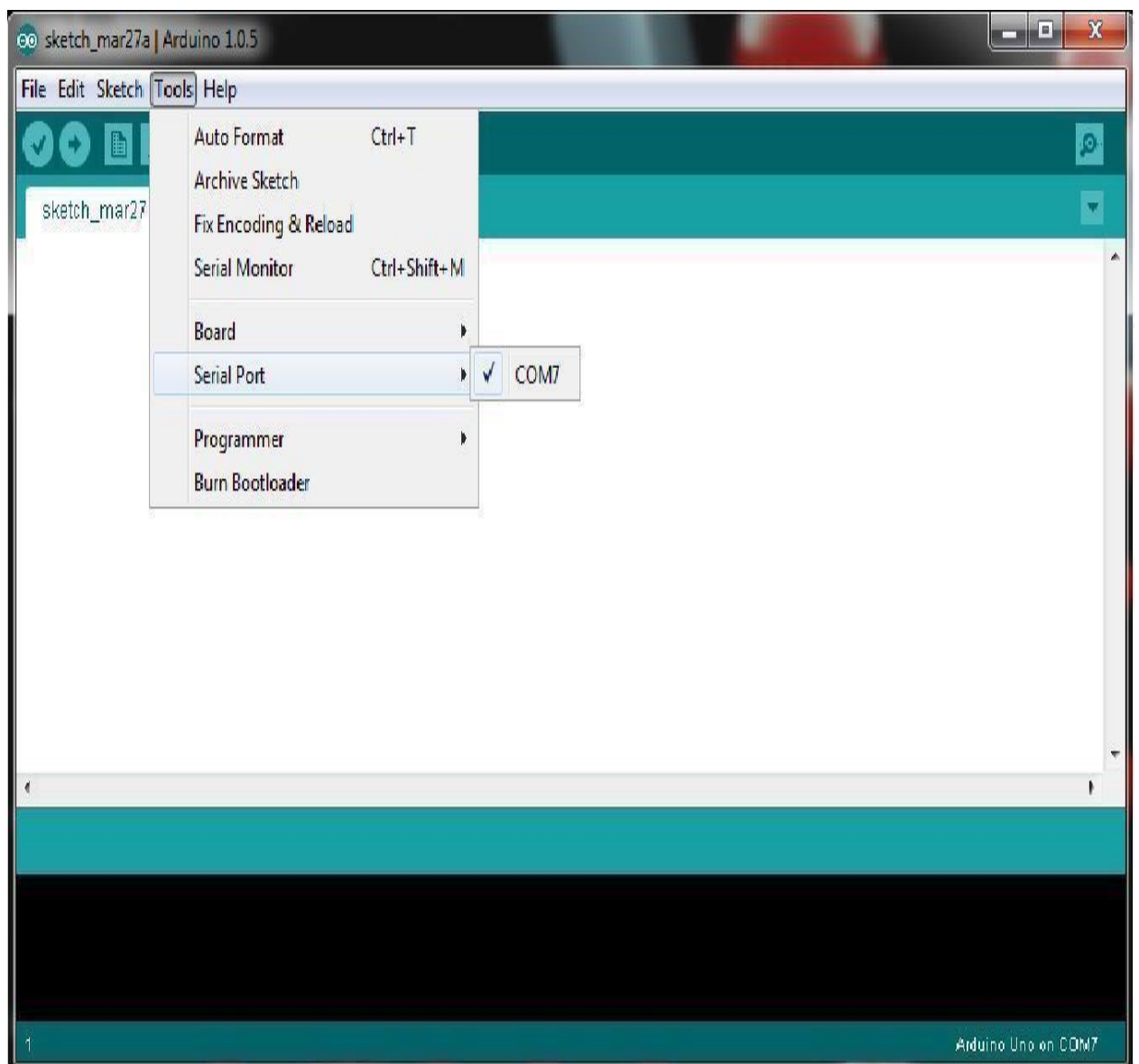


Fig 4.33 select COM PORT

3. Select the required Arduino board from Tools as shown below

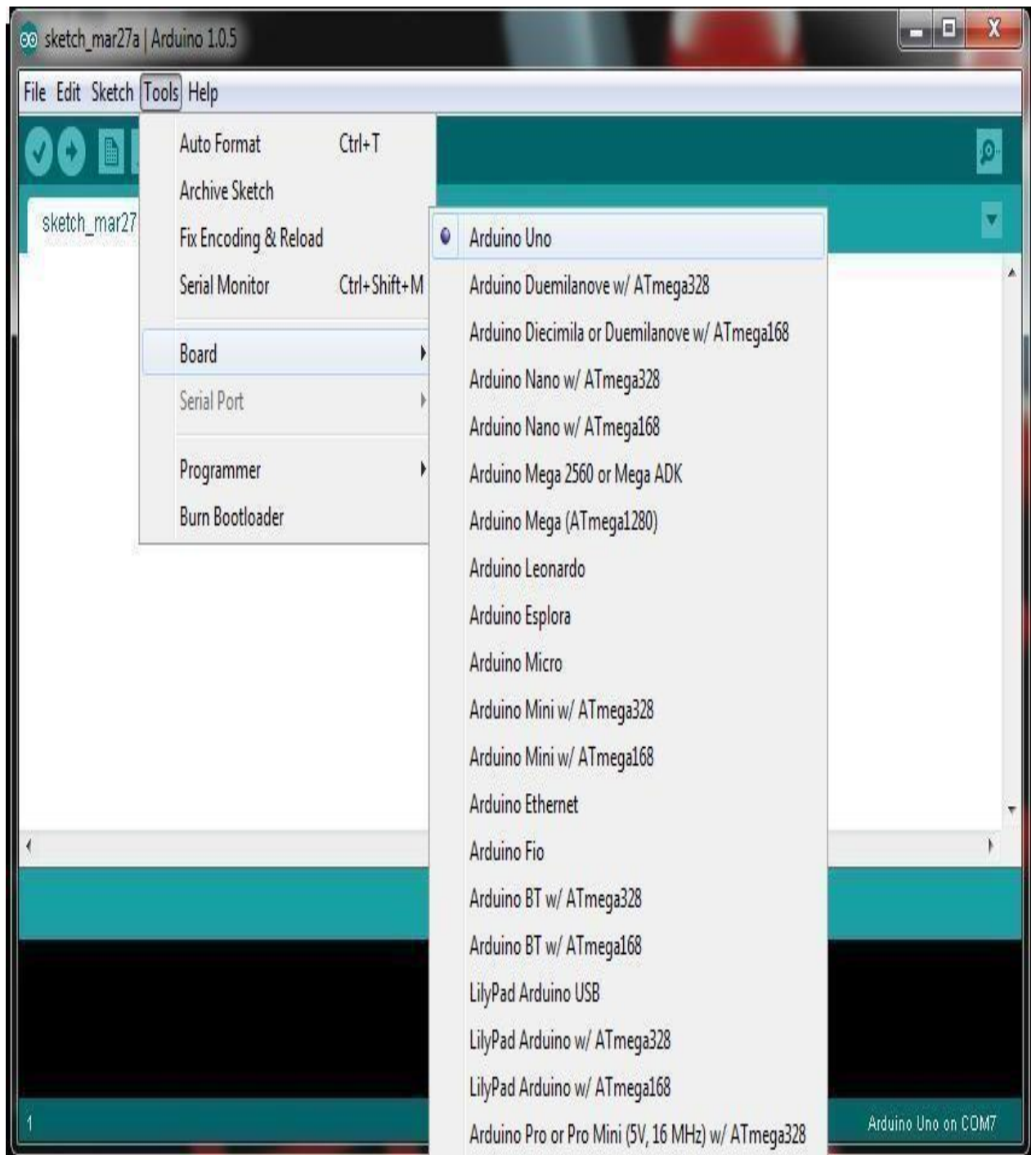


Fig 4.34 select Arduino tools

4. Write the sketch in Arduino IDE

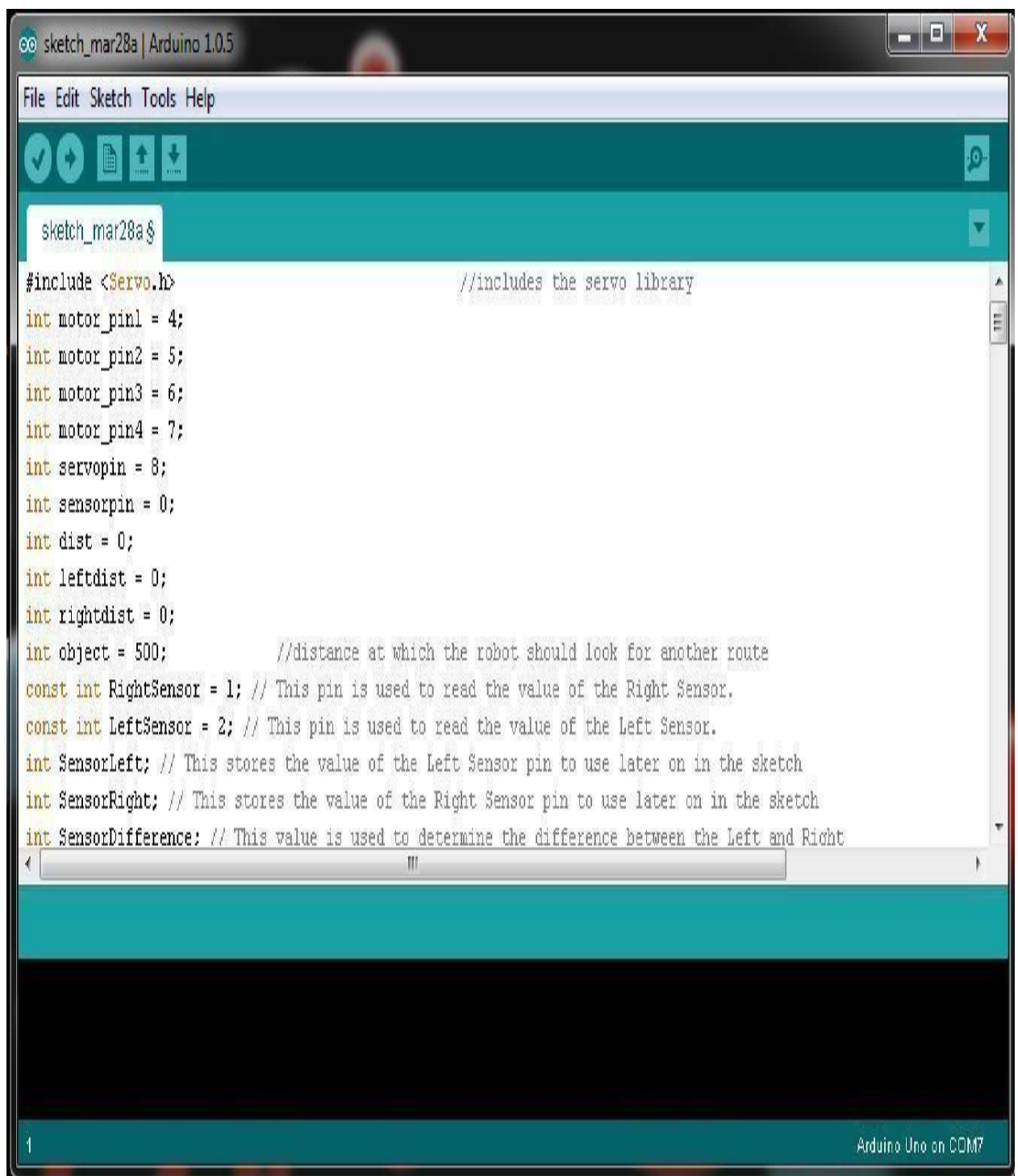


Fig 4.35 write sketch

5. Compile and upload the Sketch to Arduino board upload the Sketch to Arduino board



Fig 4.36 upload sketch

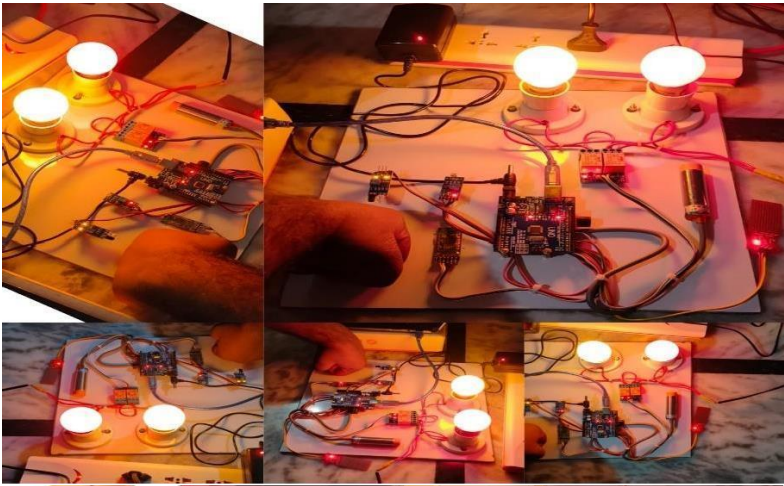
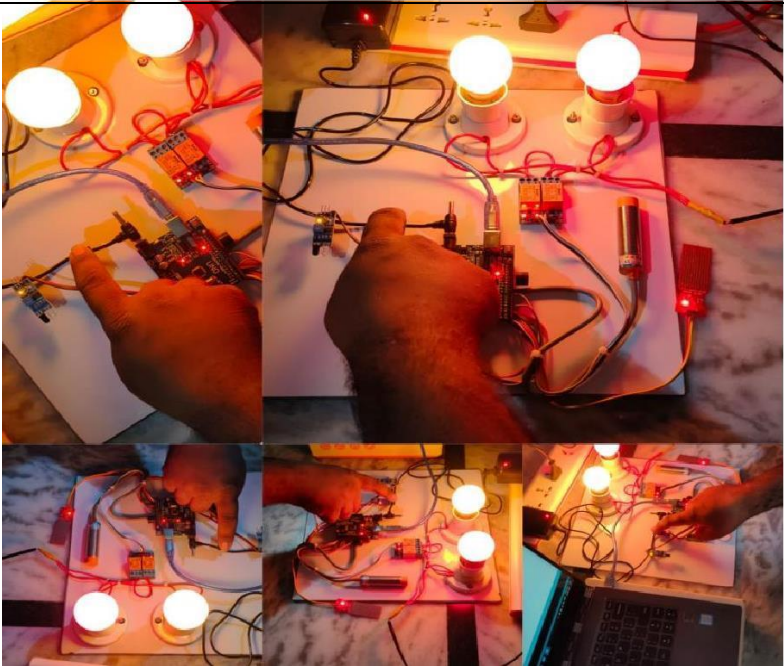
- APPLICATIONS: Automobile Applications
- Industrial Application
- Home applications
- Monitoring device applications
- Remote control devices

CHAPTER-5

RESULT AND

DISCUSSIONS

RESULT:

SI.NO	TYP E	HARDWARE OUTPUT
1	PI R S E N S O R	
2	L D R S E N S O R	

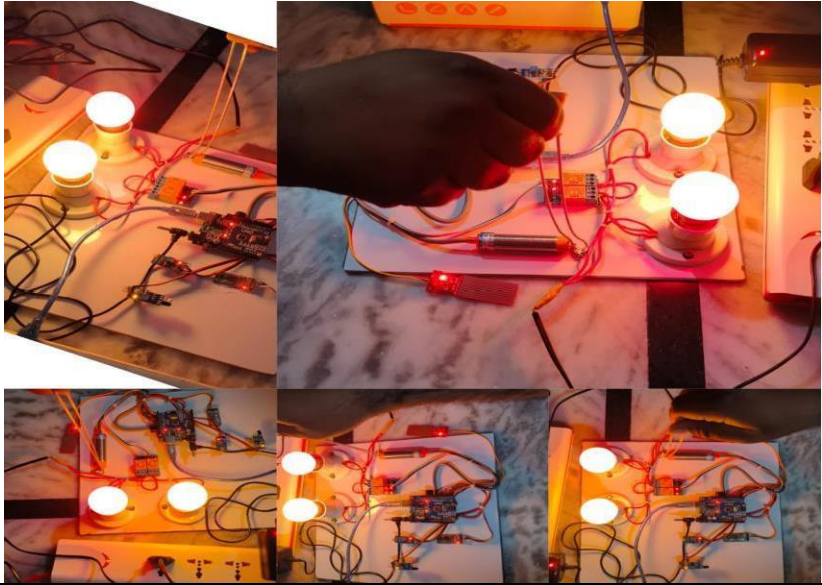
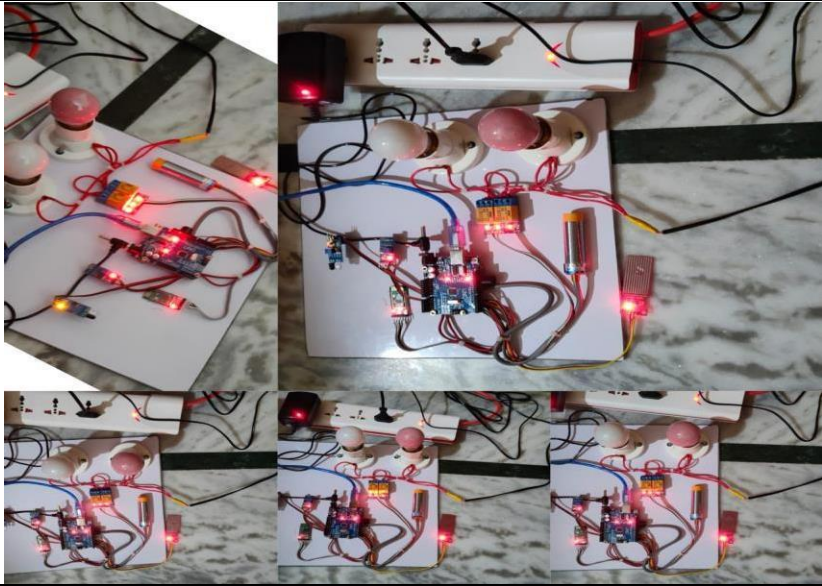
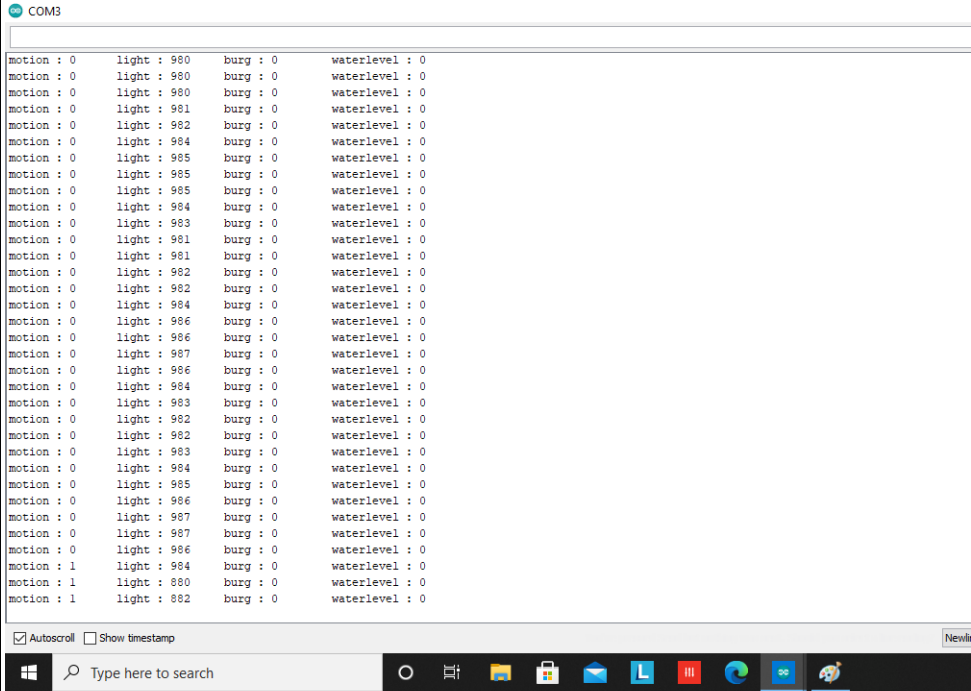
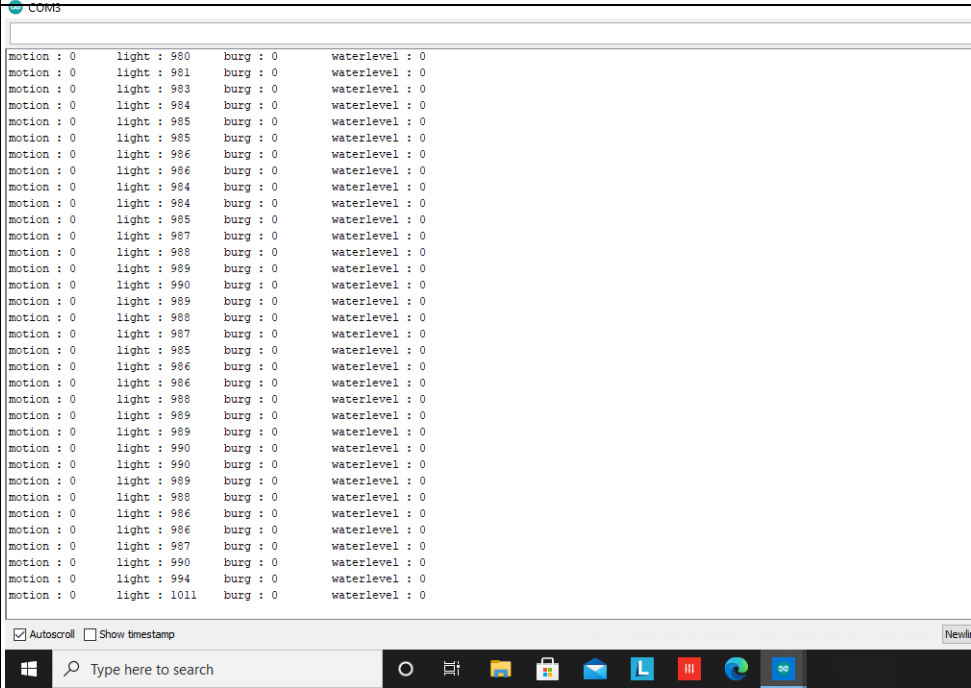
3	METAL DETECTOR SENSOR	
4	WATER LEVEL SENSOR	

Table 5.1 hardware output

SI. NO	TYPE OF SENSOR	DIGITAL OUTPUT

1	PIR SE NS OR	
2	LD R SE NS OR	

[illegible]

Table 5.2 digital output

CHAPTER-6

CONCLUSION

AND

FUTURE

USES

CONCLUSION:

In conclusion, a home based automation can be designed in a better way by using arduino and c language .This prototype is useful for daily life activities and security purposes. This is a simple prototype and is very useful. The PIR sensor it detects the person entering the room and turn on and turn off when the person get out of the room this saves electricity. The LDR sensor detects the intensity of light around it and and switch on the light like street light, gate lights etc. The Metal detector detects the person entering with the heavy metal and the alarm will be blared so that person inside the house gets alerted. The Water level sensor detects the water inside the tank/container and turns off the motor this prevents the wastage of water.

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