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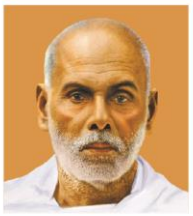

SAMPLE OF PROJECT

SREE NARAYANA GURU COLLEGE OF ENGINEERING & TECHNOLOGY

(Affiliated to APJ Abdul Kalam Technological University and approved by AICTE New Delhi)

PROJECT PHASE II

REPORT ON

AUTOMATIC FISH AND PLANT CULTIVATION

Submitted in partial fulfilment of the requirement for the awardof

the degree of Bachelor of Technology

Presented by

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

A P J ABDUL KALAM TECHNOLOGICAL UNIVERSITY

2022-2023

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PRINCIPAL

SREE NARAYANA GURU COLLEGE OF ENGINEERING & TECHNOLOGY

(Affiliated to APJ Abdul Kalam Technological University and approved by AICTE New Delhi)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that the Project entitled **"AUTOMATIC FISH AND PLANT CULTIVATION"** is a Bonafide record of the work done by **ARJUN ASHOK K, JITHIN SASIDHARAN N V,KEERTHANA CV,MARIYAMBI ,SANISHMA SACHITHANAND** of Eighth Semester **Electronics and Communication Engineering** towards the partial fulfilment for the award of the degree of **Bachelor of Technology** by KTU Technological University.

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ACKNOWLEDEGMENT

I would like to express my whole hearted gratitude to all who helped in this endeavor. I also take this opportunity to thank our management, **Sree Bhakthi Samvardhini Yogam, Kannur**. I also thank our Principal **Dr. Leena A.V** for having provided me with all facilities required forsuccessful completion of our project.

My sincere thanks to **Ms. Leena Narayanan**, Head of Department ECE, Sree Narayana Guru College of Engineering and Technology, Payyanur for her encouragement and well wishes to carry out this project.

I express my heartfelt gratitude to our Project Phase II coordinator, **Ms. Vani R** Assistant Professor ECE, and, guided by **Ms. Meera M** Sree Narayana Guru College of Engineering and Technology Payyanur for their valuable suggestion and guidance.

I pay my regards to all our teachers and non-teaching staffs in our college for the knowledge they have imparted for us. I am also grateful to our family members and friends for their cooperation and support.

Above all, I also owe my gratitude to God almighty for showering abundant blessing upon me. Above all it is the grace and blessing of God the Almighty, which make this endeavor a success

HoD ECE

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ABSTRACT

Fish and plant cultivation has been separately done till date. Our project conveys the idea of combining fish and plant cultivation under same roof. By using the technique ,we could save both time and space. This technique also promotes sustainable organic waste management. Our project, automatic fish and plant cultivation focuses on growing fishes and plants under the same roof. On the ground part of the apparatus we fix aquarium and lettuce plant production on top of it. So that we could take the impure water from the aquarium and purify it by giving it into plant production part .thus the impure water can be purified by the process of leeching. Leeching is the process of sweeping down of water through soil thus water getting purified. The water after leeching can be reused into aquarium once again so that there is no wastage of water. Aquaponics is a food production method that combines the traditional hydroponics with aquaculture in a symbiotic relationship that facilitates a sustainable system with necessary input as all the water and nutrients within are re-circulated in order to grow terrestrial plants and aquatic life. This technique of agriculture can possibly replace other traditional methods if brought in use effectually. And when traditional Aquaponics meets the technology, remarkable outcomes could become visible. The IoT based Aquaponics Monitoring system features to monitor pH value, temperature and humidity level, water level using the specific sensors has been done and then after perceiving those values from the sensors. A new technology, Internet of Things has been introduced that bridges the gap between the physical world and the digital world and that starts with things. To connect the sensors with the internet, the database server and application server can be managed so as to display the information regarding the sensors. In order to introduce technology to the traditional aquaponics system.

HoD ECE

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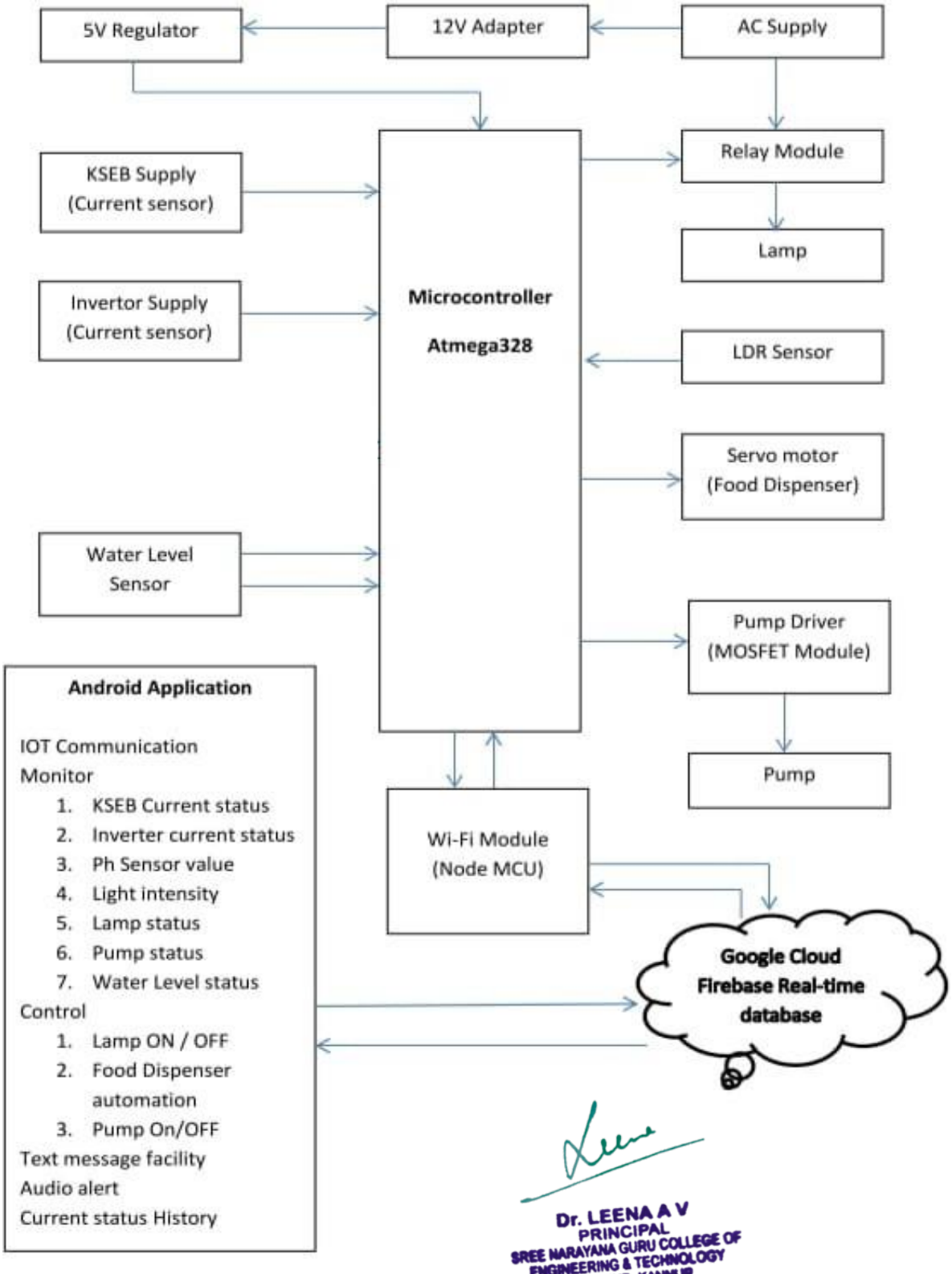
CHAPTER 1

INTRODUCTION

Research in aquaculture is an input to increase stabilized production. In last decade various scientists have made sustained efforts that resulted in development of modern production technologies that have revolutionized farm production. The main aim of the project is to remote monitoring of the fish farming system by using the various sensors to reduce the risks. In this processes we use sensors like pH value, current sensors and level sensors. By using these sensors all the work is automated and it will also be easy to monitor the fish farming remotely from other location. Fish farming have been used for more than three decades. Research in aquaculture is an input to increase and stabilize production. Fish farming refers to farming variety of marine species such as shellfish, sport fish, bait fish, ornamental fish, crustaceans, mollusks, algae, sea vegetables, and fish eggs to breed, rear and harvest in different water environments such as ponds, rivers, lakes, and ocean. Fish are cold-blooded animals, regulating their body temperature directly by the water environment. Changes in water temperature affect the amount of dissolved oxygen in the water and fish oxygen consumption. A chilling injury will cause the fish to rush into, paralysis with a loss of balance, leading to death. The reason may be the respiratory center, or osmotic regulation is affected at high temperatures, we cannot control such things. But we can provide air follow through the water to increase the oxygen level in the water. If the amount of dissolved oxygen in water is reduced to below a certain limit fish growth will be hindered. When the amount of dissolved oxygen becomes lower than the fish survival conditions the fish will die. And if the follow of air is stopped the fish will die. In general fish farming the acidity and alkaline of the water should be maintained between 6 to 8. Too acidic or alkaline will cause adverse effects, acid erosion of the gill tissue, tissue coagulation necrosis, increased mucus secretion, abdominal congestion and inflammation. If the PH value is less than 4.5, the fish will die.

CHAPTER 2

BLOCK DIGRAM



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CHAPTER 3

BLOCK EXPLANATION

INTRODUCTION TO ATMEGA328

Atmega328 is a single-chip microcontroller created by Atmel in the mega AVR family(later Microchip Technology acquired Atmel in 2016).It has a modified Harvard architecture 8- bit RISC processor core.ATmega328 is basically an Advanced Virtual RISC (AVR) micro- controller. It supports the data up to eight (8) bits. ATmega328 has 32KB internal built-in memory. This micro-controller has a lot of other characteristics.

ATmega328 has 1KB Electrically Erasable Programmable Read Only Memory (EEPROM). This property shows if the electric supply supplied to the micro-controller is removed, even then it can store the data and can provide results after providing it with the electric supply. Moreover, ATmega328 has 2KB Static Random Access Memory (SRAM).

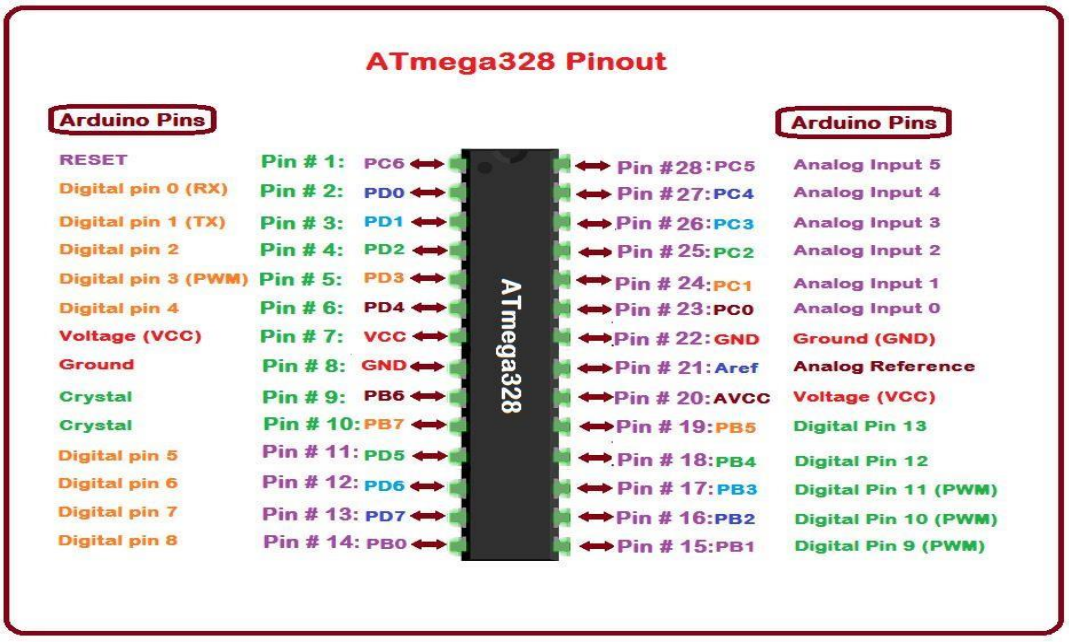

Fig 1 AT mega 328

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ATmega328 has several different features which make it the most popular device in today's market. These features consist of advanced RISC architecture, good performance, low power consumption, real timer counter having separate oscillator, 6 PWM pins, programmable Serial USART, programming lock for software security, throughput up to 20 MIPS etc. ATmega-328 is mostly used in Arduino.

ATmega328 is an eight (8) bit Microcontroller. It can handle the data sized of up to eight (8)bits. It is an AVR based micro-controller. Its built-in internal memory is around 32KB. It operates ranging from 3.3V to 5V. It has an ability to store the data even when the electrical supply is removedfrom its biasing terminals. Its excellent features include the cost efficiency, low power dissipation, programming lock for security purposes, and real timer counter with separate oscillator. It's normallyused in Embedded Systems applications.

ATmega328 Pins

- ATmega-328 is an AVR Microcontroller having twenty eight (28) pins in total.
- All of the pins in chronological order are listed in the table shown in the figure given below.

ATmega328 Pins			
Pin Number	**Pin Name**	**Pin Number**	**Pin Name**
1	PC6	15	PB1
2	PD0	16	PB2
3	PD1	17	PB3
4	PD2	18	PB4
5	PD3	19	PB5
6	PD4	20	AVCC
7	Vcc	21	AREF
8	GND	22	GND
9	PB6	23	PC0
10	PB7	24	PC1
11	PD5	25	PC2
12	PD6	26	PC3
13	PD7	27	PC4
14	PB0	28	PC5

ATmega328 Pins Description

- Functions associated with the pins must be known in order to use the device appropriately.
- ATmega328 pins are divided into different ports which are given in detail below.

VCC is a digital voltage supply.

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AVCC is a supply voltage pin for analog to digital converter.

GND denotes Ground and it has a 0V.

Port A consists of the pins from **PA0** to **PA7.** These pins serve as analog input to analog to digital converters. If analog to digital converter is not used, **port A** acts as an eight (8) bit bidirectional input/output port.

Port B consists of the pins from **PB0** to **PB7.** This port is an 8 bit bidirectional port having an internal pull-up resistor.

Port C consists of the pins from **PC0** to **PC7.** The output buffers of **port C** has symmetrical drive characteristics with source capability as well high sink.

Port D consists of the pins from **PD0** to **PD7.** It is also an 8 bit input/output port having an internal pull-up resistor.

- All of the AVR ports are shown in the figure given below

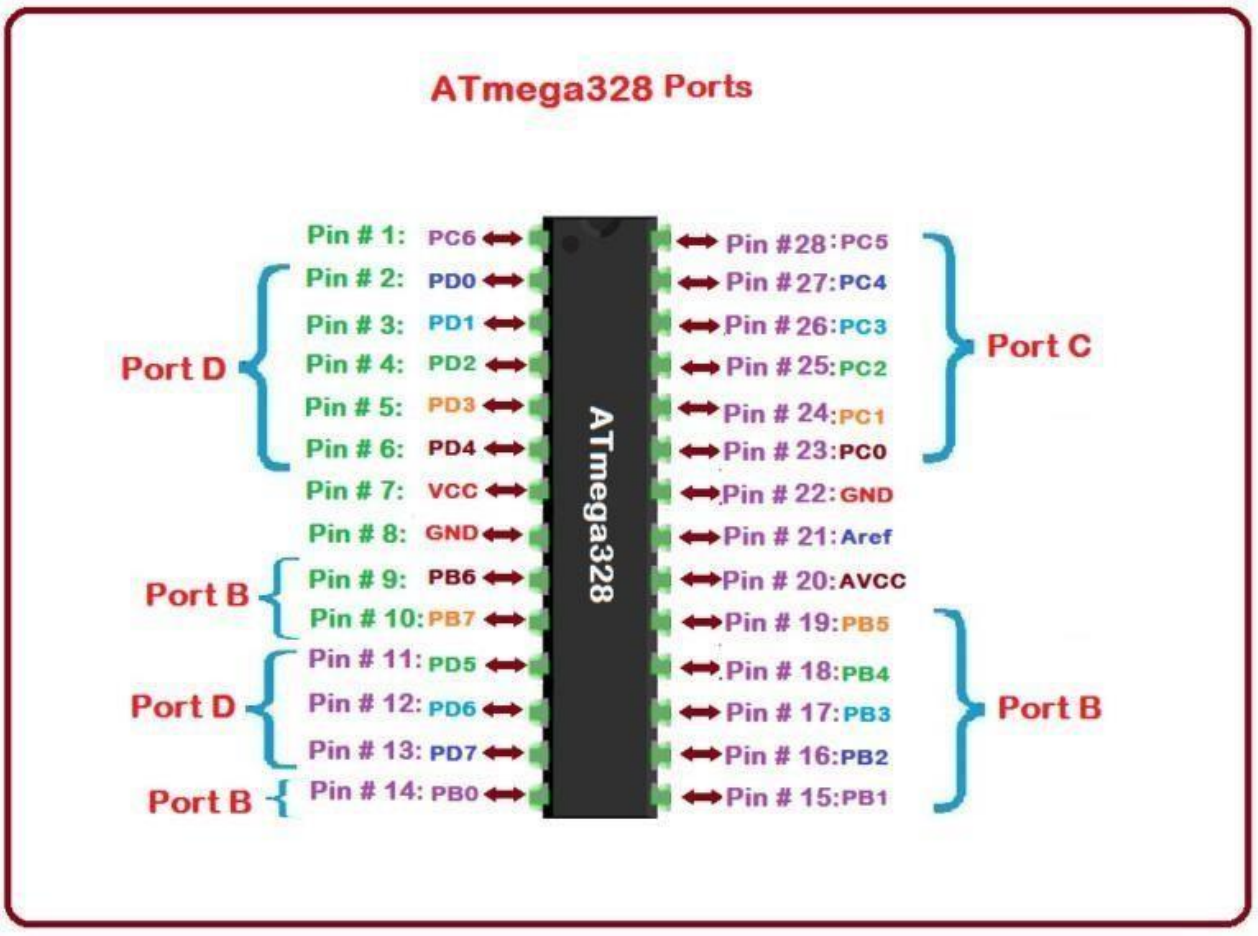

Fig 2 ATmega 328 port

AREF is an analog reference pin for analog to digital converter.

- So this was the brief of all the pins in ATmega328 AVR micro-controller.

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ATmega328 Memory

- ATmega328 has three types of memories e.g. EEPROM, SRAM etc.
- The capacity of each memory is explained in detail below.

Flash Memory has 32KB capacity. It has an address of 15 bits. It is a Programmable Read Only Memory (ROM). It is nonvolatile memory.

SRAM stands for Static Random Access Memory. It is a volatile memory i.e. data will be removed after removing the power supply.

EEPROM stands for Electrically Erasable Programmable Read Only Memory. It has a long term data.

- AVR memory spaces are shown in the figure given below.

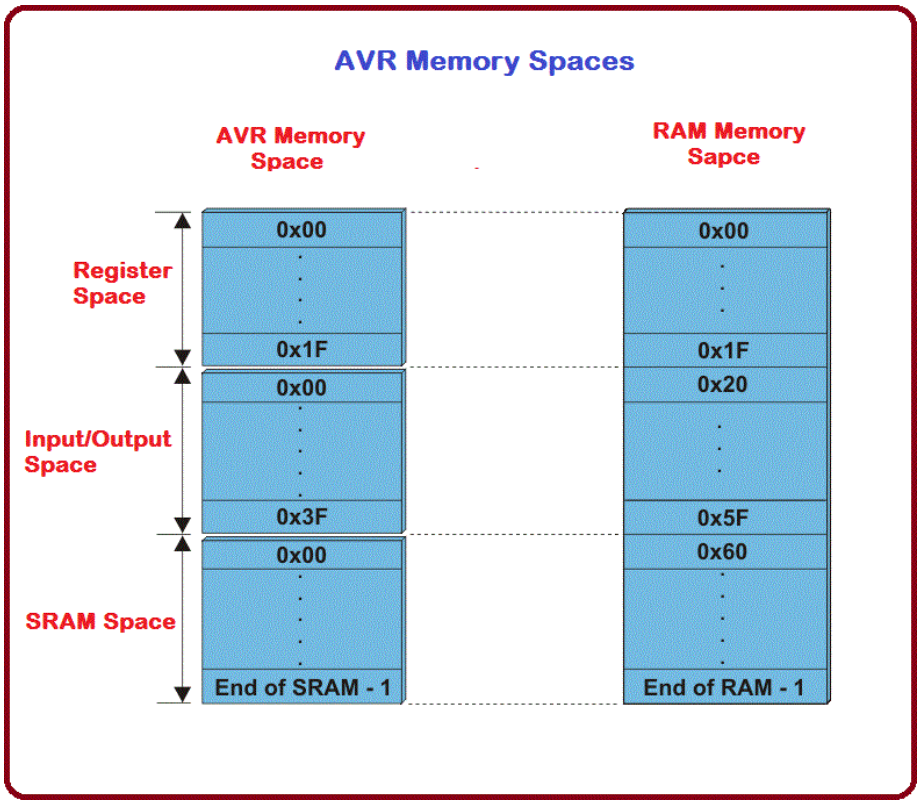

Fig 3 AVR memory

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Atmega328 Architecture

- Architecture of a device presents each information about the particular device.
- ATmega-328 architecture is shown in the figure given below.

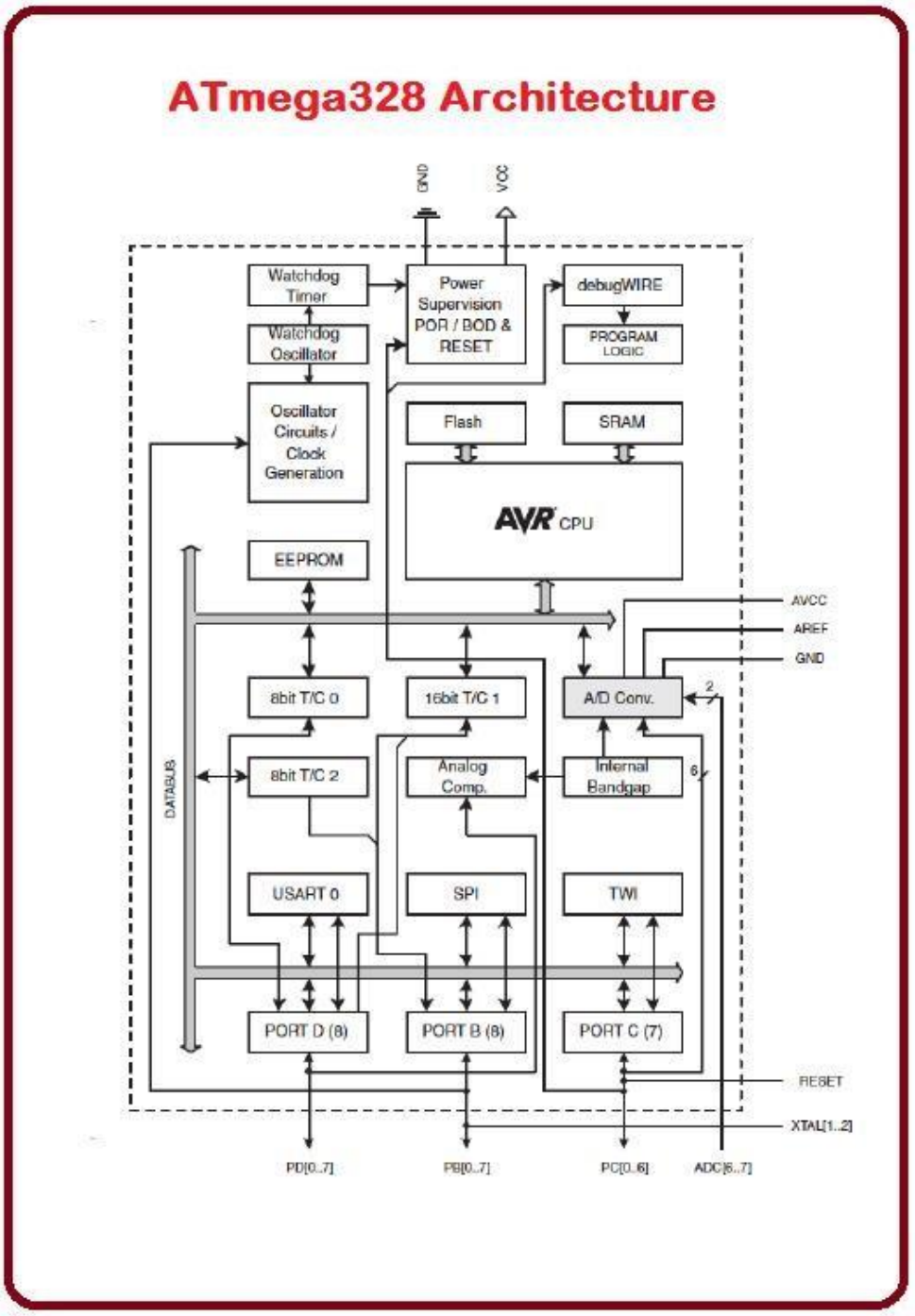

Fig 4 ATmega328 architecture

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ATmega328 and Arduino

- ATmega328 is the most micro-controller that is used while designing.
- ATmega328 is the most important part of Arduino.
- The program is uploaded on the AVR micro-controller attached on Arduino.
- AVR attached on Arduino is shown in the figure given below.

Fig 5 ATmega328 & Arduino

POWER SUPPLY

Power is the backbone of any electronic system and the power supply is what feeds the system. Choosing the right supply can be the critical difference between a device working at optimum levels and one that may deliver inconsistent results. The power supply unit is the part of the hardware that is used to convert the power provided from the outlet into usable power to many parts inside an electrical device. Every energy supply must drive its load, which is connected to it. Depending on its design, a power supply unit may obtain energy from various types of energy sources, like

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electrical energy transmission systems, electromechanical systems such as generators and alternators, solar power converters, energy storage devices such as a battery and fuel cells, or other power supply.

There are two types of power supplies existed, AC and DC power supply. Based on the electrical device's electric specifications it may use AC power or DC power.

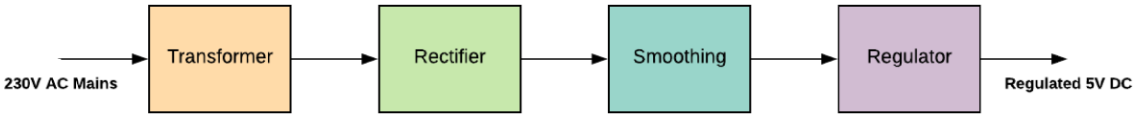
What is a Power Supply?

The power supply can be defined as it is an electrical device used to give electrical supply to electrical loads. The main function of this device is to change the electrical current from a source to the accurate voltage, frequency and current to supply the load. Sometimes, these power supplies can be named to as electric power converters. Some types of supplies are separate pieces of loads, whereas others are fabricated into the appliances that they control.

Power Supply Block Diagram

The Power supply circuit is used in various electrical & electronic devices. The power supply circuits are classified into different types based on the power they utilize for providing for circuits or devices. For instance, the microcontroller based circuits are generally the 5V DC regulated power supply (RPS) circuits, which can be designed with the help of different method for changing the power from 230V AC to 5V DC.

The power supply block diagram, and the step by step conversion of 230V AC to 12V DC is discussed below.



- A step-down transformer converts the 230V AC into12v.
- The bridge rectifier is used to change AC to DC
- A capacitor is used to filter the AC ripples and gives to the voltage regulator.
- Finally voltage regulator regulates the voltage to 5V

.

Input Transformer

The input transformer is used to convert the incoming line voltage down to the required level of the power supply. It also isolates the output circuit from the line supply. Here we are using a step-down transformer.

Rectifier

The rectifier used to convert the incoming signal from an AC format into raw DC. For rectification purpose we use a diode, a diode is a device that allows current to pass only in

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one direction i.e. when the anode of the diode is positive with respect to the cathode also called as forward biased condition & blocks current in the reversed biased condition.

Filter Capacitor

The pulsated DC from the rectifier is fed to the smoothing capacitor. It will remove the unwanted ripples in the pulsated DC.

Voltage Regulator

A Voltage regulator is a device which converts varying input voltage into a constant regulated output voltage.

AC-DC CONVERSION BASICS

A power supply takes the AC from the wall outlet, converts it to unregulated DC, and reduces the voltage using an input power transformer, typically stepping it down to the voltage required by the load. For safety reasons, the transformer also separates the output power supply from the mains input.

Once the voltage has been rectified, there is still fluctuation in the waveform—the time between the peaks—that needs to be removed. The rectified AC voltage is then filtered or "smoothed" with a capacitor.

The capacitor is typically quite large and creates a reservoir of energy that is applied to the load when the rectified voltage drops. The incoming energy is stored in the capacitor on the rising edge and expended when the voltage falls. This significantly reduces the amount of voltage droop and smoothes out the voltage. Increasing the storage capacity of the capacitor generally produces a higher quality power supply.

Once the voltage conversion is complete, there is still some variation in output, called ripple. In a regulated power supply, the voltage is then passed through a regulator to create a fixed DC output with less ripple.

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5V Power Supply Using 7805

Circuit diagram of 5V power supply is given below.

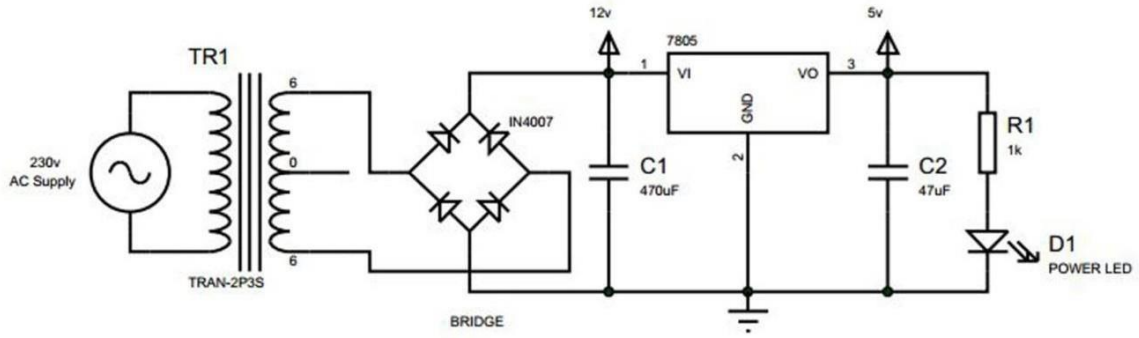

Fig 6 5V power supply

Components Used

- 6-0-6 Step Down Transformer
- 4 x 1N4007 Diode (Bridge Rectifier)
- 470uF Electrolytic Capacitor
- 7805 Voltage Regulator
- 47uF Electrolytic Capacitor
- 1k Resistor
- 3mm Red Led (Power Indication)

Step Down Transformer

A Transformer is a static apparatus, with no moving parts, which transforms electrical power from one circuit to another with changes in voltage and current and no change in frequency. There are two types of transformers classified by their function: Step up Transformer and Step down Transformer.

Principle of Working of Transformers

An electrical transformer works on the principle of Mutual Induction, which states that a uniform change in current in a coil will induce an E.M.F in the other coil which is inductively coupled to the first coil.

In its basic form, a transformer consists of two coils with high mutual inductance that are electrically separated but have common magnetic circuit. The following image shows the basic construction of a Transformer.

Relation between Voltage and Turns

Let N_P be the number of turns of the coil in the Primary Winding and N_S be the number of turns of the coil in the Secondary Winding. If the alternating voltage at the primary side of the transformer is V_P and the alternating voltage at the secondary side of the transformer is V_S, then the

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relation between the voltages at primary and secondary and number of turns of the coil in primary and secondary is given as follows.

$$V_P/V_S = N_P/N_S$$

Step Down Transformer

A Step down Transformer is a type of transformer, which converts a high voltage at the primary side to a low voltage at the secondary side.

If we speak in terms of the coil windings, the primary winding of a Step down Transformer has more turns than the secondary winding. The following image shows a typical step down transformer.

Bridge Rectifier

Before going to bridge rectifier, we need to know what actually a rectifier is and what is the need for a rectifier? So first let's take a look at the evolution of rectifiers.

Evolution of Rectifiers

Rectifiers are mainly classified into three types: Half-wave rectifier, Center tapped full-wave rectifier and Bridge rectifier. All these three rectifiers have a common aim that is to convert Alternating Current (AC) into Direct Current (DC). Not all these three rectifiers efficiently convert the Alternating Current (AC) into Direct Current (DC), only the center tapped full-wave rectifier and bridge rectifier efficiently convert the Alternating Current (AC) into Direct Current (DC).
The rectifier efficiency of a bridge rectifier is almost equal to the center tapped full wave rectifier. The only advantage of bridge rectifier over center tapped full wave rectifier is the reduction in cost. In bridge rectifier, instead of using the center-tapped transformer, four diodes are used.

Bridge Rectifier Construction

The bridge rectifier is made up of four diodes namely D_1, D_2, D_3, D_4 and load resistor R_L. Thefour diodes are connected in a closed loop (Bridge) configuration to efficiently convert the Alternating Current (AC) into Direct Current (DC). The main advantage of this bridge circuit configuration is that we do not require an expensive center tapped transformer, thereby reducing its cost and size.

The input AC signal is applied across two terminals A and B and the output DC signal is obtained across the load resistor R_L which is connected between the terminals C and D. The four diodes D_1, D_2, D_3, and D4 are arranged in series with only two diodes allowing electric current during each half cycle. For example, diodes D_1 and D_3 are considered as one pair allows electric

current during the positive half cycle whereas diodes D_2 and D_4 are considered as another pair which allows electric current during the negative half cycle of the input AC signal.

How Bridge Rectifier works?

When input AC signal is applied across the bridge rectifier, during the positive half cycle diodes D_1 and D_3 are forward biased and allows electric current while the diodes D_2 and $D_4$are reverse biased and blocks electric current. On the other hand, during the negative half cycle diodes D_2 and D_4 are forward biased and allow electric current while diodes D_1 and $D_3$are reverse biased and blocks electric current.

During the positive half cycle, the terminal A becomes positive while the terminal B becomes negative. This causes the diodes D_1 and D_3 forward biased and at the same time, it causes the diodes D_2 and D_4 reverse biased. The current flow direction during the positive half cycle is shown in the figure A (I.e. A to D to C to B).

During the negative half cycle, the terminal B becomes positive while the terminal A becomes negative. This causes the diodes D_2 and D_4 forward biased and at the same time, it causes the diodes D_1 and D_3 reverse biased. The current flow direction during negative half cycle is shown in the figure B (I.e. B to D to C to A).

From the above two figures (A and B), we can observe that the direction of current flow across load resistor R_L is same during the positive half cycle and negative half cycle. Therefore, the polarity of the output DC signal is same for both positive and negative half cycles. The output DC signal polarity may be either completely positive or negative. In our case, it is completely positive. If the direction of diodes is reversed then we get a complete negative DC voltage.

Thus, a bridge rectifier allows electric current during both positive and negative half cycles of the input AC signal. The output waveforms of the bridge rectifier is shown in the below figure.

Advantages of Bridge Rectifiers

The advantages of bridge rectifier are listed below.

Low ripples in the output DC signal

The DC output signal of the bridge rectifier is smoother than the half wave rectifier. In other words, the bridge rectifier has fewer ripples as compared to the half wave rectifier. However, the ripple factor of the bridge rectifier is same as the center tapped full wave rectifier.

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High rectifier efficiency

The rectifier efficiency of the bridge rectifier is very high as compared to the half wave rectifier. However, the rectifier efficiency of bridge rectifier and center tapped full wave rectifier is same.

Low power loss

In half wave rectifier only one half cycle of the input AC signal is allowed and the remaining half cycle of the input AC signal is blocked. As a result, nearly half of the applied input power is wasted.

However, in the bridge rectifier, the electric current is allowed during both positive and negative half cycles of the input AC signal. So the output DC power is almost equal to the input AC power

7805 Voltage Regulator

It is a positive voltage regulator used for providing constant output voltage overa wide range of input voltage. Voltage regulation is referred as the measure of voltagechange between input and output. The IC 7805 does the same thing. It provides constant output voltage when a range of different voltage is applied at the input terminal. This component comes with three terminals called input, ground, and output.This is called positive voltage regulator because it generates positive voltage with respect to the ground terminal. Transistors and voltage regulator IC like 7805 work in a similar way with the intention of providing voltage regulation.

7805 is an IC used for voltage regulation and comes in TO-220 version. This component belongs to 78xx series where xx defines the output voltage it generates. Voltage fluctuation is a common practice during the execution of many electronic projects. This component overcomes and prevents this voltage fluctuation by providing a constant output voltage at the output terminal.

The best part is that it doesn't require any additional components to set output voltage. It is a compact IC that comes with a built-in protection circuit that avoids the circuits from too much heating, making it suitable for circuits drawing high current. The input voltage range applied to the input terminals of this IC varies from 7 V to 18 V (in some cases 7 to 35 V), resulting in the generation of constant output voltage around 5 V.

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You can see, there is a huge difference between input voltage and the output voltage that gets regulated. This difference is discharged as heat. The surge of heat generation can damage the device and affect the overall project performance. There are two ways to overcome this heat generation i.e. you can use a heat sink that is widely used for heat dissipation OR you can limit the input current 2 to 3 V above the regulated voltage at the output terminal. For example, you'll get 5 Vat the output terminal, so itis suitable to limit input voltage within 7 or 8 V.

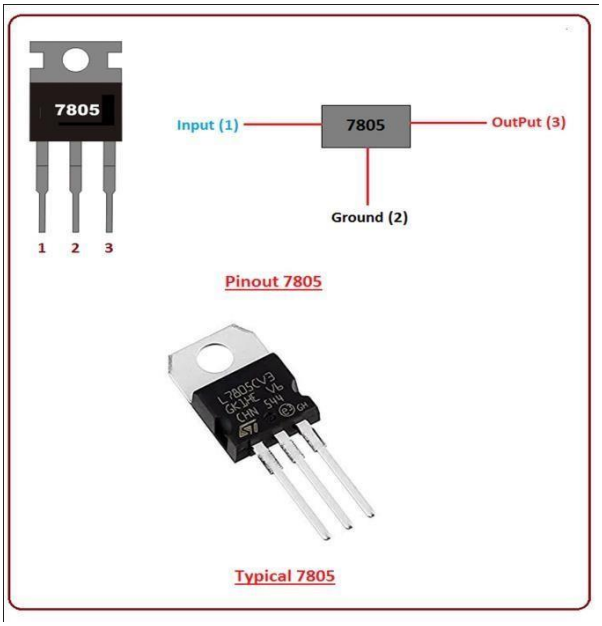

Fig 7 7805 voltage regulator

Heat sink comes in different sizes based on the amount of heat that is required to disperse. Itis advised to calculate the size of heat sink before you put your voltage regulator in operation. With the addition of heat sink, this IC can control output current at around 1.0 A.

This voltage regulator is an ideal choice for the applications where safe area compensation, thermal shutdown, and current limiting are required. This device is designed with the purpose of getting constant output voltage; however, it can be coupled with external components with the intention of generating desired voltage and current. This IC comes with an accurate circuit which generates constant voltage so no capacitors are required to produce smooth output, however, it is advised to place 10µF capacitors in the input and output terminal to remain in the safer side.

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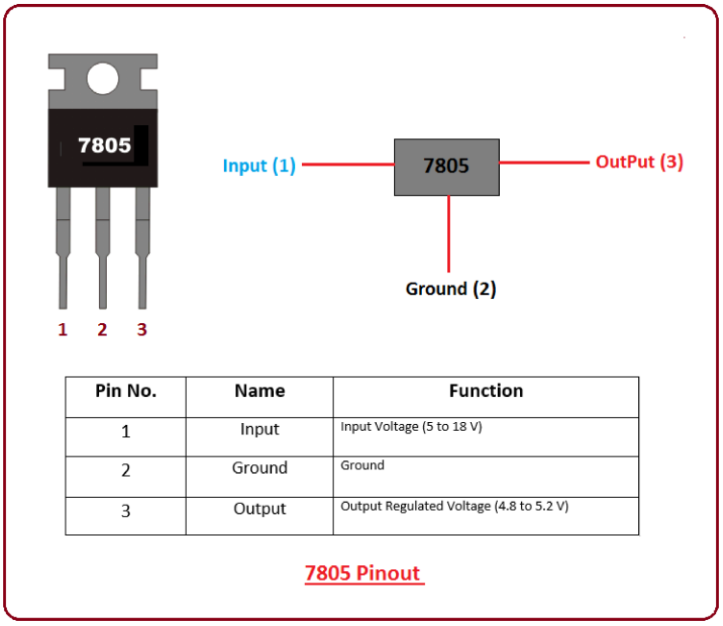
Pinout of 7805

Following figure shows the pinout of this voltage regulator.



Pin No.	Name	Function
1	Input	Input Voltage (5 to 18 V)
2	Ground	Ground
3	Output	Output Regulated Voltage (4.8 to 5.2 V)

7805 Pinout

Fig 8 pinout of 7805

- Pin 1 shows the input voltage applied to this regulator which ranges between 7 to 18 V.
- Pin 2 shows the ground terminal. Voltage regulator generates positive voltage with respect to the ground terminal.
- Pin 3 shows the output terminal where regulated voltage is obtained. Regulated voltage shows the tolerance between 1.5 % to 2 %.
- This regulator has a capacity of controlling output current around 1 A.
- It shows a voltage dropout around 2 V. It is advised to provide minimum 7 V at the input terminal in order to obtain exact 5 V at the output terminal.

Introduction to NodeMCU

The NodeMCU (**N**ode **M**icro **C**ontroller **U**nit) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Exspress if Systems, contains the crucial elements of a computer: CPU, RAM, networking (Wi-Fi), and even a modern operating system and SDK. That makes it an excellentchoice for the Internet of Things (IoT) projects of all kinds.

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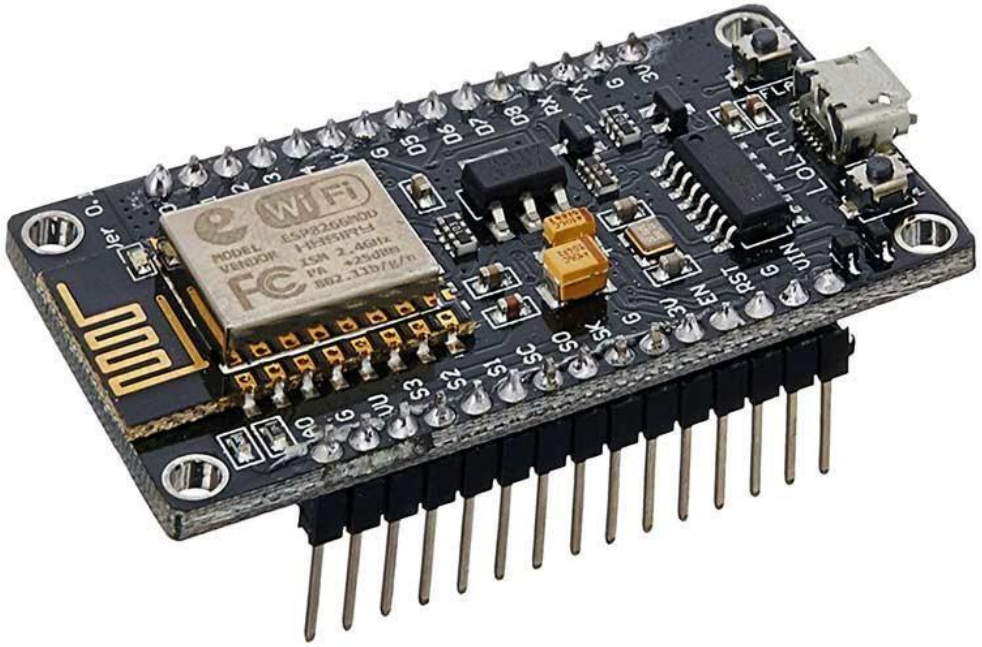

Fig 9 Node MCU

Since NodeMCU is an open-source platform, its hardware design is open for edit/modify/build. NodeMCU Dev Kit/board consists of ESP8266 Wi-Fi enabled chip. The **ESP8266** is a low-cost Wi-Fi chip developed by Espressif Systems with TCP/IP protocol.

Hardware Specification:

The development board equips the ESP-12E module containing ESP8266 chip having **Tensilica Xtensa 32-bit LX106 RISC microprocessor** which operates at **80 to 160 MHz** adjustable clock frequency and supports **RTOS**.

There's also **128 KB RAM and 4MB of Flash memory** (for program and data storage) just enough to cope with the large strings that make up web pages, JSON/XML data, and everything we throw at IoT devices nowadays.

The ESP8266 Integrates **802.11b/g/n HT40 Wi-Fi transceiver**, so it can not only connect to a Wi-Fi network and interact with the Internet, but it can also set up a network of its own, allowing other devices to connect directly to it. This makes the ESP8266 NodeMCU even more versatile.

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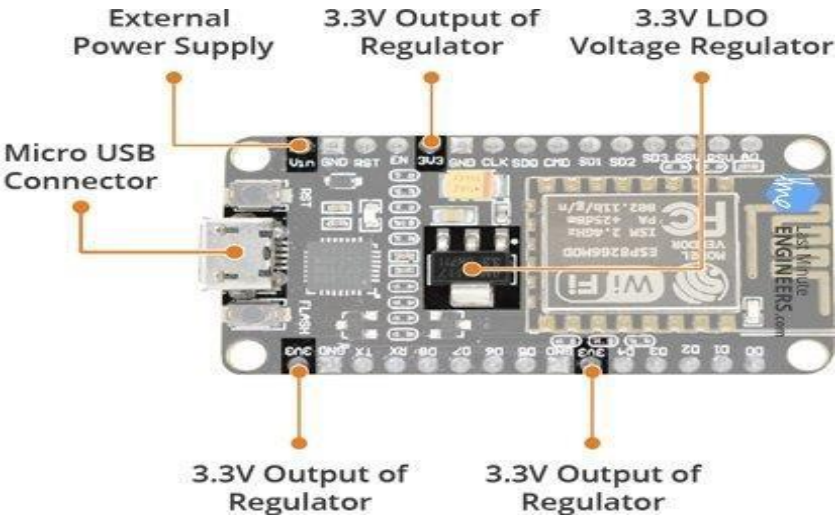
Power Requirements:

As the operating voltage range of ESP8266 is **3V to 3.6V**, the board comes with a LDO voltage regulator to keep the voltage steady at 3.3V. It can reliably supply up to 600mA, which should be more than enough when ESP8266 pulls as much as **80mA during RFtransmissions**. The output of the regulator is also broken out to one of the sides of the board and labelled as 3V3. This pin can be used to supply power to external components.



Power to the ESP8266 NodeMCU is supplied via the **on-board MicroB USB connector**. Alternatively, if you have a regulated 5V voltage source, the **VIN pin** can be used to directly supply the ESP8266 and its peripherals.

Peripherals and I/O:

The ESP8266 NodeMCU has total **17 GPIO pins** broken out to the pin headers on both sides of the development board. These pins can be assigned to all sorts of peripheral duties, including:

- **ADC** channel - A 10-bit ADC channel.
- **UART** interface - UART interface is used to load code serially.
- **PWM** outputs - PWM pins for dimming LEDs or controlling motors.
- **SPI, I2C** interface - SPI and I2C interface to hook up all sorts of sensors and peripherals.

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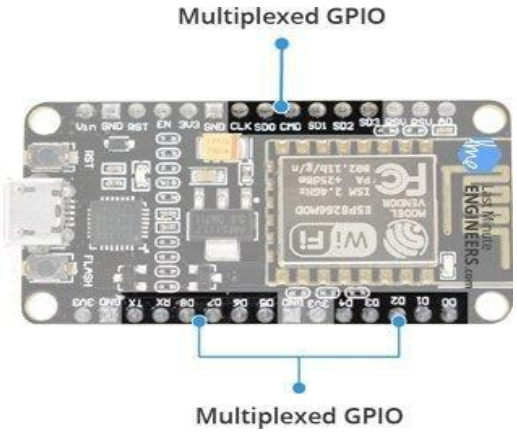
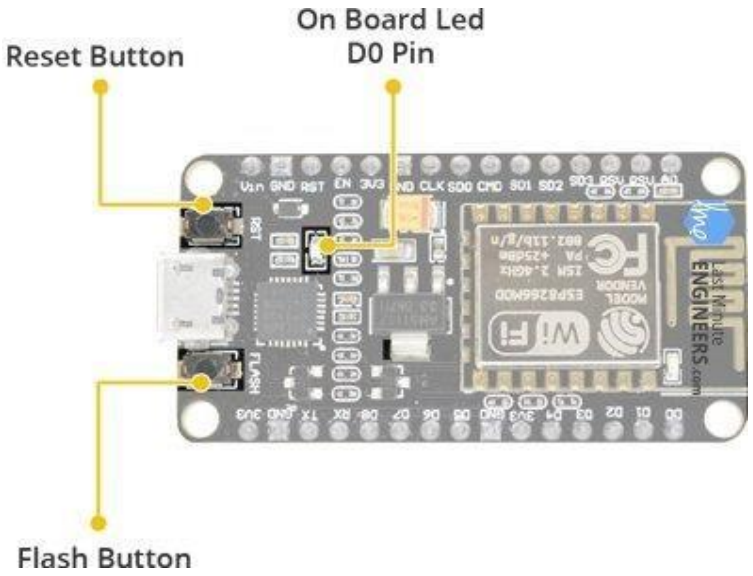


Thanks to the ESP8266's **pin multiplexing feature** (Multiple peripherals multiplexed on a single GPIO pin). Meaning a single GPIO pin can act as PWM/UART/SPI.

On-board Switches and LED Indicator:

The ESP8266 NodeMCU features two buttons. One marked as **RST** located on the top left corner is the Reset button, used of course to reset the ESP8266 chip. The other **FLASH** button on the bottom left corner is the download button used while upgrading firmware.



The board also has a **LED indicator** which is user programmable and is connected to the D0 pin of the board.

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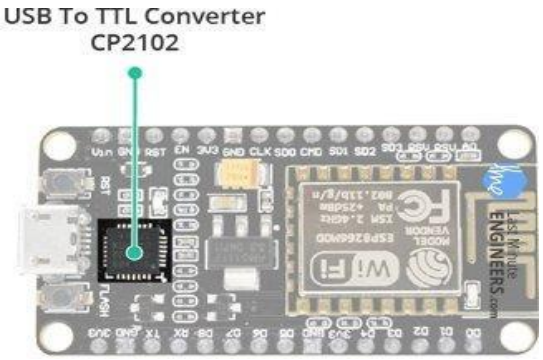
Serial Communication:

The board includes CP2102 USB-to-UART Bridge Controller from Silicon Labs, which converts USB signal to serial and allows your computer to program and communicate with the ESP8266 chip.



ESP8266 NodeMCU PINOUT:

The ESP8266 NodeMCU has total 30 pins that interface it to the outside world. The connections are as follows:

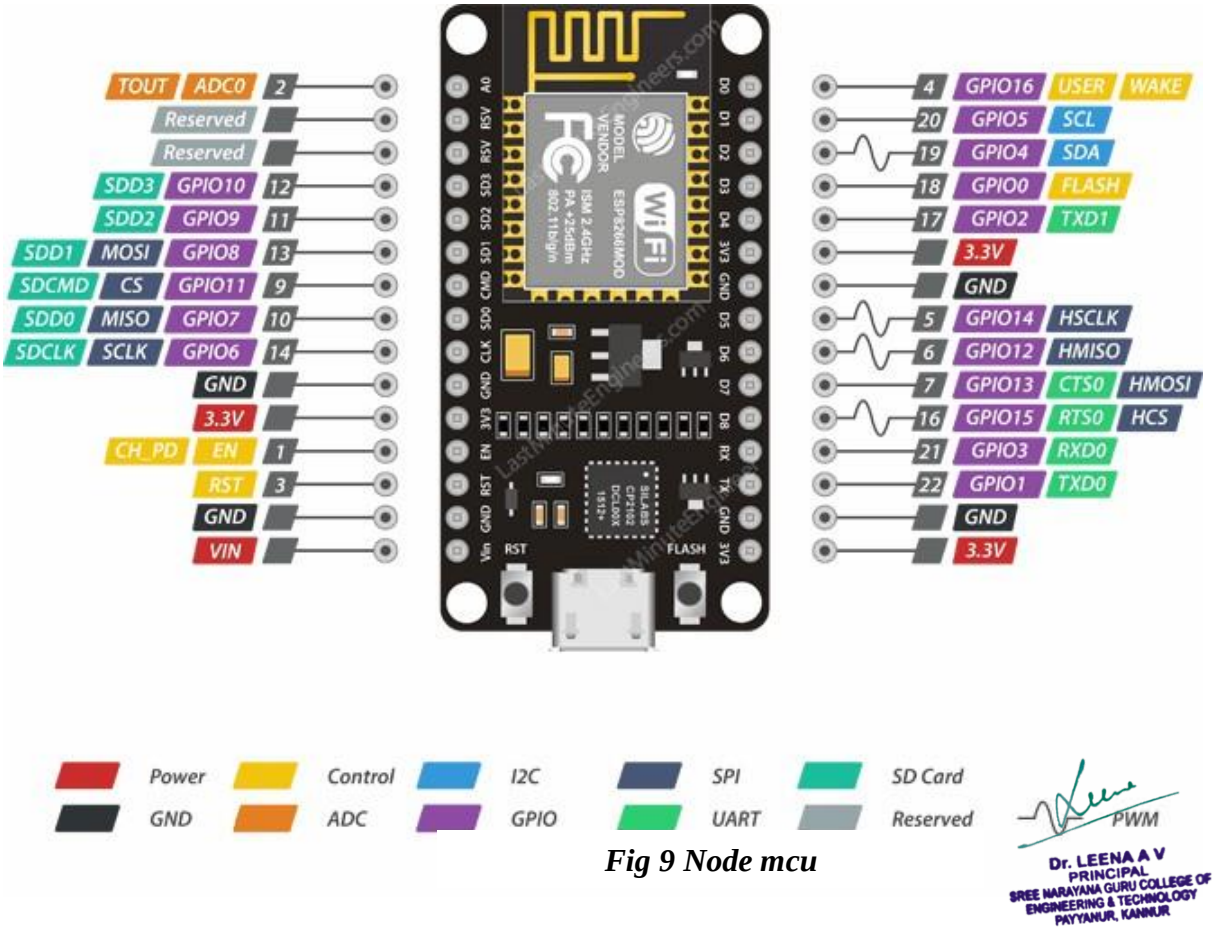


Fig 9 Node mcu

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Power Pins:

There are four power pins. one VIN pin & three 3.3V pins. The VIN pin can be used to directly supply the ESP8266 and its peripherals, if you have a regulated 5V voltage source. The3.3V pins are the output of an on-board voltage regulator. These pins can be used to supply power toexternal components.

GND:

GND is a ground pin of ESP8266 NodeMCU development board.

I2C Pins:

These pins used to hook up all sorts of I2C sensors and peripherals in your projects. Both I2C Master and I2C Slave are supported. I2C interface functionality can be realized programmatically, and the clock frequency is 100 kHz at a maximum.

It should be noted that I2C clock frequency should be higher than the slowest clock frequency of the slave device.

GPIO Pins:

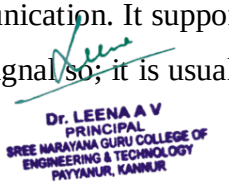
ESP8266 NodeMCU has 17 GPIO pins which can be assigned to various functions such as I2C, I2S, UART, PWM, IR Remote Control, LED Light and Button programmatically. Each digital enabled GPIO can be configured to internal pull-up or pull-down, or set to high impedance. When configured as an input, it can also be set to edge-trigger or level-trigger to generate CPU interrupts.

ADC Channel:

The NodeMCU is embedded with a 10-bit precision SAR ADC. The two functions can be implemented using ADC viz. Testing power supply voltage of VDD3P3 pin and testing input voltage of TOUT pin. However, they cannot be implemented at the same time.

UART Pins:

ESP8266 NodeMCU has 2 UART interfaces, i.e. UART0 and UART1, which provide asynchronous communication (RS232 and RS485), and can communicate at up to 4.5 Mbps. UART0 (TXD0, RXD0, RST0 & CTS0 pins) can be used for communication. It supports fluid control. However, UART1 (TXD1 pin) features only data transmit signal so; it is usually used for printing log.



SPI Pins:

ESP8266 features two SPIs (SPI and HSPI) in slave and master modes. These SPIs also support the following general-purpose SPI features:

- 4 timing modes of the SPI format transfer.
- Up to 80 MHz and the divided clocks of 80 MHz .
- Up to 64-Byte FIFO

SDIO Pins:

ESP8266 features Secure Digital Input/output Interface (SDIO) which is used to directly interface SD cards. 4-bit 25 MHz SDIO v1.1 and 4-bit 50 MHz SDIO v2.0 are supported.

PWM Pins:

The board has 4 channels of Pulse Width Modulation (PWM). The PWM output can be implemented programmatically and used for driving digital motors and LEDs. PWM frequency range is adjustable from 1000 μs to 10000 μs, i.e., between 100 Hz and 1 kHz.

Control Pins:

These are pins used to control ESP8266. These pins include Chip Enable pin (EN), Reset pin (RST) and WAKE pin.

- EN pin – The ESP8266 chip is enabled when EN pin is pulled HIGH. When pulled LOW the chip works at minimum power.
- RST pin – RST pin is used to reset the ESP8266 chip.
- WAKE pin – Wake pin is used to wake the chip from deep-sleep.

Introduction to DC Pumb:

What is a DC Water Pump? A DC water pump is an electric pump with low voltage. They are quiet and use little power. They are used for many applications, including automotive, household, and water wells. Various DC water pumps are available in the market, including the DC Fountain Pump VP30, a five-volt mini water pump perfect for a solar fountain. You can also find DC Submersible Pumps VP30A and VP40A for aquariums, tabletop crafts, and even fish tanks.

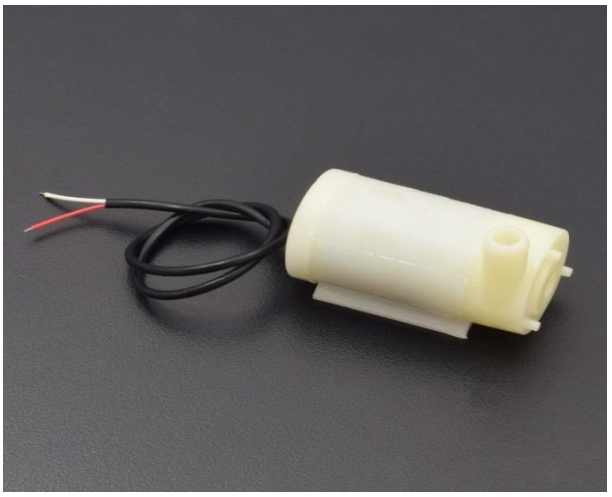


Fig 10 DC pumb

When selecting a small water pump, it's important to check its power consumption. Most pumps draw up to 9.5 amps, so it's important to choose one that matches your power needs. Check that the motor is corrosion-resistant and can withstand multiple freeze-thaw cycles. In addition, the housing should be intact and have no cracks. Finally, choose a pump that comes with a warranty. If a mini water pump fails after just a few years, it may be good to look for a brand that offers a warranty. After-sales support can also help you replace any parts if needed.

DC Water Pump Used For:

DC water pumps are small pumps powered by a battery, dc power supply, or solar panel. Their primary use is to circulate, pressurize, and emulsify liquids. They are particularly useful in environments where water is in short supply. Listed below are some other uses for DC submersible pump. This article will explain the most common applications for DC water pumps.

When purchasing a small water pump, paying attention to its maximum head is important. The max head refers to the maximum water flow rate that the pump can handle. This figure must be higher than the maximum pumping height specified on the label. Often, there is a margin of about five to ten percent between the maximum and normal flow rates. Mini water pumps have a higher maximum flow rate

than other pumps, which means you should choose a pump accordingly. Another important point to remember when purchasing a DC water pump is the power supply. Micro DC pumps are designed to work with low voltage supplies, so they cannot overheat. They can used safely even in locations where the power supply is unstable. Micro DC pumps are also available in a wide range of sizes and types. It's important to understand the differences between these two types andhow each differs from one another.

A DC pump is more efficient and versatile than its AC counterpart. It has a higher life span and can runcompletely off the electricity of the power line. Some advanced designs have brushless motors and magnetically coupled drives. They also have no fans or shaft leakage. There are two main types of DCpumps – the PV and B12 models. The PV models are solar direct. B12 models are design to connect toa 12-volt battery. Both will work, though the PV model will run slightly slower, and the B12 model will need a power source.

DC Pump Working:

Here's the ultimate guide if you're considering buying a DC water pump for your RV. First, consider the size of your RV. A 12 volt DC water pump will run on its built-in 12-volt power system. A large commercial pump requires a 230-volt power supply, while a 12-volt model requires only a 120-volt power source. Both options will require a mini water pump.

To get the proper flow, you'll need to ensure the pump can handle the required amount of water. Make sure the pipe is made of drinking water grade PVC. A pump designed for 24 Volts may have a 3/4-inch outlet. For 12 Volts, you'll need a pump compatible with the smaller pipe size. The difference in size will affect how much water a pump will be able to draw from the tank.

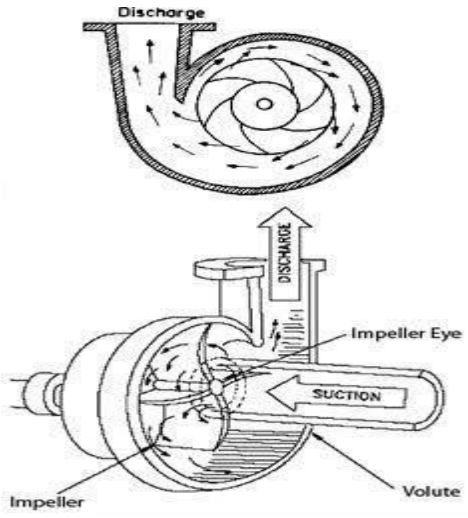


Fig 11 working of DC pumb

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Fortunately, there are many reasons to consider a DC water pump. One major advantage of a **DC submersible pump** is its flexibility of installation. If you have an existing power source, you can easily install a DC submersible pump anywhere. Manufacturers can even install them without needing a dedicated electrical grid. This will increase the flexibility of installation. You can even put one in your RV's water tank! So if you have an RV, now's the perfect time to get one!

INTRODUCTION TO LDR:

LIGHT DEPENDENT RESITOR

Light dependent resistors, LDRs or photo resistors are often used in circuits where it is necessary to detect the presence or the level of light. They can be described by a variety of names from light dependent resistor, LDR, photo resistor, or even photo cell, photocell or photoconductor.

A photo resistor or light dependent resistor is a component that is sensitive to light. When light falls upon it then the resistance changes. Values of the resistance of the LDR may change over many orders of magnitude the value of the resistance falling as the level of light increases. It is not uncommon for the values of resistance of an LDR or photo resistor to be several mega ohms in darkness and then to fall to a few hundred ohms in bright light. With such a wide variation in resistance, LDRs are easy to use and there are many LDR circuits available. The sensitivity of light dependent resistors or photo resistors also varies with the wavelength of the incident light. LDRs are made from semiconductor materials to enable them to have their light sensitive properties. Many materials can be used, but one popular material for these photo resistors is cadmium sulphide, CdS.

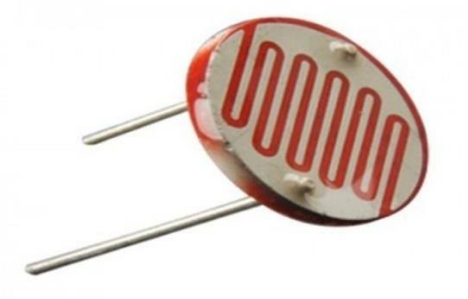
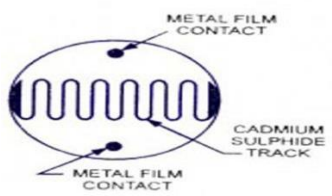


Fig 12 LDR sensor

LDR STRUTURE AND WORKING

The basic structure of an LDR is shown below.



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

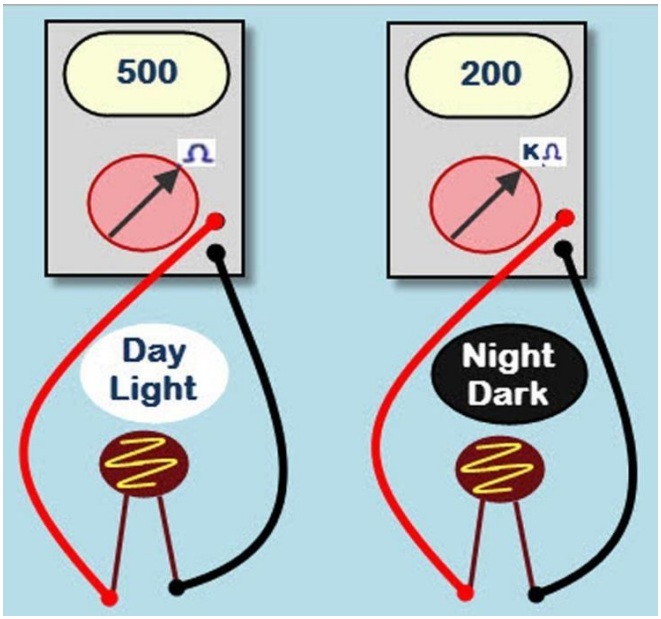

Fig 13Variation of LDR Resistance with Variation in Light Intensity

If a constant "V' is applied to the LDR, the intensity of the light increased and current increases. The figure below shows the curve between resistance Vs illumination curve for a particular light dependent resistor.

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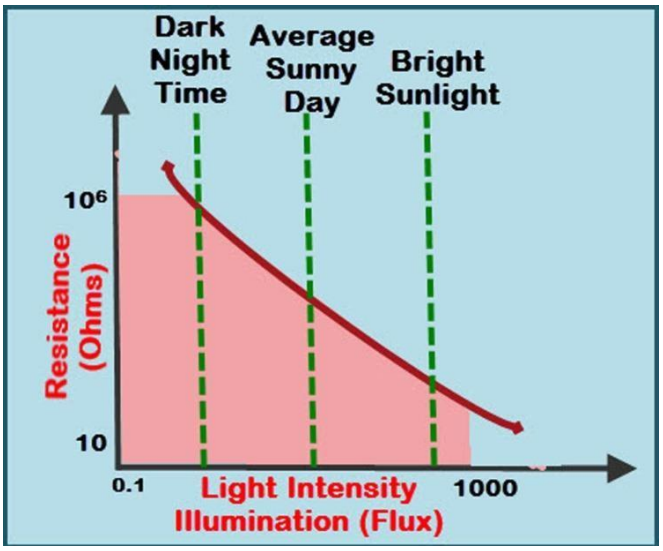

Fig 14 Light Intensity vs LDR Resistances

Types of light Dependent Resistors

Light dependent resistors are classified based on the materials used.

Intrinsic Photo Resistors

These resistors are pure semiconductor devices like silicon or germanium. When the light falls on the LDR, then the electrons get excited from the valence band to the conduction band and number of charge carriers increases.

Extrinsic Photo Resistors

These devices are doped with impurities and these impurities create a new energy bands above the valence band. These bands are filled with electrons. Hence this decrease the band gap and small amount of energy is required in moving them. These resistors are mainly used for long wavelengths.

INTRODUCTION TO RELAY MODULE:

Relay is one kind of electro-mechanical component that functions as a switch. The relay coil is energized by DC so that contact switches can be opened or closed. A single channel 5V relay module generally includes a coil, and two contacts like normally open (NO) and normally closed (NC). This article discusses an overview of the 5V relay module & its working but before going to discuss what is relay module is, first we have to know what is relay and its pin configuration.

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What is a 5V Relay?

A 5v relay is an automatic switch that is commonly used in an automatic control circuit and to control a high-current using a low-current signal. The input voltage of the relay signal ranges from 0 to 5V.

5V Relay Pin Configuration:

The pin configuration of the 5V relay is shown below. This relay includes 5-pins where each pin and its functionality are shown below.

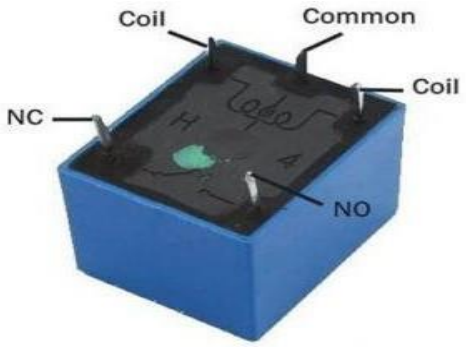

Fig 15 5V Relay

- **Pin1 (End 1):** It is used to activate the relay; usually this pin one end is connected to 5Volts whereas another end is connected to the ground.
- **Pin2 (End 2):** This pin is used to activate the Relay.
- **Pin3 (Common (COM)):** This pin is connected to the main terminal of the Load to make it active.
- **Pin4 (Normally Closed (NC)):** This second terminal of the load is connected to either NC/ NO pins. If this pin is connected to the load then it will be ON before the switch.
- **Pin5 (Normally Open (NO)):** If the second terminal of the load is allied to the NO pin, then the load will be turned off before the switch.

Features:

The **features of the 5V relay** include the following.

- Normal Voltage is 5V DC
- Normal Current is 70mA
- AC load current Max is 10A at 250VAC or 125V AC
- DC load current Max is 10A at 30V DC or 28V DC
- It includes 5-pins & designed with plastic material
- Operating time is 10msec
- Release time is 5msec
- Maximum switching is 300 operating per minute

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5V Relay Module:

The relay module with a single channel board is used to manage high voltage, current loads like solenoid valves, motor, AC load & lamps. This module is mainly designed to interface through different microcontrollers like PIC, Arduino, etc.

5V Relay Module Pin Configuration:

The pin configuration of the 5V relay module is shown below. This module includes 6-pins where each pin and its functionality are discussed below.

Fig 16 Relay Module Pin Diagram

- **Normally Open (NO):** This pin is normally open unless we provide a signal to the relay modules signal pin. So, the common contact pin smashes its link through the NC pin to make a connection through the NO pin
- **Common Contact:** This pin is used to connect through the load that we desire to switch by using the module.
- **Normally Closed (NC):** This NC pin is connected through the COM pin to form a closed circuit. However, this NC connection will break once the relay is switched through providing an active high/low signal toward the signal pin from a microcontroller.
- **Signal Pin:** The signal pin is mainly used for controlling the relay. This pin works in two cases like active low otherwise active high. So, in active low case, the relay activates once we provide an active low signal toward the signal pin, whereas, in an active high case, the relay will trigger once we provide a high signal toward the signal pin.

However, these modules generally work on an active high signal which will strengthen the relay coil to make contact with the common terminal with the normally open terminal.

- **5V VCC:** This pin needs 5V DC to work. So 5V DC power supply is provided to this pin.
- **Ground:** This pin connects the GND terminal of the power supply

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LAMP:

The light bulb is one of the wonders of the modern world. Found nearly everywhere on the planet, light bulbs are so common and widespread that it's easy to forget how dependent we are on them. The light bulb is an electric light source that's technically called a lamp. This term is, of course, also more commonly used by consumers to mean a portable type of lighting such as a table lamp or a desk lamp.

The **most common type of "lamp" or bulb** is the incandescent light bulb. These types of light bulbs are the oldest and simplest form of bulb technology, dating back to Thomas Edison's experiments with filament types back in 1879.

Fig 17 lamp

How Incandescent Bulbs Work?

An incandescent bulb works on **the principle of incandescence**, a general term **meaning light produced by heat**. In an incandescent type of bulb, an electric current is passed through a thin metal filament, heating the filament until it glows and produces light.

So, how do incandescent light bulbs work? Incandescent bulbs typically use a tungsten filament because of tungsten's high melting point. A tungsten filament inside a light bulb can reach temperatures as high as 4,500 degrees Fahrenheit. A glass enclosure, the glass "bulb", prevents oxygen in the air from reaching the hot filament. Without this glass covering and the vacuum it helps create, the filament would overheat and oxidize in a matter or moments.

After the electricity has made its way through the tungsten filament, it goes down another wire and out of the bulb via the metal portion at the side of the socket. It goes into the lamp or fixture and out a neutral wire.

This is an elegantly simple system and it works quite well at producing light. It's perfect for a wide range of applications, cheap and easy to manufacture, and is compatible with either AC or DC current

.

INTRODUCTION TO WATER LEVEL SENSOR

The Water level sensor is used to measure the water content (moisture) . In the presence of water, the module output is at high level; else the output is at low level.

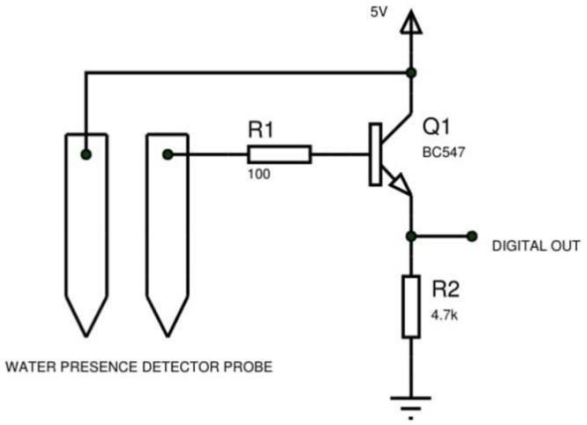

Fig 18 water level sensor

We have used an NPN transistor to detect water presence. . This water presence detector circuit can be used in many applications like Automatic plant irrigation system, Greenhouse projects etc.

Working Explanation:

This Water presence Detector Circuit is very simple. Here we have used a water presence detector probe to sense the water presence and an NPN transistor to get digital output. Working on this circuit is straightforward and clearly understandable. Here we have connected one wire of probe directly to 5V and another probe to the base of the transistor Q1 and 100 ohm resistor is used for the sensitivity of the circuit. Now when there is no water presence then probes does not allow 5V to the base of transistor Q1 so the digital output will be LOW. Now, whenever both probes will come in contact with water then both the probe gets shorted, because water is good conductor of electric current. And when probes get shorted then the base of the transistor gets 5V.

As we know when we apply some voltage to the base of an **NPN Transistor** it gets turn on and allow current to pass through the collector to emitter. And as soon as transistor turns on and digital output will be HIGH.

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INTRODUCTION TO SERVO MOTOR

A servo motor is a type of motor that can rotate with great precision. Normally this type of motor consists of a control circuit that provides feedback on the current position of the motor shaft, this feedback allows the servo motors to rotate with great precision. If you want to rotate an object at some specific angles or distance, then you use a servo motor. It is just made up of a simple motor which runs through a servo mechanism. If motor is powered by a DC power supply then it is called DC servo motor, and if it is AC-powered motor then it is called AC servo motor. For this tutorial, we will be discussing only about the DC servo motor working. Apart from these major classifications, there are many other types of servo motors based on the type of gear arrangement and operating characteristics. A servo motor usually comes with a gear arrangement that allows us to get a very high torque servo motor in small and lightweight packages. Due to these features, they are being used in many applications like toy car, RC helicopters and planes, Robotics, etc.

Servo motors are rated in kg/cm (kilogram per centimeter) most hobby servo motors are rated at 3kg/cmor 6kg/cm or 12kg/cm. This kg/cm tells you how much weight your servo motor can lift at a particular distance. For example: A 6kg/cm Servo motor should be able to lift 6kg if the load is suspended 1cm away from the motors shaft, the greater the distance the lesser the weight carrying capacity. The position of a servo motor is Servo Motor Working Mechanism

It consists of three parts:

1. Controlled device
2. Output sensor
3. Feedback system

It is a closed-loop system where it uses a positive feedback system to control motion and the final position of the shaft. Here the device is controlled by a feedback signal generated by comparing output signal and reference input signal.

Here reference input signal is compared to the reference output signal and the third signal is produced by the feedback system. And this third signal acts as an input signal to the control the device. This signal is present as long as the feedback signal is generated or there is a difference between the reference input signal and reference output signal. So the main task of servomechanism is to maintain the output of a system at the desired value at presence of noises.

Servo Motor Working Principle

A servo consists of a Motor (DC or AC), a potentiometer, gear assembly, and a controlling circuit. First of all, we use gear assembly to reduce RPM and to increase torque of the motor. Say at initial position of servo motor shaft, the position of the potentiometer knob is such that there is no electrical signal generated at the output port of the potentiometer. Now an electrical signal is given to another input terminal of the error detector amplifier. Now the difference between these two signals, one comes from the potentiometer and another comes from other sources, will be processed in a feedback mechanism and output will be provided in terms of error signal. This error signal acts as the input for motor and motor starts rotating. Now motor shaft is connected with the potentiometer and as the motor rotates so the potentiometer and it will generate a signal. So as the potentiometer's angular position changes, its output feedback signal changes. After sometime the position of potentiometer reaches at a position that the output of potentiometer is same as external signal provided. At this condition, there will be no output signal from the amplifier to the motor input as there is no difference between external applied signal and the signal generated at potentiometer, and in this situation motor stops rotating.

Interfacing Servo Motors with Microcontrollers:

Interfacing hobby Servo motors like s90 servo motor with MCU is very easy. Servos have three wires coming out of them. Out of which two will be used for Supply (positive and negative) and one will be used for the signal that is to be sent from the MCU. An MG995 Metal Gear Servo Motor which is most commonly used for RC cars humanoid bots etc. The picture of MG995 is shown below:

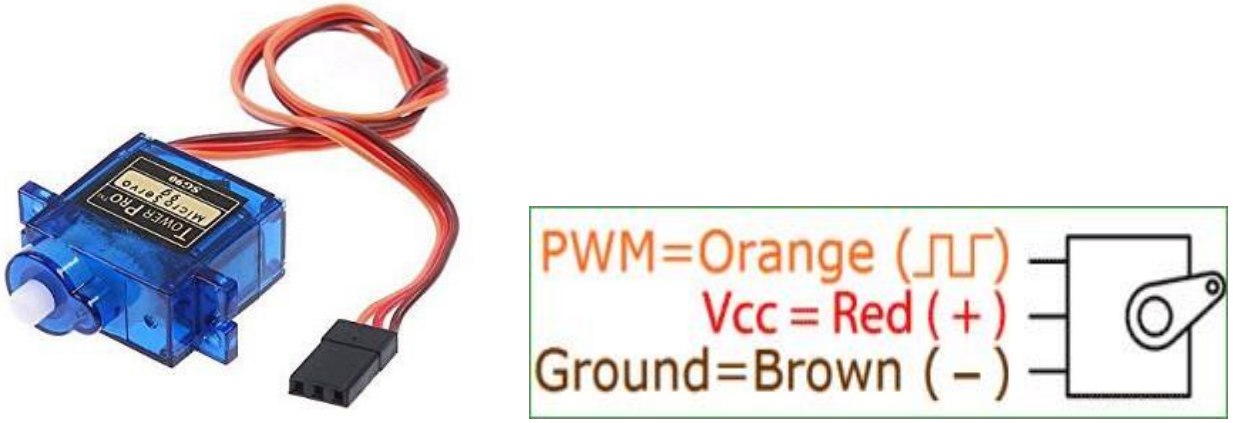


Fig 19 servo motor

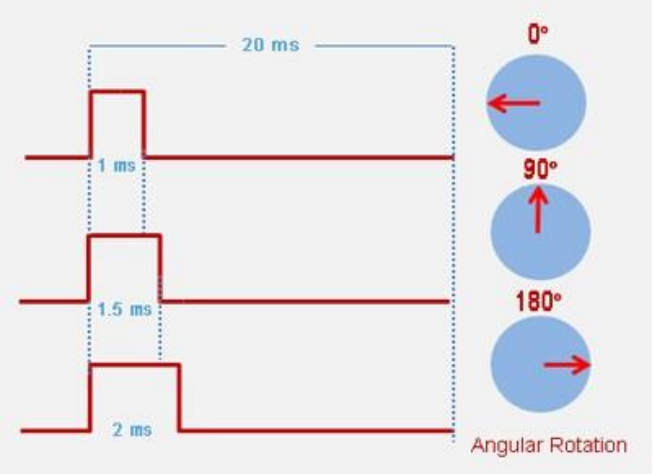
The color coding of your servo motor might differ hence check for your respective datasheet.All servo motors work directly with your +5V supply rails but we have to be careful on the amount of current the motor would consume if you are planning to use more than two servo motors a proper servo shield should be designed.

Controlling Servo Motor:

All motors have three wires coming out of them. Out of which two will be used for Supply (positive and negative) and one will be used for the signal that is to be sent from the MCU.

Servo motor is controlled by PWM (Pulse with Modulation) which is provided by the control wires. There is a minimum pulse, a maximum pulse and a repetition rate. Servo motor can turn 90 degree from either direction form its neutral position. The servo motor expects to see a pulse every 20 milliseconds (ms) and the length of the pulse will determine how far the motor turns. For example, a 1.5ms pulse will make the motor turn to the 90° position, such as if pulse is shorter than 1.5ms shaft moves to 0° and if it is longer than 1.5ms than it will turn the servo to 180°.Servo motor works on PWM (Pulse width modulation) principle, means its angle of rotation is controlled by the duration of applied pulse to its Control PIN. Basically servo motor is made up of DCmotor which is controlled by a variable resistor (potentiometer) and some gears. High speed force of DC motor is converted into torque by Gears. We know that WORK= FORCE X DISTANCE, in DC motor Force is less and distance (speed) is high and in Servo, force is High and distance is less The potentiometer is connected to the output shaft of the Servo, to calculate the angle and stop the DC motor on the required angle.

Servo motor can be rotated from 0 to 180 degrees, but it can go up to 210 degrees, depending on the manufacturing. This degree of rotation can be controlled by applying the **Electrical Pulse** of proper width, to its Control pin. Servo checks the pulse in every 20 milliseconds. The pulse of 1 m s (1 millisecond) width can rotate the servo to 0 degrees, 1.5ms can rotate to 90 degrees (neutral position) and 2 m s pulse can rotate it to 180 degree. All servo motors work directly with your +5V supply rails but we have to be careful about the amount of current the motor would consume if you are planning to use more than two servo motors a proper servo shield should be designed.



BUZZER:

A buzzer is an audio signaling device which may be mechanical, electrical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of user input such as a mouse click or keystroke. A buzzer takes some sort of input and emits a sound in response to it. They may use various means to produce the sound; everything from metal clappers to electromechanical devices.

A buzzer needs to have some way of taking in energy and converting it to acoustic energy. Many buzzers are part of a larger circuit and take their power directly from the device's power source. In other cases, however, the buzzer may be battery powered so that it will go off in the event of a mains outage. Some devices that provide emergency power have buzzers on them so that the user knows that they are running on backup power and not on mains power.

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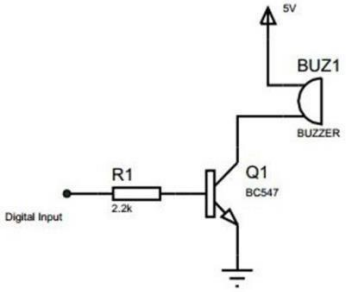
Circuit diagram of Buzzer is given below;



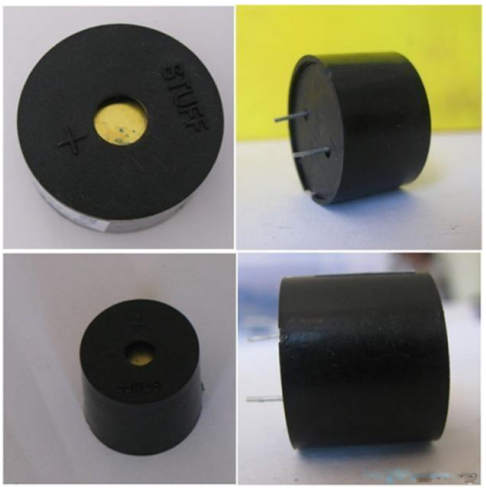


Figure 20 buzzer

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LED (LIGHT EMITTING DIODE):

A light-emitting diode (LED) is a semiconductor light source. LEDs are used as indicator lamps in many devices, and are increasingly used for lighting. Introduced as a practical electronic component in 1962,[2] early LEDs emitted low-intensity red light, but modern versions are available across the visible, ultraviolet and infrared wavelengths, with very high brightness. When a light-emitting diode is forward biased (switched on), electrons are able to recombine with holes within the device, releasing energy in the form of photons. This effect is called electroluminescence and the color of the light (corresponding to the energy of the photon) is determined by the energy gap of the semiconductor. An LED is usually small in area (less than 1 mm2), and integrated optical components are used to shape its radiation pattern and assist in reflection.[3] LEDs present many advantages over incandescent light sources including lower energy consumption, longer lifetime, improved robustness, smaller size, faster switching, and greater durability and reliability. LEDs powerful enough for room lighting are relatively expensive and require more precise current and heat management than compact fluorescent lamp sources of comparable output.

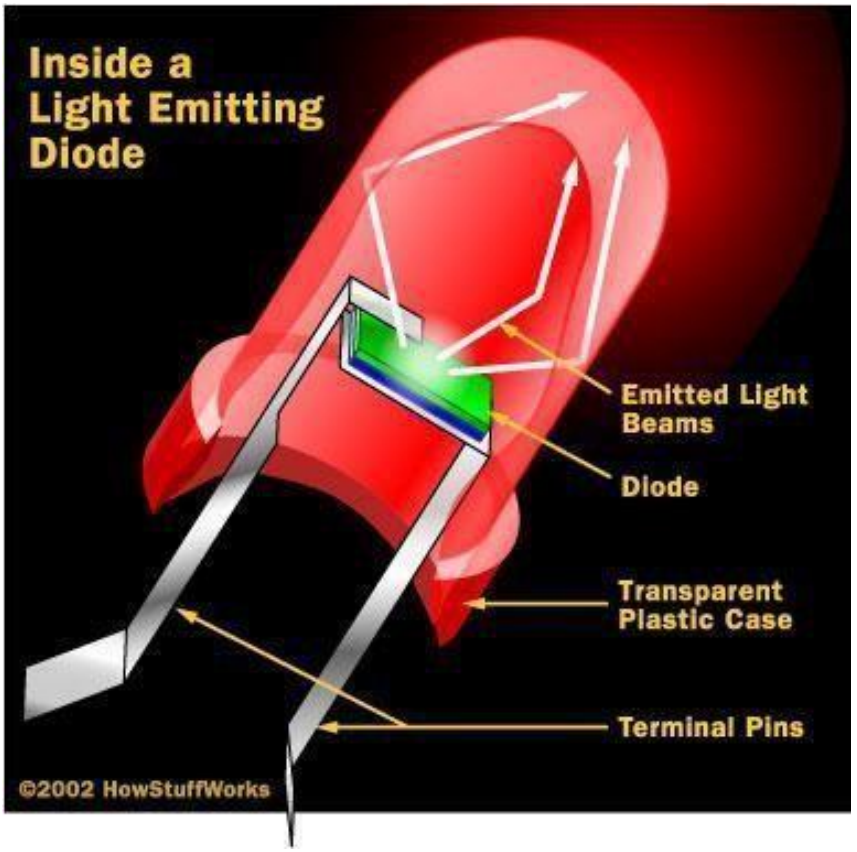

***Fig** 20 LED*

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INTRODUCTION TO IoT:

The 'Thing' in IoT can be any device with any kind of built-in-sensors with the ability to collect and transfer data over a network without manual intervention. The embedded technology in the object helps them to interact with internal states and the external environment, which in turn helps in decisions making process.

In a nutshell, IoT is a concept that connects all the devices to the internet and let them communicate with each other over the internet. IoT is a giant network of connected devices – all of which gather and share data about how they are used and the environments in which they are operated .By doing so, each of your devices will be learning from the experience of other devices, as humans do. IoT is trying to expand the interdependence in human- i.e. *interact*, *contribute* and c*ollaborate* to things. I know this sounds a bit complicated, let's understand this with an example.

A room temperature sensor gathers the data and sends it across the network, which is then used by multiple device sensors to adjust their temperatures accordingly. For example, refrigerator's sensor can gather the data regarding the outside temperature and accordingly adjust the refrigerator's temperature. Similarly, your air conditioners can also adjust its temperature accordingly. This is how devices can interact, contribute & collaborate.

Benefits of IoT

Since IoT allows devices to be controlled remotely across the internet, thus it created opportunities to directly connect & integrate the physical world to the computer-based systems using sensors and internet. The interconnection of these multiple embedded devices will be resulting in automation in nearly all fields and also enabling advanced applications. This is resulting in improved accuracy, efficiency and economic benefit with reduced human intervention. It encompasses technologies such as smart grids, smart homes, intelligent transportation and smart cities. The major benefits of IoT are:

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- **Improved Customer Engagement** – IoT improves customer experience by automating the action. For e.g. any issue in the car will be automatically detected by the sensors. The driver, as well as the manufacturer, will be notified about it. Till the time driver reaches the service station, the manufacturer will make sure that the faulty part is available at the service station.
- **Technical Optimization** – IoT has helped a lot in improving technologies and making them better. The manufacturer can collect data from different car sensors and analyze them to improve their design and make them much more efficient.
- **Reduced Waste** – Our current insights are superficial, but IoT provides real-time information leading to effective decision making & management of resources. For example, if a manufacturer finds fault in multiple engines, he can track the manufacturing plant of those engines and can rectify the issue with manufacturing belt.

Nowadays, we are surrounded by lots of IoT enabled devices which are continuously emitting data and communicating through multiple devices.

Components used in IoT

There are four main components used in IoT:

1. **Low power embedded systems**

   Less battery consumption, high performance is the inverse factors play a significant role during the design of electronic systems.

2. **Cloud Computing**

   Data collected through IoT devices is massive and this data has to be stored on a reliable storage server. This is where cloud computing comes into play. The data is processed and learned, giving more room for us to discover where things like electrical faults/errors are within the system.

3. **Availability of Big Data**

   We know that IoT relies heavily on sensors, especially real-time. As these electronic devices spread throughout every field, their usage is going to trigger a massive flux of big data.

4. **Network Connection**

   In order to communicate, internet connectivity is a must where each physical object is represented by an IP address. However, there are only a limited number of addresses available according to the IP naming. Due to the growing number of devices, this naming system will not be feasible anymore. Therefore, researchers are looking for another alternative naming system to represent each physical object.

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Applications of IoT

Energy Applications: The energy rates have raised to a great instinct. Individuals and organizations, both are searching ways to reduce and control the consumption. IoT provides a way to not only monitor the energy usage at the appliance-level but also at the house-level, grid level or could be at the distribution level. Smart Meters & Smart Grid are used to monitor energy consumption. It also detects threats to the system performance and stability, which protect appliances from downtime and damages.

Healthcare Application: Smart watches and fitness devices have changed the frequency of health monitoring. People can monitor their own health at regular intervals. Not only this, now if a patient is coming to the hospital by ambulance, by the time he or she reaches the hospital his health report is diagnosed by doctors and the hospital quickly starts the treatment. The data gathered from multiple healthcare applications are now collected and used to analyze different disease and find its cure.

Education: IoT provides education aids which helps in fulfilling the gaps in the education industry. It not only improves the quality of education but also optimizes the cost and improves the management by taking into consideration students response and performance.

Government: Governments are trying to build smart cities using IoT solutions. IoT enhances armed force systems and services. It provides better security across the borders through inexpensive & high-performance devices. IoT helps government agencies to monitor data in real-time and improve their services like healthcare, transportation, education etc.

Air and Water Pollution: Through various sensors, we can detect the pollution in the air and water by frequent sampling. This helps in preventing substantial contamination and related disasters. IoT allows operations to minimize the human intervention in farming analysis and monitoring. Systems automatically detect changes in crops, soil, environment, and more.

Transportation: IoT has changed the transportation sector. Now, we have self-driving cars with sensors, traffic lights that can sense the traffic and switch automatically, parking assistance, giving us the location of free parking space etc. Also, various sensors in your vehicle indicate you about the current status of your vehicle, so that you don’t face any issues while travelling.

Marketing your product: Using IoT, organizations can better analyze & respond to customer preferences by delivering relevant content and solutions. It helps in improving business strategies .

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CHAPTER 4

CIRCUIT DIAGRAM

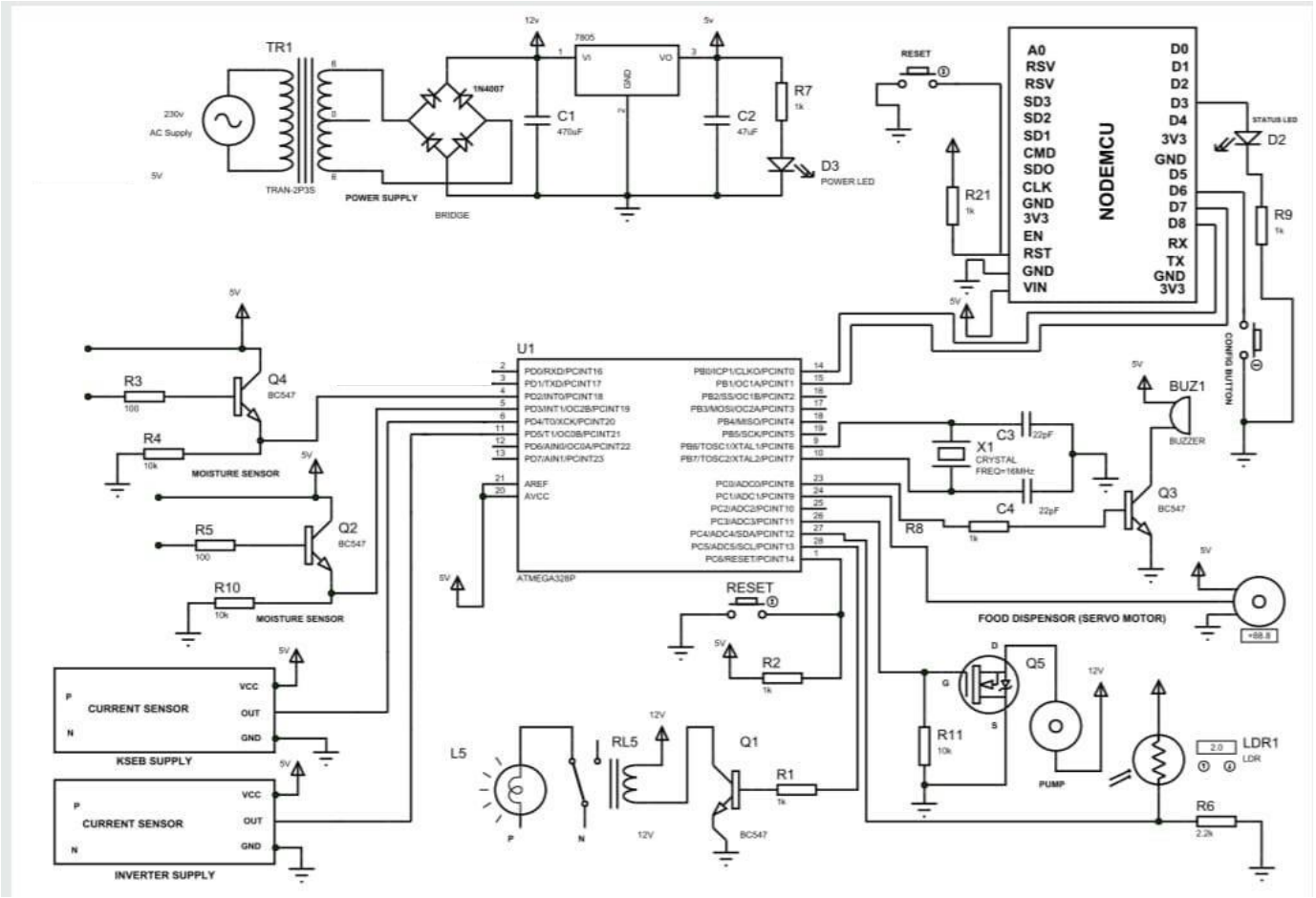

Fig 21 circuit diagram

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CHAPTER 5

WORKING

The prototype is designed for fish farmers, the system is connected with different sensors such as current sensor, LDR,Water level sensors. These sensors are connected to microcontroller ATMega328. And send the sensor data to Node MCU controller which have built in Wi-Fi module , so it can share the sensor data to firebase real-time database. From the firebase the android application can collect the data and show it to users. Similarly user can control the feeder servo by clicking the open feeder button in android application and by setting the clock timer in application. There is a lamp installed in the system that will turn on when the LDR sensor value is less than 200 and will turn off otherwise.

The android application will alert the user when the KSEB current status is OFF as well as Inverter current is low. Also the history of current status will also show in application that will be great help for famers to turn on generator accordingly to maintain the air flow pump to keeps on to maintaindissolved oxygen in the fish tank.

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CHAPTER 6

SOFTWARE SECTION

INTRODUCTION TO ARDUINO IDE

Here we are discussing about Introduction **to Arduino IDE** where IDE stands for Integrated Development Environment – official software introduced by Arduino.cc, that is mainly used for writing, compiling and uploading the code in the Arduino Device. Almost all Arduino modules are compatible with this software that is an open source and is readily available to install and start compiling the code on the go.

Introduction

Arduino IDE is open source software that is mainly used for writing and compiling the code into the Arduino Module. It is official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process. It is easily available for operating systems like MAC, Windows, Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role for debugging, editing and compiling the code in the environment. A range of Arduino modules available including Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino Micro and many more. Each of them contains a microcontroller on the board that is actually programmed and accepts the information in the form of code.

The main code, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and uploaded in the controller on the board. The IDE environment mainly contains two basic parts: Editor and Compiler where former is used for writing the required code and later is used for compiling and uploading the code into the given Arduino Module. This environment supports both C and C++ languages.

The IDE environment is mainly distributed into three sections

1. Menu Bar
2. Text Editor
3. Output Panel

As you download and open the IDE software, it will appear like an image below.

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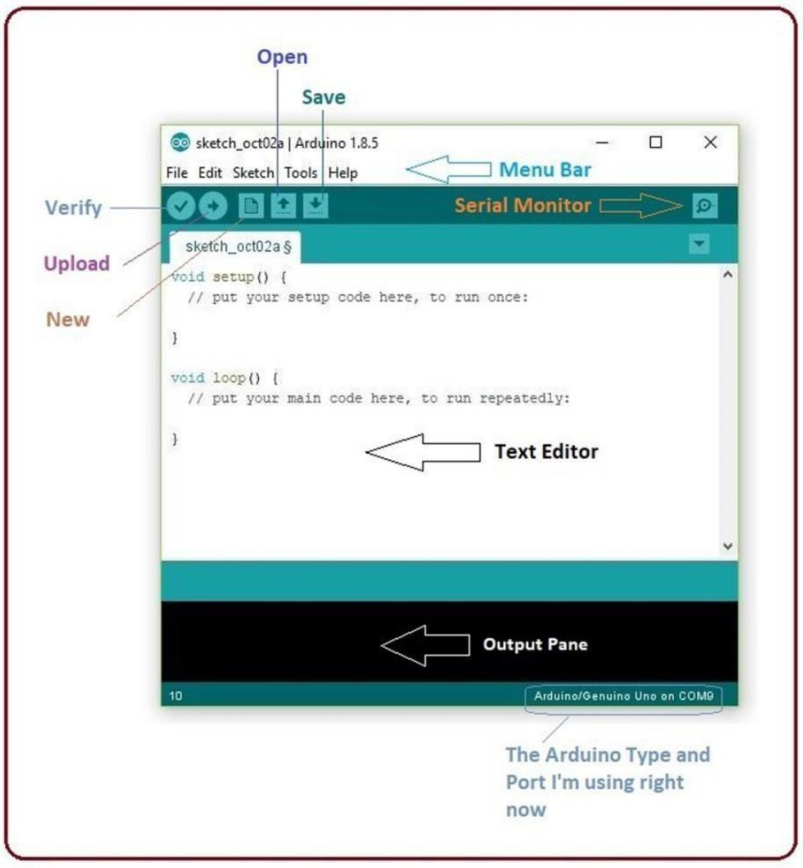
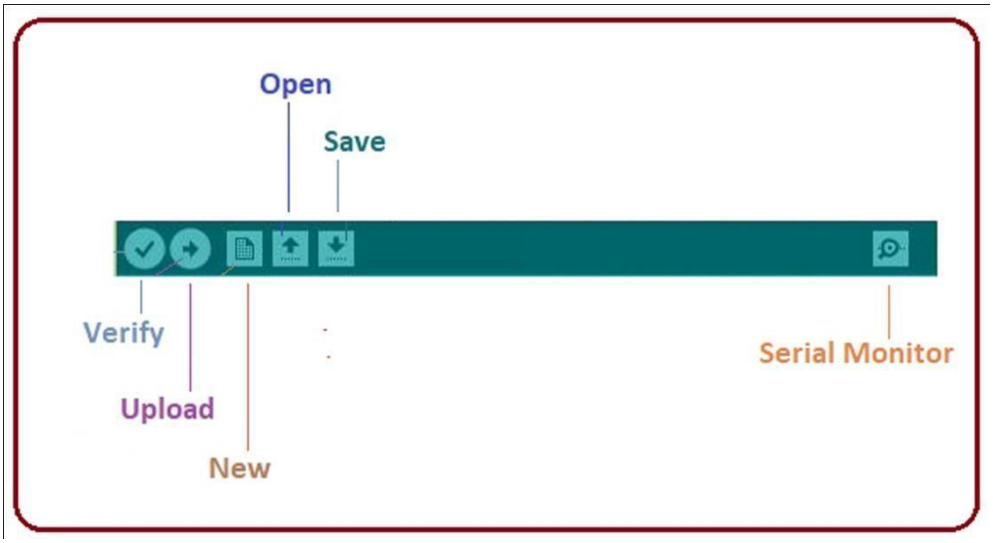


Fig 23 IDE software

The **Six Buttons** appearing under the Menu tab are connected with the running program as follow.



- The check mark appearing in the circular button is used to verify the code. Click this once you have written your code.
- The arrow key will upload and transfer the required code to the Arduino board.
- The dotted paper is used for creating a new file.
- The upward arrow is reserved for opening an existing Arduino project.

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- The downward arrow is used to save the current running code.
- The button appearing on the top right corner is a **Serial Monitor** – A separate pop-up window that acts as an independent terminal and plays a vital role for sending and receiving the Serial Data. You can also go to the Tools panel and select Serial Monitor, or pressing Ctrl+Shift+M all at once will open it instantly. The Serial Monitor will actually help to debug the written Sketches where you can get a hold of how your program is operating. Your Arduino Module should be connected to your computer by USB cable in order to activate the Serial Monitor.
- You need to select the baud rate of the Arduino Board you are using right now. For my Arduino Uno Baud Rate is 9600, as you write the following code and click the Serial Monitor, the output will show as the image below.

MIT APP INVENTOR

App Inventor for Android is an open-source web application originally provided by Google, and now maintained by the Massachusetts Institute of Technology (MIT).

It allows newcomers to computer programming to create software applications for the Android operating system (OS). It uses a graphical interface, very similar to Scratch and the Star Logo TNG user interface, which allows users to drag-and-drop visual objects to create an application that can run on Android devices. In creating App Inventor, Google drew upon significant prior research in educational computing, as well as work done within Google on online development environments.

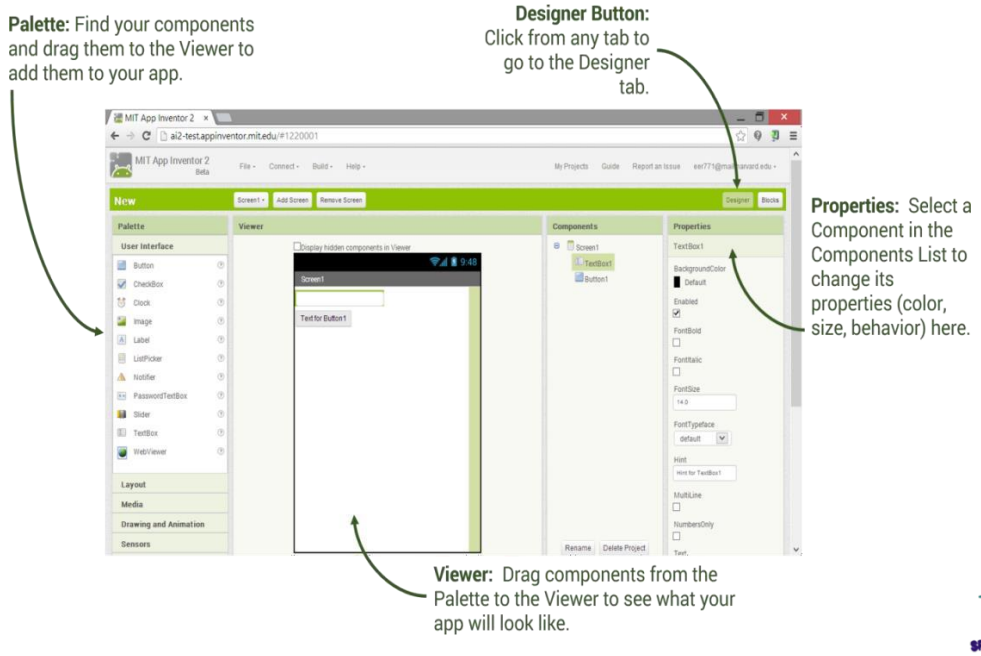

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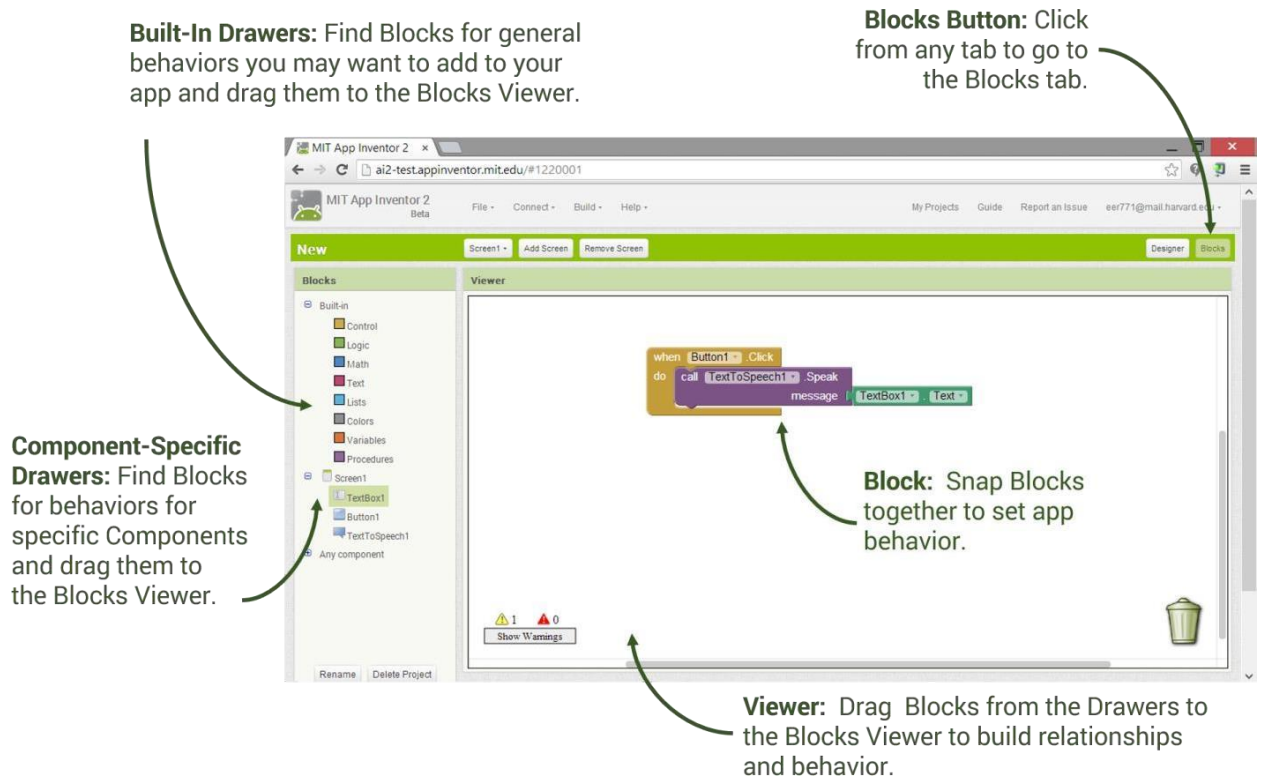
Fig 23 MIT app inventor



MIT App Inventor is basically for creating Android Apps in your browser where you design how the app will look and function. Like fitting together puzzle pieces, you set how your app will behave to different events by simply signing in with your Gmail Account, so that the App Inventor server can store your work and help you keep track of projects.

It basically consists of two parts

1. App Inventor Designer
2. App Inventor Block Editor

In **App Inventor Designer** you select the components for your app while in **App Inventor Block Editor** you assemble program blocks that specify how the components should behave visually, fitting pieces together like pieces of a puzzle. After completing the above phases you may run your app directly in your Android phone by connecting it to your computer or may run it on Android Emulator if you don't have an Android phone. Moreover you may even download your app (.apk file) and install and run it on your Android device directly.The figure below shows an overview of how **MIT App Inventor** works!

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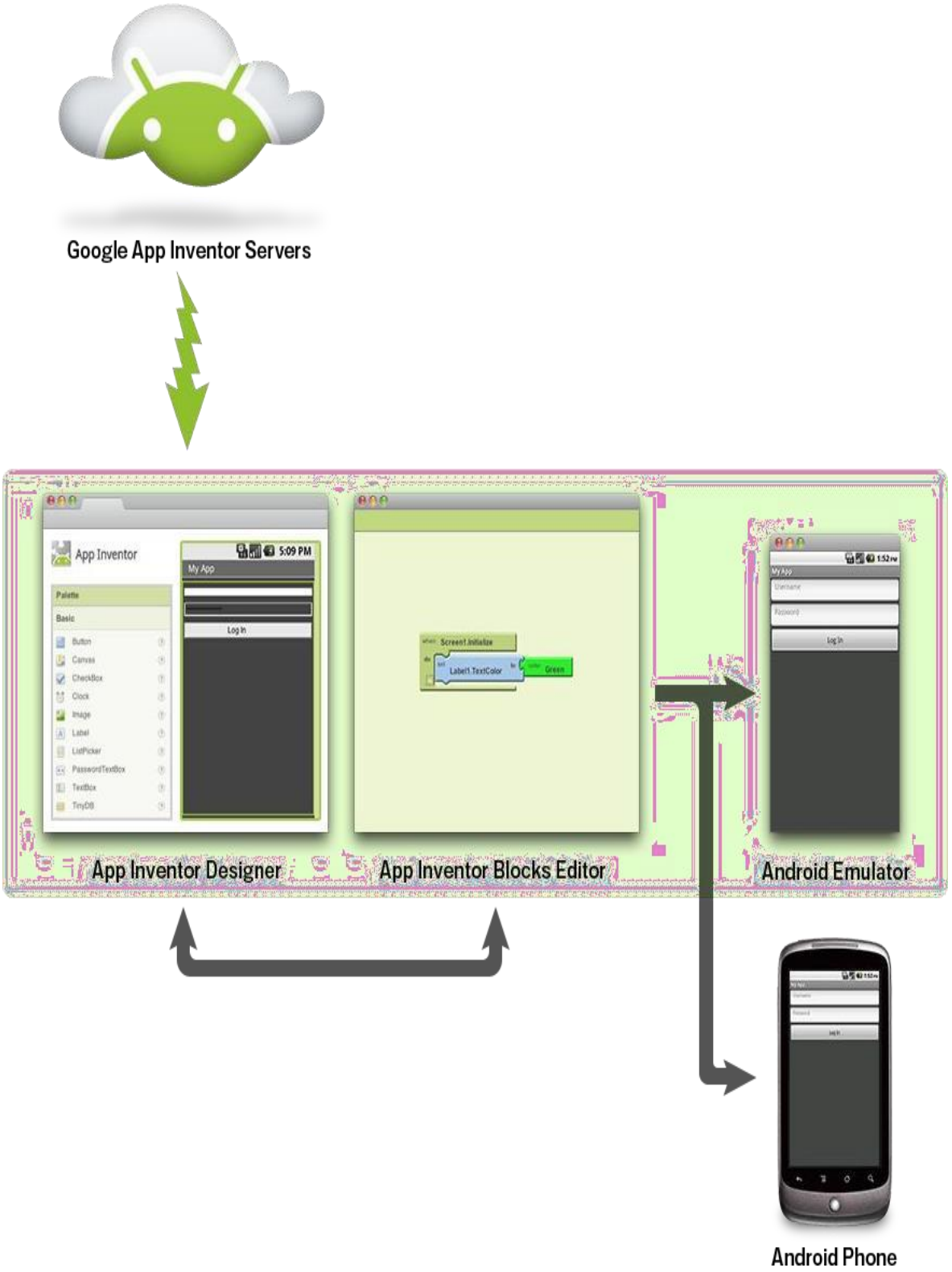

Fig 24 working of MIT app inventor

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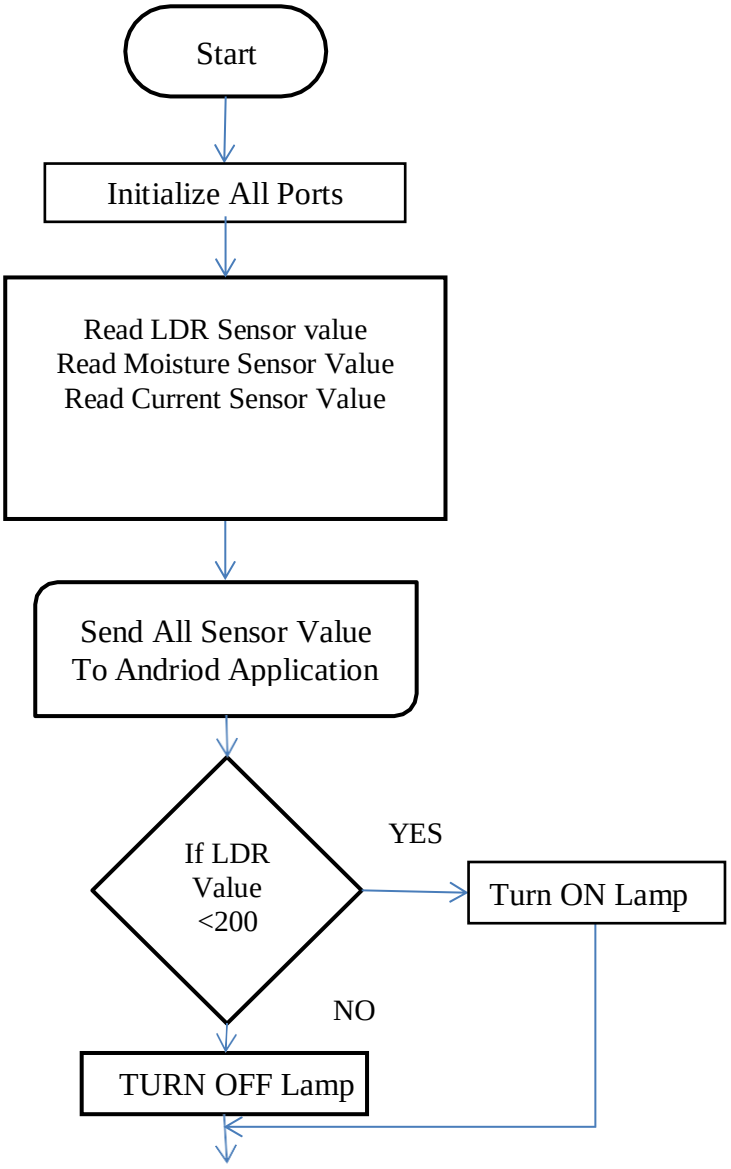
FLOW DIAGRAM



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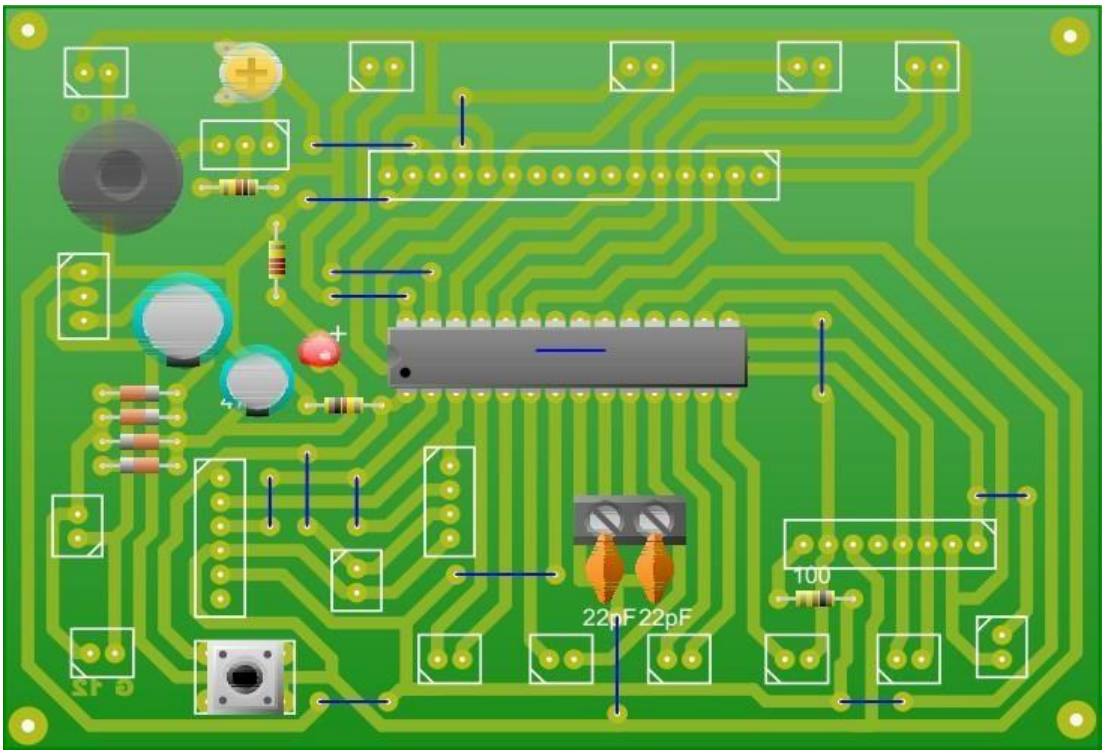
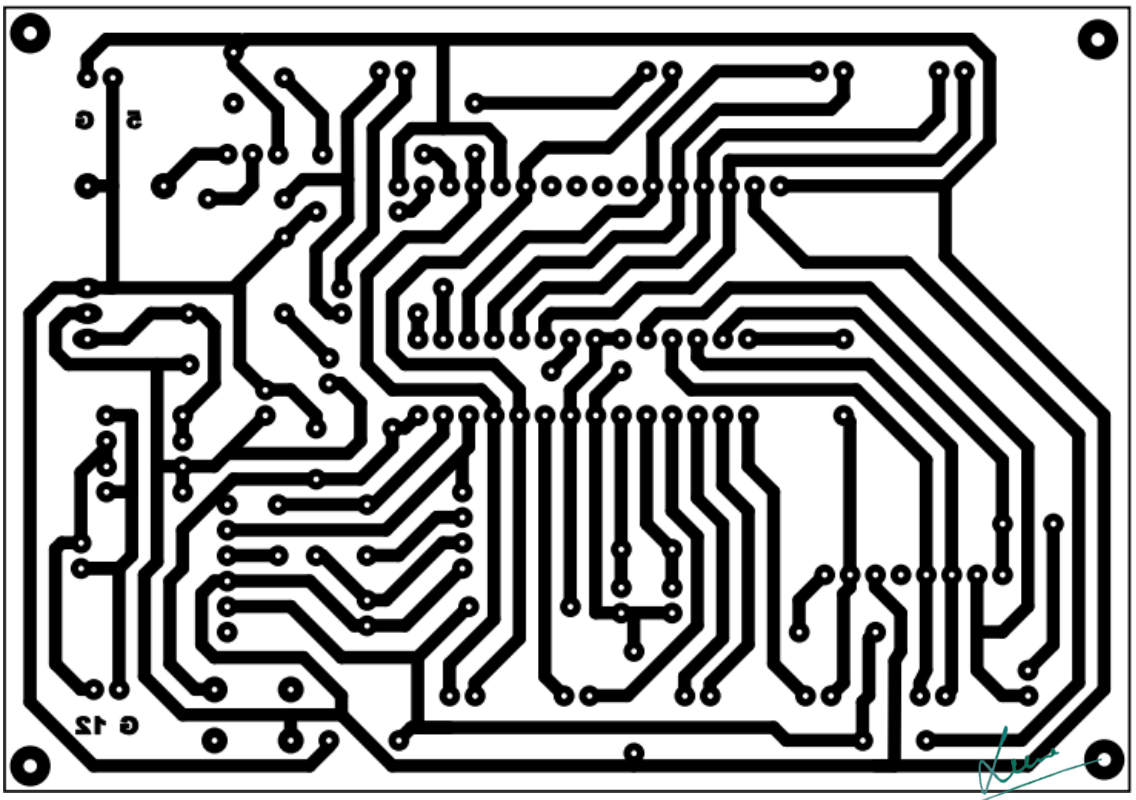
CHAPTER 7

PCB DESIGN & FABRICATION





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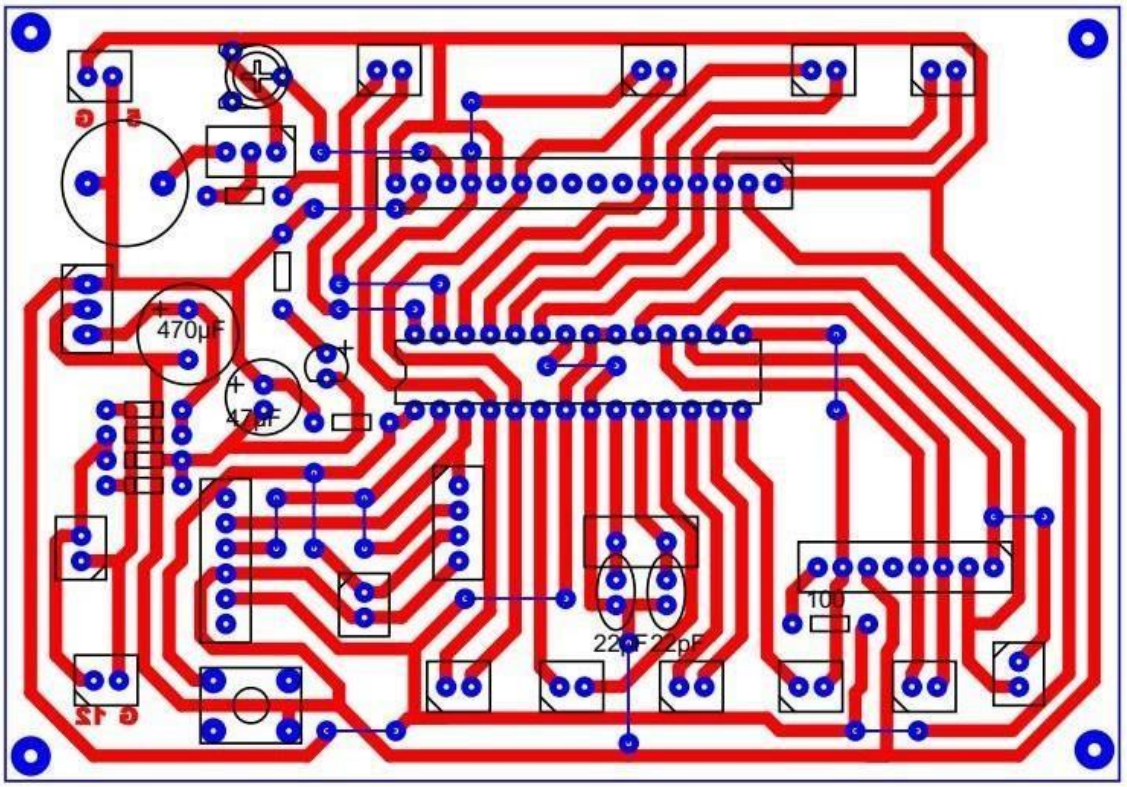

Fig 25 PCB design

Design of printed circuit board (PCB) can be considered as the last step in electronic circuit design as well as the first step in production. It plays important role in the performance and reliability of electronic circuits, the productivity of the PCB's its assembling, and its service ability depends on design. All these factors get reflected in a piece of electronic equipment. It is clear that task of PCB design is not very simple or always straight forward. The schematic is follower by layout generation. Layout design is the stage where engineering capacity combined with creativity is the governing inputs.

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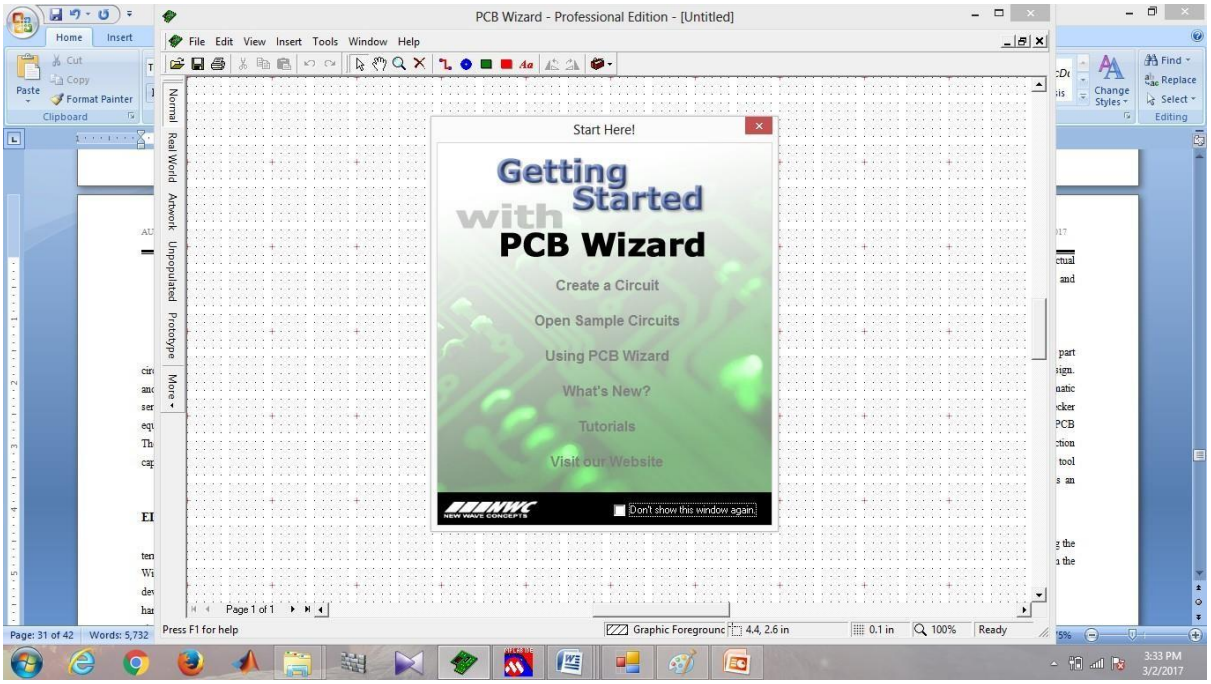

Fig 25 PCB Wizard Software to design the PCB LAYOUT.

ELECTRONIC DESIGN AUTOMATION TOOLS

Most product testing is being done is done with the help of computer programs. The term Electronic Design Automation (EDA) is being used to describe the use of these tools. With the help of advanced powerful computing systems and interactive software tools and development of electronic circuits has undergone automation. Thus the software and hardware tools, which enables this automation includes PCB designing, IC design, circuit simulation etc. These tools help us in such a way that we can draw the circuit; test the functioning of the circuit in response to test inputs in simulation software. After successfully simulation we can get the PCB art work done by replacing the routing software. The design automation tool used here is ORCAD.

- **PCB DESIGN PROCEDURES**

  The PCB designing procedure consists of following steps:

DRAWING THE CIRCUIT SCHEMATIC

Drawing of circuit is done through ORCAD CAPTURE. It includes many libraries with thousands of component symbols. We can select the required symbol from the library and place it in the schematic page. After placing the component symbols, we can complete the interconnection using wire or bus control. The next step is to assign part reference. Each component has to be assigned footprint or PCB pattern name. The footprint gives the actual size physical representation of components on the PCB artwork. The component symbol and foot symbol should correspond inall respects.

DESIGN RULE CHECK AND NET LIST CREATION

After the circuit schematic is completed with all required information such as part reference and footprints, the design rule check can be used for checking errors in the design. It will check for duplicate symbols, overlapped lines and dangling lines. After the schematic design file passes the DRC check, it is processed by a program called an electric rule checker (ERC) that checks for writing errors. The final operation to be done before starting PCB artwork is the net list creation. A net list creation of the components and interconnection along with other information such as foot prints, track width etc. A net list software or tool can take the circuit schematic as input and generate net list. The net list can be used as an information source for the remaining stages.

CREATING THE PCB ARTWORK

In automatic design, the net list obtained from the previous stage is used for getting the required foot print and interconnections. The software used for the PCB artwork design in the ORCAD LAYOUT.

- **PCB FABRICATION**

You need to generate a positive (copper black) UV translucent art work film. You will never get a good board without good art work, so it is important to get the best possible quality at this stage. The most important thing is to get a clear sharp image with a very solid opaque black. Art work is done using ORCAD software. It is absolutely essential that your PCB software prints holes in the middle of pads, which will act as center marks when drilling. It is virtually impossible to accurately hand-drill boards without these holes. If you are looking to buy PCB software at any cost level and

- **ETCHING**

Ferric chloride etchant is a messy stuff, but easily available and cheaper than most alternatives. It attacks any metal including stainless steel. So when setting up a PCB etching area, use a plastic or ceramic sink, with plastic fitting and screws wherever possible, and seal any metal screws with silicon. Copper water pipes may be splashed or dripped-on, so sleeve or cover them in plastic; heat-shrink sleeve is great if you are installing new pipes. Fume extraction is not normally required, although a cover over the tank or tray when not in use is a good idea. You should always use the hex hydrate type of ferric chloride, which shouldbe dissolved in warm water until saturation. Adding a teaspoon of table salt helps to make the

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etchant clearer for easier inspection. Avoid anhydrous ferric chloride. It creates a lot of heat when dissolved. So always add the powder very slowly to water; do not add water to the powder, and use gloves and safety glasses.

Copper clad laminate

- **DRILLING**

Drilling of PCB

If you have fiber glass (FR4) board, you must use tungsten carbide drill bits. Fiberglass eats normal high-speed steel (HSS) bits very rapidly, although HSS drills are alright for older larger sizes (> 2mm). Carbide drill bits are available as straight-shank or thick-shank. In straight shank, the hole bit is the diameter of the hole, and in thick shank, a standard size (typically about 3.5 mm) shank tapers down to the hole size. The straight-shank drills are usually preferred because they break less

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easily and are usually cheaper. The longer thin section provides more flexibility. Small drills for PCB use usually come with either a set of collets of various sizes or a three-jaw chuck. Sometimes the 3-jaw chuck is an optional extra and is worth getting for the time it saves on changing collets. For accuracy, however, 3-jaw chucks are not brilliant, and small drill sizes below 1 mm quickly formed grooves in the jaws, preventing good grip. Below 1 mm, you should use collets, and buy a few extra of the smallest ones; keeping one collect per drill size as using a larger drill in a collect will open it out and it no longer grips smaller drills well. You need a good strong light on the board when drilling, to ensure accuracy. A dichroic halogen lamp, under run at 9V to reduce brightness, can be mounted on a microphone gooseneck for easy positioning. It can be useful to raise the working surface above 15 cm above the normal desk height for more comfortable viewing. Dust extraction is nice, but not essential and occasional blow does the trick! A foot pedal control to switch the drill 'off' and 'on' is very convenient, especially when frequently changing bits. Avoid hole sizes less than 0.8 mm unless you really need them. When making two identical boards, drill them both together to save time. To do this, carefully drill a 0.8 mm hole in the pad near each corner of each of the two boards, getting the center as accurately as possible. For larger boards, drill a hole near the center of each side as well. Lay the boards on the top of each other and insert a 0.8 mm track pin in two opposite corners,using the pins as pegs to line the PCBs up. Squeeze or hammer the pins into boards, and then into the remaining holes.

The metals involved are not the only things to consider in a solder. Flux is vital to a good Solder joint. Flux is an aggressive chemical that removes oxide and impurities from the parts to be soldered. The chemical reactions at the point(s) of connection must take place for themetal to fuse. RMA type flux (Rosin Mildly Active) is the least corrosive of the readily available materials, and provides an adequate oxide. In electronics, a 60/40 fixed core solder isused. This consists of 60%lead and 40% tin, with flux cores added to the length of solder. There are certain safety measures which you should keep in mind when soldering. The tin materialused in soldering contains dangerous substances like lead (40-60% of typical soldering tins are lead and lead is poisonous). Also, the various fumes from the soldering flux can be dangerous.While it is true that lead does not vaporize at the temperature at which soldering is typically done.When soldering, keep the room well ventilated and use a small fan or fume trap. A proper fume trap of a fan will keep the most pollution away from your face. Professional electronic workshopsuse expensive fume extraction systems to protect their workers. Those fume extraction deviceshave a special filter which filters out the dangerous fumes. If you can connect a duct to the output from the trap to the outside, that would be great. Always wash hands prior to smoking, eating, drinking or going to the bathroom.

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CHAPTER 8

ADVANTAGES

- Current sensor helps to know the current status whether the KSEB supply or Invertor supplyis present or not.
- LDR sensor relay combination helps to turn ON/OFF the Lamp according to Light intensity status.
- Water level sensor helps to maintain the water level.
- Fish feeder helps to feed the fish based on set time and manual time.
- The IOT application helps to monitor all the system status through users mobile phone.
- Less dependence on labor as opposed to absenteeism and inefficiency.
- Uniform growth in the tank: With the correct distribution of the feed in the tanks, using dispersers integrated into the feeding system, more homogeneous batch of fish or shrimp are achieved.
- The farmed fish provides high quality protein for human consumption.
- Fish farming can be integrated into the existing farm to create additional income and improve its water management. The farmers can select the fish species with desired characteristics to raise

.

DISADVANTAGES

- The main disadvantage of this system is that it will be use-less when the current-connection to the system break.
- Disadvantages Of Using pH Meters,You will need to clean it regularly to avoid possible contamination of samples. As most pH meters contain a probe with a glass tip, these are extremely fragile so can be easily broken or damaged if exposed to corrosive substances.
- Memory limitations. Less powerful. Processing power is weaker than the microcontroller. node MCU.
- Lacks performance compared to higher bit microcontrollers. ATMEGA 328.
- To Operate DC Motor,

  1. You need a separate DC Power Supply to operate. The modern world is moving towards AC motors.

2. If there is only AC Source Available then a converter is required and will cost converter cost.

3. Losses will occur in AC to DC converters

Extra Motor Safety and Precautions are Required as the DC Voltage peak value won't go to Zero like AC Voltage. i.e one accidental touch leads to death.

- Uninterrupted power supply required.

- Due to the continuous usage temperature occurs and causes damage to the components.

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CHAPTER 9

APPLICATIONS

1. High density Fish farming regions.
2. High tech Aquarium.
3. Automatic Fish Feeders Are Reliable.
4. Better Fishing Spots.
5. Increase Your Stocks.
6. Stronger Food Chain.
7. Fish Feed is Affordable.

CHAPTER 10

CONCLUSIONS

The IOT enabled Fish automation system is designed and developed successfully. There are lot of challenges we faced such as Pump controlling, Microcontroller and Node MCU serial communication, Node MCU Firebase communication , Firebase to android application communication etc. Finally we obtained a successful result and the system works very well.

PROGRAM

```
#include <ESP8266HTTPClient.h>
#include <ESP8266WiFi.h>
#include <DNSServer.h>
#include <ESP8266WebServer.h>
#include <WiFiClientSecureBearSSL.h>

#include <WiFiManager.h>
WiFiManager wifiManager;

#include <ArduinoJson.h>
DynamicJsonDocument doc(1024);

#include <SoftwareSerial.h>
SoftwareSerial mySerial(D5, D2);

//String bUrl = "https://fish-automation-55h6koaz7a-uc.a.run.app";
String bUrl = "https://fish-automation-pinarayi-55h6koaz7a-uc.a.run.app";
String baseUrl = bUrl;
int httpCode = 0;

HTTPClient https;

int configPin = D4;
int connectionLed = D3;
bool initialConfig = false;

unsigned long previousMillis = 0;
unsigned long dataPreviousMillis = 0;
long interval = 1000;

String payload = "", nodeMCU_data = "";

//int lamp = D0;
//int current_sensor1 = D1; //inverter
//int current_sensor2 = D5; //kseb

//int current_status1 = 0, current_status2 = 0;

//String ph_value_string, ldr_value_string, temp_value_string;
String data, controlData;
//String pH, lightIntensity, temperature, lamp_status_data, kseb_status, inverter_status;

//float ph_data = 0, ldr_data = 0, temp_data = 0;

void setup()
{
  pinMode(configPin,INPUT_PULLUP);
  pinMode(connectionLed,OUTPUT);
```

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```
  Serial.begin(115200);
  mySerial.begin(9600);

  if (WiFi.SSID()=="")
  {
   initialConfig = true;
  }
  else
  {
   WiFi.begin(WiFi.SSID(),WiFi.psk());
  }
}

void loop()
{

  unsigned long currentMillis = millis();

  if (currentMillis - previousMillis >= interval)
  {
   previousMillis = currentMillis;
   digitalWrite(connectionLed, !digitalRead(connectionLed));
  }

//////////////////////////////////////////////////////////////////

  if(WiFi.status() == WL_CONNECTED)
  {
   std::unique_ptr<BearSSL::WiFiClientSecure> client(new BearSSL::WiFiClientSecure);
   client->setInsecure();

   interval = 1000;

   if (currentMillis - dataPreviousMillis >= 3000)
   {
    dataPreviousMillis = currentMillis;
    mySerial.print("S");
    Serial.println("data sent");
   }

   https.begin(*client, baseUrl + "/control");
   httpCode = https.GET();
   if (httpCode > 0)
   {
    payload = https.getString();
    https.end();
    deserializeJson(doc, payload);
    JsonObject obj = doc.as<JsonObject>();
    String feederControl = obj[String("feeder")];
    String lampControl = obj[String("lamp")];
    String pumpControl = obj[String("pump")];
    if (feederControl == "1")
```

```
{
  mySerial.print("O");
  Serial.println("feeder opened");
  https.begin(*client, baseUrl + "/control");
  https.addHeader("Content-Type", "application/json");
  controlData = "0";
  data = "{\"feeder\":\"" + controlData + "\"}";
  httpCode = https.POST(data);
  https.end();
}
if (lampControl == "1")
{
  mySerial.print("A");
  //lamp_status_data = "1";
  https.begin(*client, baseUrl + "/control");
  https.addHeader("Content-Type", "application/json");
  controlData = "2";
  data = "{\"lamp\":\"" + controlData + "\"}";
  httpCode = https.POST(data);
  https.end();
}
else if(lampControl == "0")
{
  mySerial.print("a");
  //lamp_status_data = "0";
  https.begin(*client, baseUrl + "/control");
  https.addHeader("Content-Type", "application/json");
  controlData = "2";
  data = "{\"lamp\":\"" + controlData + "\"}";
  httpCode = https.POST(data);
  https.end();
}
if (pumpControl == "1")
{
  mySerial.print("P");
  //lamp_status_data = "1";
  https.begin(*client, baseUrl + "/control");
  https.addHeader("Content-Type", "application/json");
  controlData = "2";
  data = "{\"pump\":\"" + controlData + "\"}";
  httpCode = https.POST(data);
  https.end();
}
else if(pumpControl == "0")
{
  mySerial.print("p");
  //lamp_status_data = "0";
  https.begin(*client, baseUrl + "/control");
  https.addHeader("Content-Type", "application/json");
  controlData = "2";
  data = "{\"pump\":\"" + controlData + "\"}";
  httpCode = https.POST(data);
```

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```
        https.end();
      }
    }

    if (mySerial.available() > 0)
    {
      delay(100);
      nodeMCU_data = mySerial.readString();
      Serial.println(nodeMCU_data);
      https.begin(*client, baseUrl + "/data");
      https.addHeader("Content-Type", "application/json");
      data = "{\"hardwareData\":\"" + nodeMCU_data + "\"}";
      httpCode = https.POST(data);
      https.end();
    }
  }
  else
  {
    interval = 50;
    Serial.println("not connected");
  }
  if ((digitalRead(configPin) == LOW) || (initialConfig))
  {
    digitalWrite(connectionLed,HIGH);
    wifiManager.startConfigPortal("ThinkFoTech","admin123");
    digitalWrite(connectionLed,LOW);
    initialConfig = false;
    ESP.reset();
  }
}
```

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