1. INTRODUCTION

1.1 Introduction

Hydroponics is a subset of hydro culture, which is a method of growing plants without soil by using mineral nutrient solutions in a water solvent. Terrestrial plants may be grown with only their roots exposed to the mineral solution, or the roots may be supported by an inert medium, such as perlite or gravel. Hydroponics became popularized by the news media in the 1920s when the scientist named Dr.William F. Gericke of the University of California when the put laboratory experiments in plant nutrition on a commercial scale. In doing so he termed this nutri culture system HYDROPONICS .The word was derived from the Greek words HYDRO (water), and PONOS (labour), literally, “water working”.The hydroponic gardener regulates the composition of nutrients vin the liquid solution used to water the plants. It also regulates the frequency of supplying the nutrients to the plants. Simply, the hydroponic gardener controls the growing environment of the plants. The system is highly automated of course but still requires to be well managed.

1.2 Overview

The overview of our project is to grow crops without using soil and water by using compressor. In our project we have used Atmega328p microcontroller for sensing the moisture content and based on the output from sensor the controller will turn on/off the compressor and instead of sunlight we are providing artificial lightning through led strip to the crops for photosynthesis.

1.3 Objective

As stated above, the process is managed, not simply controlled. Therefore, it is water efficient and nutrient efficient, both of which are delivered directly to the plant's root structure. Because the levels of water and nutrients are monitored, these elements are supplied as and when needed at the required levels. Together, water and nutrients contribute to the success of and rate of growth. The lighting factor is also critical in crop production. This is achieved by planting out in vertical structures where lighting is maximized while plant density, crowding and shading are minimized. Present day hydroponic farming embrace the 3-D approach and are grown vertically in multilevel growing beds. So now we have ideal growing conditions in terms of nutrients, water and light, plus the ability to grow in the vertical. This adds significantly to the yield per unit area as the growing area is no longer 2-dimensional (2-D) but has become a 3-D concept and design. This maximizes the actual growing area and uses what could have been unutilized areas in enclosed gardening environments. With a multi-level bedding structure that is movable, plants can now be exposed to ideal lighting at all times throughout the growing period. [1]

1.4 Purpose

The main purpose of our project is to grow nutritious crops using the atmospheric water present in the atmosphere using condensation process.

2. LITERATURE SURVEY

2.1 Study of Research Paper

Hydroponics world wide

Merle H Jensen

International Symposium on growing media and hydroponics, 1997

Growing greenhouse vegetable is one of the most exacting and intense forms of all agricultural enterprises. In combination with greenhouses, hydroponics is becoming increasingly popular, especially in the United State Canada, Western Europe and Japan. It is high technology and capital intensive. It is highly productive, conservative of water and protective of the environment for production leafy vegetables and herbs deep floe of hydroponics is common. For growing raw crops such as tomato, cucumber and pepper, the most popular artificial growing media are Rockwool and perlite. Computers today operate hundreds of devices with in a greenhouse by utilizing dozens of input parameter, maintain the most desired growing environment. The future of hydroponic/soilless culture systems appears the most positive today then any time over the last 50 years. [3]

2.2 As per Research gate

Hydroponics and aeroponics are cultivation methods that are used to grow plants without the use of soil. The difference in hydroponics and aeroponics is that plants using the hydroponics method will have their roots soaked in a trough filled with water containing nutrients while the plants using the aeroponics method will have their roots sprayed with water containing nutrients. In aeroponics, the roots are also suspended in the air and are sprayed at regular intervals using an automatic timer. However the similarity in both cultivation methods is that the plants will be kept in an enclosed misty environment. In their enclosed environment, they will have all the required things to grow such as: oxygen, nutrients and water. Hydroponics systems do not have as many items to set up compared to aeroponics systems hence hydroponics systems are considered easy to use and set up. [5]

2.3 Problem Definition

The main aim of our project is to grow nutritious seasonal vegetable in three different environments available for the whole year. The three environments in which we will be growing the vegetables in is hydroponics. We chose this topic because we wanted to know which environment will allow the plant the fastest rate of growth. We asked ourselves "Which environment will have the fastest rate of growth?". We want to solve this question because it will help people to produce faster crops, help them to save money, and help them to save their lands and grow more crops in less area using vertical farming. We solely research on the vegetable that have the highest amount of nutrients content. We found out that using compressor we can convert the atmospheric water vapor into liquid form. [4]

2.4 Embedded Systems

An embedded system is a special-purpose computer system designed to perform one or a few dedicated functions, often with real-time computing constraints. It is usually *embedded* as part of a complete device including hardware and mechanical parts. In contrast, a general-purpose computer, such as a personal computer, can do many different tasks depending on programming.

Embedded systems control many of the common devices in use today. Since the embedded system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product, or increasing the reliability and performance. Some embedded systems are mass-produced, benefiting from economics of scale. Physically, embedded systems range from portable devices such as digital watches and mp4 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power stations. Complexity varies from low, with a single microcontroller chip, to very high with multiple units, peripherals and networks mounted inside a large chassis or enclosure. In general, "embedded system" is not an exactly defined term, as many systems have some element of programmability. For example, handheld computers share some elements with embedded systems such as the operating systems and microprocessors which power them but are not truly embedded systems, because they allow different applications to be loaded and peripherals to be connected.

2.5 Characteristics

1. Embedded systems are designed to do some specific task, rather than be a general-purpose computer for multiple tasks. Some also have real-time performance constraints that must be met, for reasons such as safety and usability; others may have low or no performance requirements, allowing the system hardware to be simplified to reduce costs.

2. Embedded systems are not always standalone devices. Many embedded systems consist of small, computerized parts within a larger device that serves a more general purpose. For example, the features an embedded system for tuning the strings, but the overall purpose of the Robot Guitar is, of course, to play music. Similarly, an embedded system in automobiles provides a specific function as a subsystem of the car itself.

3. The program instructions written for embedded systems are referred to as firmware, and are stored in read-only memory or flash memory chips. They run with limited computer hardware resources: little memory, small or non-existent keyboard and/or screen.

3. SYSTEM DEVELOPMENT

3.1 Block Diagram

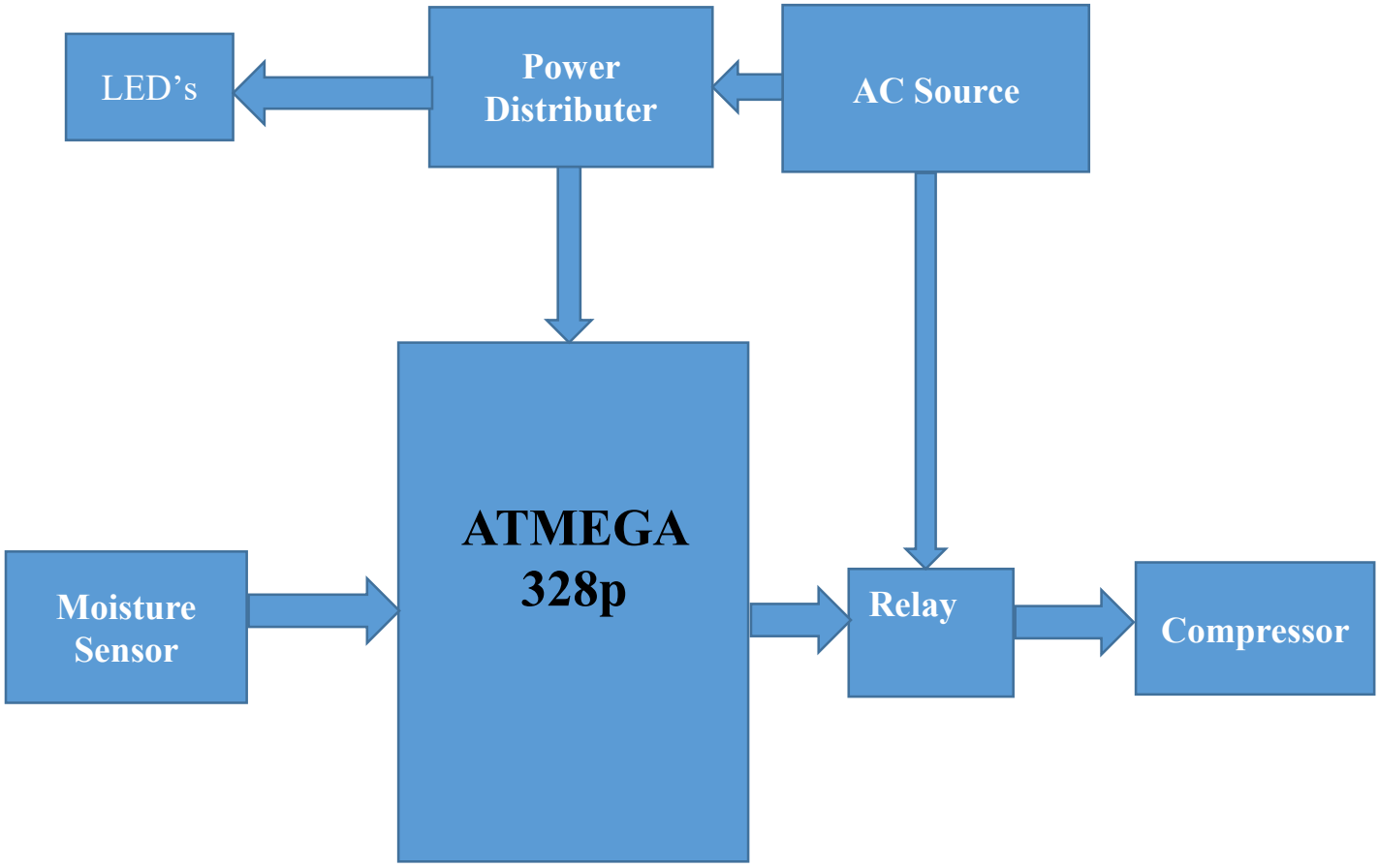


Fig No. 3.1 Block Diagram of modern hydroponic farming

3.2 Circuit Diagram

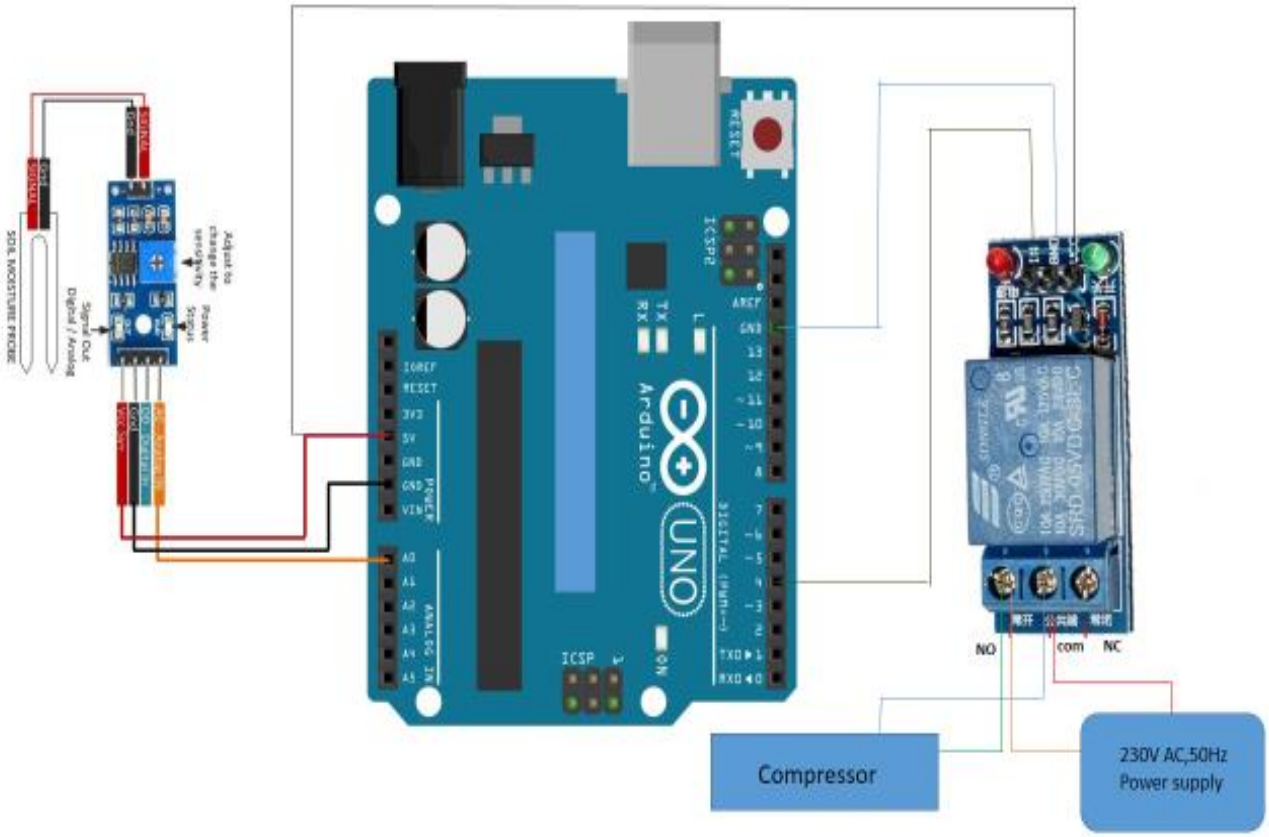


Fig No. 3.2 Circuit Diagram of Modern Hydroponic Framing

3.3 Arduino ATmega328P

Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board. Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone, or they can communicate with software running on your computer (e.g. Flash, Processing, MaxMSP.) The boards can be assembled by hand or purchased preassembled; the open-source IDE can be downloaded for free. The Arduino programming language is an implementation of Wiring, a similar physical computing platform, which is based on the Processing multimedia programming environment.

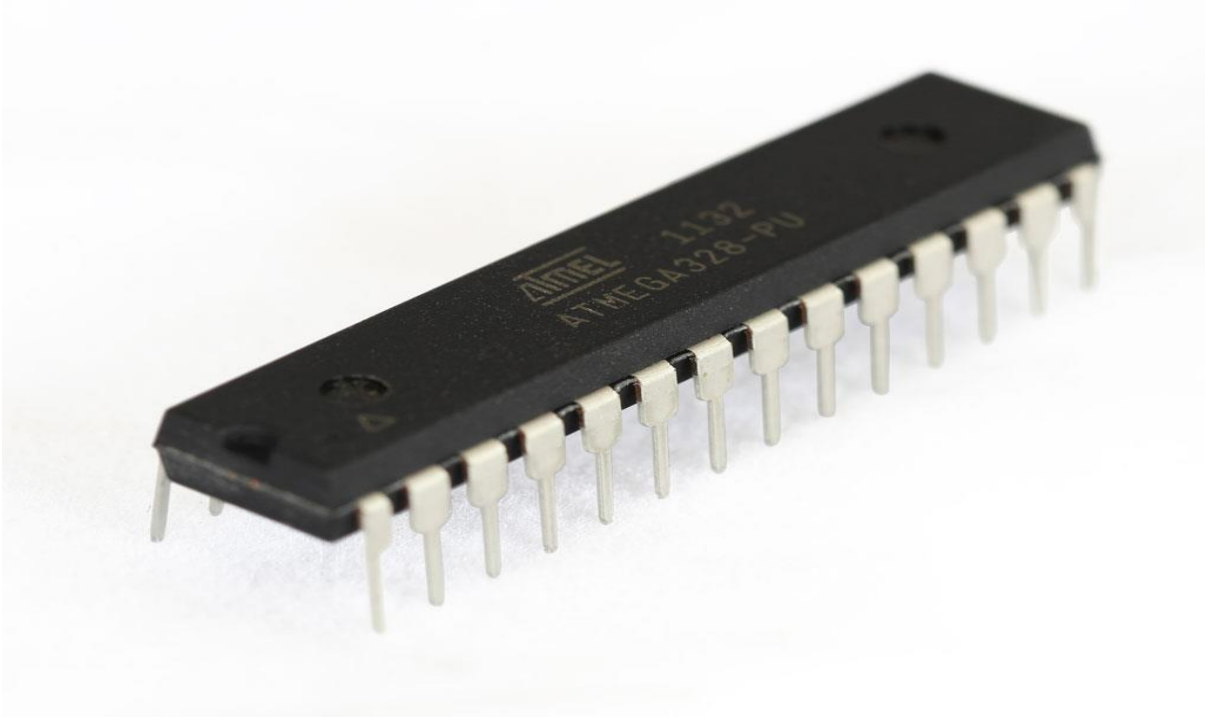


Fig No. 3.3 Image of IC ATmega328P

3.3.1 Block Diagram of Arduino ATmega328P

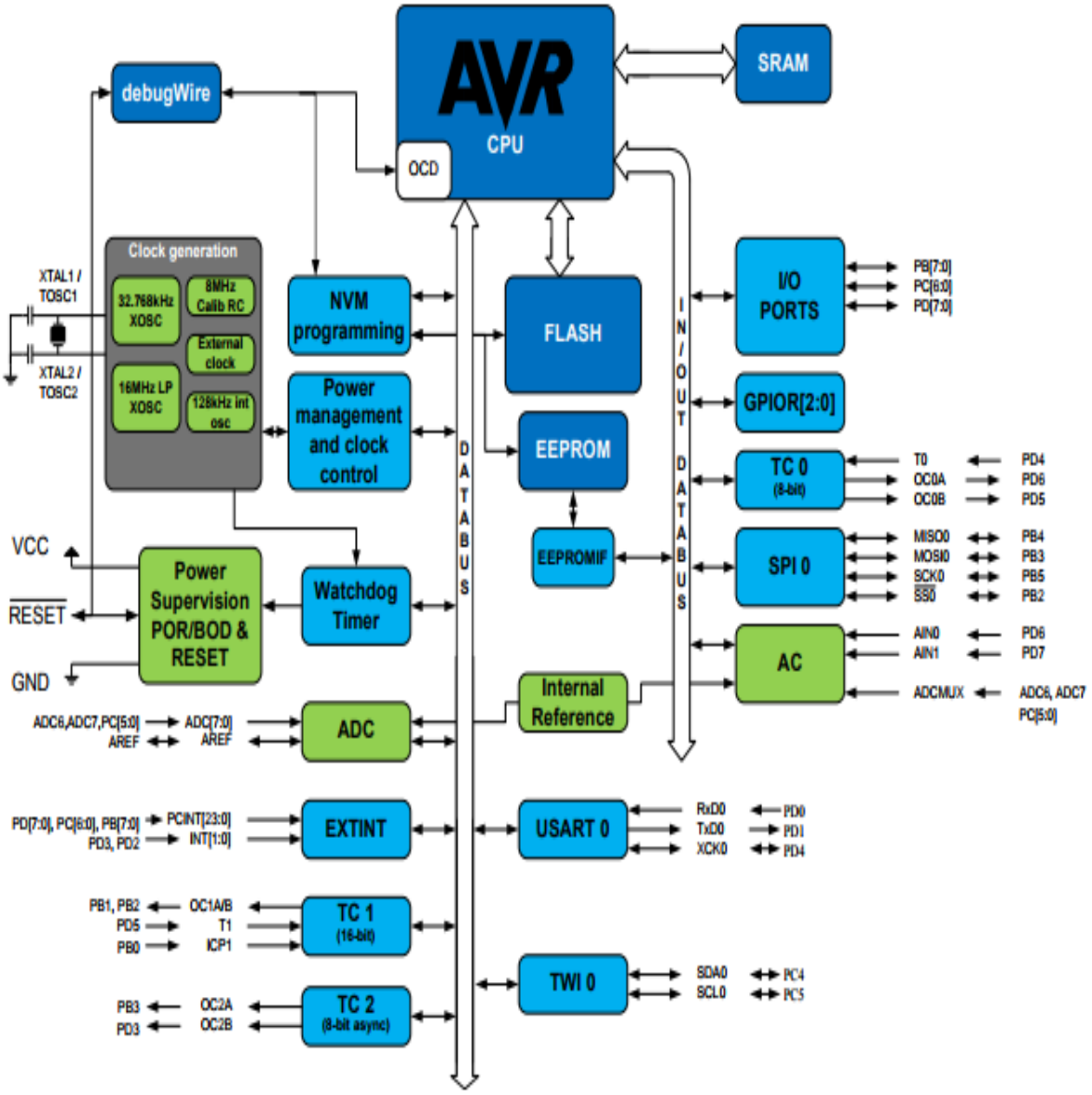


Fig No. 3.3.1 Block Diagram of ATmega328P

3.3.2 Pin Structure of ATmega328P

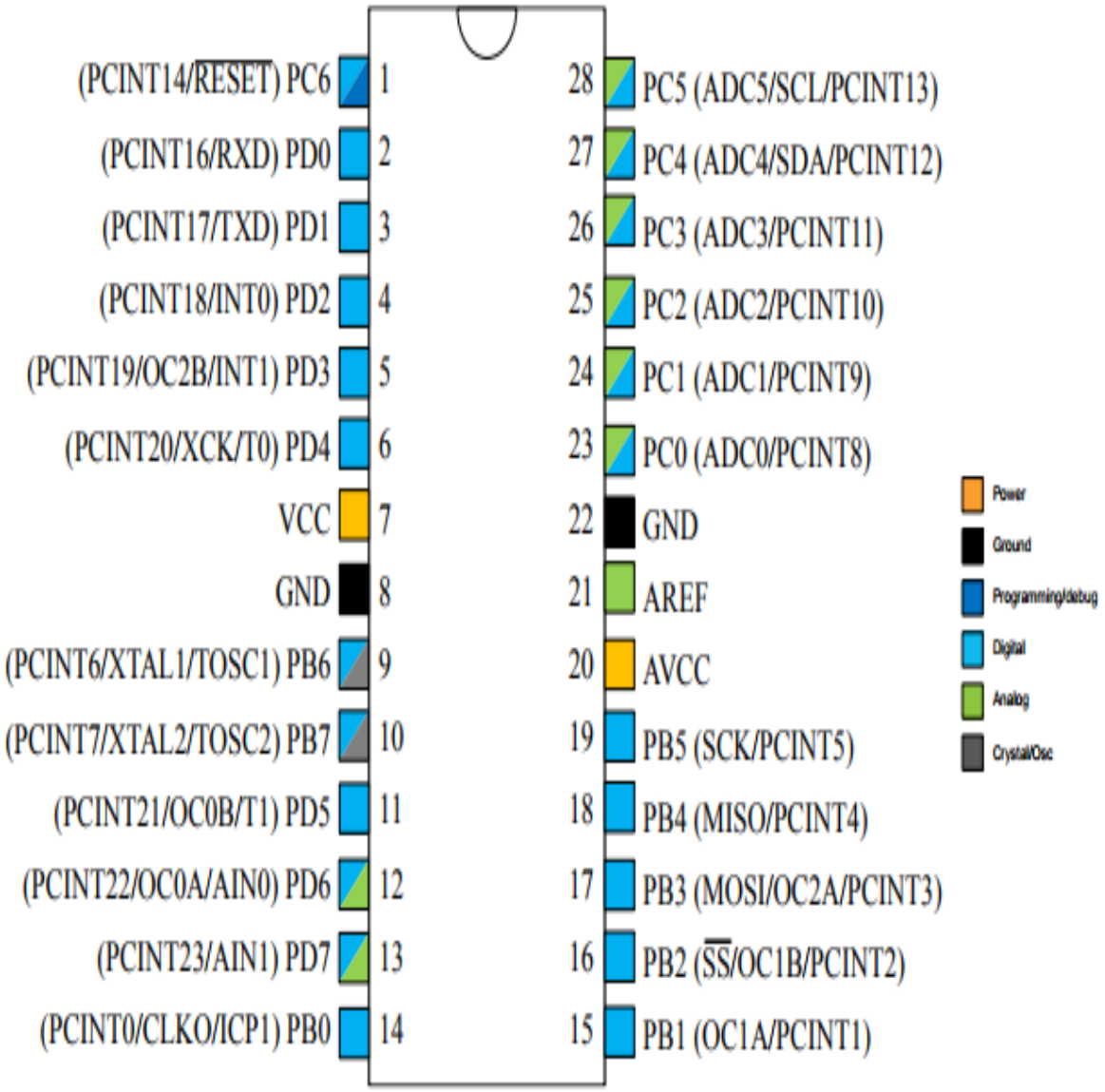


Fig No. 3.3.2 Pin Diagram of Arduino ATmega328P

3.3.3 Pin Descriptions

- VCC Digital supply voltage.
- GND Ground.
- Port B (PB [7:0]) XTAL1/XTAL2/TOSC1/TOSC2 Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running. Depending on the clock selection fuse settings, PB6 can be used as input to the inverting Oscillator amplifier and input to the internal clock operating circuit. Depending on the clock selection fuse settings, PB7 can be used as output from the inverting Oscillator amplifier. If the Internal Calibrated RC Oscillator is used as chip clock source, PB [7:6] is used as TOSC[2:1] input for the Asynchronous Timer/Counter2 if the AS2 bit in ASSR is set.
- Port C (PC [5:0]) Port C is a 7-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The PC[5:0] output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running.
- PC6/RESET If the RSTDISBL Fuse is programmed, PC6 is used as an I/O pin. Note that the electrical characteristics of PC6 differ from those of the other pins of Port C. If the RSTDISBL Fuse is unprogrammed, PC6 is used as a Reset input. A low level on this pin for longer than the minimum pulse length will generate a Reset, even if the clock is not running. Shorter pulses are not guaranteed to generate a Reset. The various special features of Port C are elaborated in the Alternate Functions of Port C section.
- Port D (PD[7:0]) Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled

low will source current if the pull-up resistors are activated. The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running.

- AVCC is the supply voltage pin for the A/D Converter, PC[3:0], and PE[3:2]. It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it

Should be connected to VCC through a low-pass filter. Note that PC[6:4] use digital supply voltage, VCC. 5.2.8. AREF is the analog reference pin for the A/D Converter.

- ADC[7:6] (TQFP and VFQFN Package Only) In the TQFP and VFQFN package, ADC[7:6] serve as analog inputs to the A/D converter. These pins are powered from the analog supply and serve as 10-bit ADC channels.

3.3.4 Arduino UNO

Fig No. 3.3.4 Image of Arduino ATmega328P

The Arduino Uno R3 is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip.

Additional features coming with the R3 version are:

- ATmega16U2 instead 8U2 as USB-to-Serial converter.
- 1.0 pin out: added SDA and SCL pins for TWI communication placed near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board and the second one is a not connected pin that is reserved for future purposes.
- Stronger RESET circuit.

"Uno" means "One" in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform.

3.3.5 Technical Specifications

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	40 Ma
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB
Flash Memory for Boot loader	0.5 KB
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz
Length	68.6 mm
Width	53.4 mm
Weight	25 g

3.4 Moisture Sensor

The Moisture sensor is used to measure the water content (moisture) of soil. When the soil is having water shortage, the module output is at high level, else the output is at low level .The soil moisture sensor consist of two probes which are used to measure the volumetric content of water. The two probes allow the current to pass through the soil and then it gets the resistance value to measure the moisture value. When there is more water, the soil will conduct more electricity which means that there will be less resistance. Therefore, the moisture level will be higher. Dry soil conducts electricity poorly, so when there will be less water, then the soil will conduct less electricity which means that there will be more resistance. Therefore, the moisture level will be lower. This sensor can be connected in two modes; Analog mode and digital mode. The Module also contains a potentiometer which will set the threshold value and then this threshold will be compared by the LM293 comparator. The output LED will light up and down according to this threshold value.

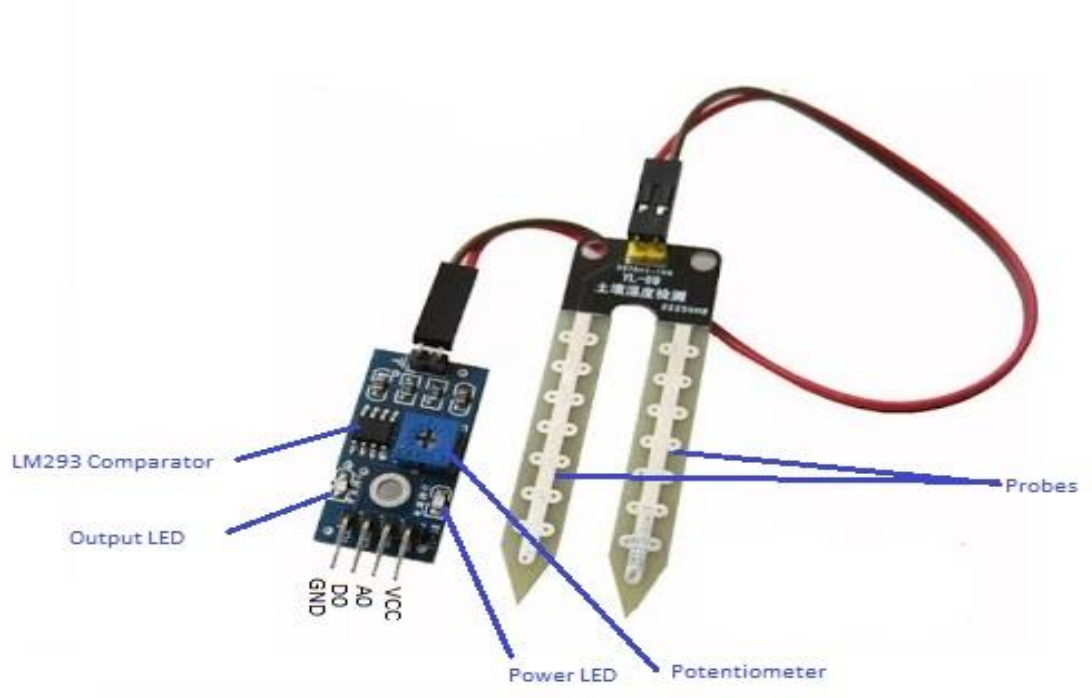


Fig No. 3.4 Image of Moisture sensor

3.4.1 Technical Specification

- Operating voltage: 3.3V~5V.
- Dual output mode, analog output more accurate.
- A fixed bolt hole for easy installation.
- With power indicator (red) and digital switching output indicator (green).
- LM293 comparator chip.
- Panel PCB Dimension: Approx.3cm x 1.5cm.
- Soil Probe Dimension: Approx. 6cm x 3cm.
- Cable Length: Approx.21cm.
- VCC: 3.3V-5V.
- GND: GND.
- DO: digital output interface (0 and 1).
- AO: analog output interface.

3.4.2 Pin Description

- VCC: For Power.
- A0: Analog output.
- D0: Digital output.
- GND: Ground.

3.5 SPDT 5V Relay

The relay module is an electrically operated switch that allows you to turn on or off a circuit using voltage and/or current much higher than a microcontroller could handle. Relay is an electromagnetic device which is used to isolate two circuits electrically and connect them magnetically. They are very useful devices and allow one circuit to switch another one while they are completely separate. They are often used to interface an electronic circuit (working at a low voltage) to an electrical circuit which works at very high voltage. A relay switch can be divided into two parts: input and output. The input section has a coil which generates magnetic field when a small voltage from an electronic circuit is applied to it. This voltage is called the operating voltage. Commonly used relays are available in different configuration of operating voltages like 5V, 12V, 24V etc. The output section consists of contactors which connect or disconnect mechanically. In a basic relay there are three contactors: normally open (NO), normally closed (NC) and common (COM). At no input state, the COM is connected to NC. When the operating voltage is applied the relay coil gets energized and the COM changes contact to NO. Different relay configurations are available like SPST, SPDT, DPDT etc, which have different number of changeover contacts. By using proper combination of contactors, the electrical circuit can be switched on and off.

Fig No. 3.5 Image of SPDT relay

3.5.1 Features

- Contact current 10A and 250V AC or 30V DC.
- Each channel has indication LED.
- Coil voltage 12V per channel.
- Kit operating voltage 5-12 V.
- Input signal 3-5 V for each channel.
- Three pins for normally open and closed for each channel.

3.5.2 Pin Description

- VCC: 5V DC.
- COM: 5V DC.
- INT1: High/Low output.
- INT2: High/Low output.
- INT3: High/Low output
- INT4: High/Low output.
- GND: ground.

3.6 LED Strip

An LED Strip Light (also known as an LED tape or ribbon light) is a flexible circuit board populated by surface mounted light-emitting diodes and other components that usually comes with an adhesive backing. Traditionally, strip lights had been used solely in accent lighting, backlighting, task lighting, and decorative lighting applications. Increased luminous efficacy and higher-power allowed LED strip lights to be used in applications such as high brightness task lighting, fluorescent and halogen lighting fixture replacements, indirect lighting applications, Ultraviolet inspection during manufacturing processes, set and costume design, and even growing plants.

White light is a mixture of several wavelengths of colors and the chlorophyll in green leaves absorb energies from all visible light except green, Then exposing white light to a green plant will result in in the faster rate of photosynthesis followed by red and blue. The color of light used for photosynthesis depends on the pigment in the plant. For example, green plants with chlorophylls and carotenoids have maximum activity with violet-blue and red light.

Fig No. 3.6 Image of LED Strip

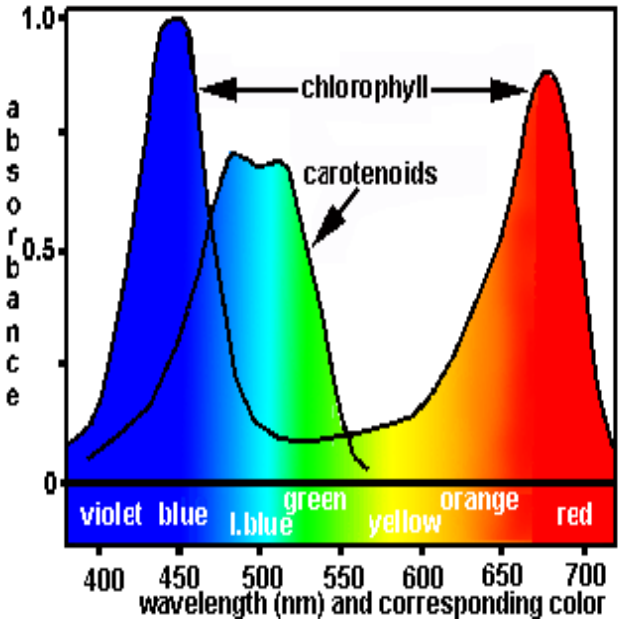


Fig No. 3.6 Light Spectrum

3.7 Hermetically Sealed Compressor

A hermetic or sealed compressor is one in which both compressor and motor are confined in a single outer welded steel shell. The motor and compressor are directly coupled on the same shaft, with the motor inside the refrigeration circuit. Thus the need for a shaft seal with the consequent refrigerant leakage problem was eliminated. All the refrigerant pipeline connections to the outer steel shell are by welding or brazing. The electrical conductors to the motor are taken out of the steel shell by sealed terminals made of fused glass. The figure below shows the cut-away view of a hermetic compressor. One can see the cooper windings inside the outer shell and also the refrigerant connections (copper pipes). Hermetic compressors are ideal for small refrigeration systems, where continuous maintenance (replenishing refrigerant and oil charge etc.) cannot be ensured. Hence they are widely used in domestic refrigerators, room air conditioners etc. Since, the motor is in the refrigerant circuit, the efficiency of hermetic compressor based systems is lower as the heat dissipated by the motor and compressor becomes a part of the system load. Also material compatibility between the electrical windings, refrigerant and oil must be ensured. Since the complete system is kept in a welded steel shell, the hermetic compressors are not meant for servicing. A variation of hermetic compressor is a semi-hermetic compressor, in which the bolted construction offers limited serviceability. [2]

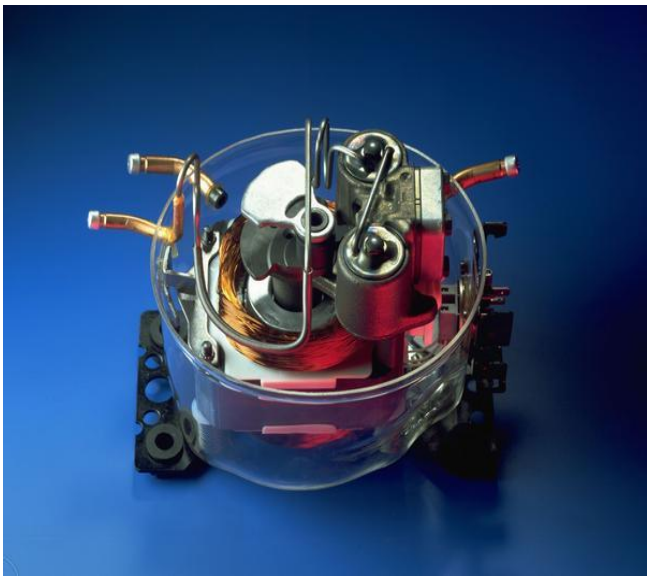


Fig No. 3.7 Image of hermetically sealed compressor

3.7.1 Specifications

- Both compressor and motor are confined in single outer welded steel shell.
- Feature both motor and compressor directly coupled on same shaft with motor inside refrigeration circuit to safeguard from leakage issues.
- Electrical conductors to motor are taken out of steel shell through sealed terminals made of fused glass5.
- Copper windings inside outer shell and copper pipe based refrigerant connections.
- Compressors ideal for small refrigeration systems requiring continuous maintenance. Widely used in domestic refrigerators, room air conditioners.
- High efficiency hermetic compressor based systems.
- Bearing superior material compatibility between electrical windings, refrigerant and oil.

3.8 Printed Circuit Board (PCB)

Printed circuit boards (PCBs) are the boards that are used as the base in most electronics – both as a physical support piece and as the wiring area for the surface-mounted and socketed components. PCBs are most commonly made out of fiberglass, composite epoxy, or another composite material. Most PCBs for simple electronics are simple and composed of only a single layer. More sophisticated hardware such as computer graphics cards or motherboards can have multiple layers, sometimes up to twelve. Although PCBs are most often associated with computers, they can be found in many other electronic devices, such as TVs, Radios, Digital cameras and Cell phones.

3.8.1 Types of PCB

1. Single-Sided PCBs.
2. Double-Sided PCBs.
3. Multilayer PCBs.
4. Rigid PCBs.
5. Flex PCBs.
6. Rigid-Flex PCBs.

Fig No. 3.8 Image of PCB

3.8.2 PCB Etching Process

ALL PCB's are made up by bonding a layer of copper over the entire substrate, sometimes both side Etching process has to be done to remove unnecessary copper after applying a temporary mask, leaving only the desired copper trace.

Fig No. 3.8.2 Image of etching process

Through there are many methods available for etching the most common method used by electronic hobbyists is etching using ferric chloride or hydrochloric acid. Both are abundant and cheap. Dip the PCB inside the solution and keep moving inside. Take it out at times and stop the process as soon as the copper layer has gone. After etching rub the PCB with little acetone to remove the black colour, thus giving the PCB shining attractive look. The PCB layout is now completed.

3.8.3 PCB drilling

The component that have to be attached to the multi-layered PCB can be done only by drilling. That is, a pated- through hole is drilled in the shape of annular ring. Small drill bits that are made out of tungsten carbide is used for the drilling. A dermal drill press is normally used to punch the holes. Usually, a 0.035 inch drill bit is used.

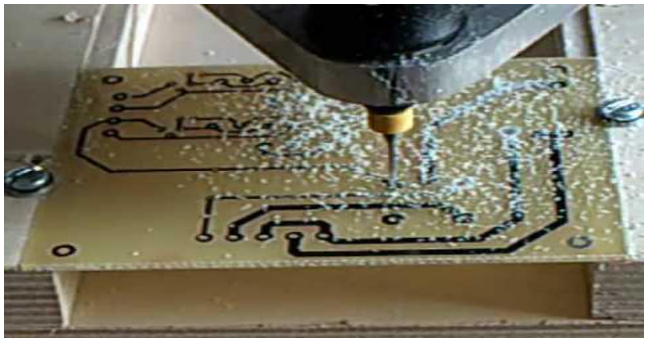


Fig No. 3.8.3 Image of drilling process

3.9 Power Supply

7805 and 7812 is a 5V and 12V fixed three terminal positive voltage regulator IC. The IC has features such as safe operating area protection, thermal shut down, internal current limiting which makes the IC very rugged. Output currents up to 1A can be drawn from the IC provided that there is a proper heat sink. We have provided 15V, 2A input supply from charger to the circuitry. 5V input supply is provided to the arduino and 12V to LED strip. 230V AC, 16A 50Hz supply is given to the compressor.

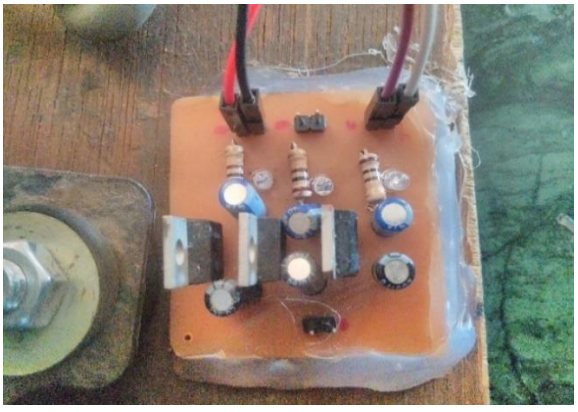


Fig No. 3.9 Image of Voltage Distributer

4. SOFTWARE & PROGRAMMING

4.1 Arduino IDE

1. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.
2. Arduino language is merely a set of C/C++ functions that can be called from your code. Your sketch undergoes minor changes (e.g. automatic generation of function prototypes) and then is passed directly to a C/C++ compiler (AVR-g++).
3. An IDE for the Arduino microcontroller. Arduino is a free software electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments.
4. The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software. This software can be used with any Arduino board. [6]

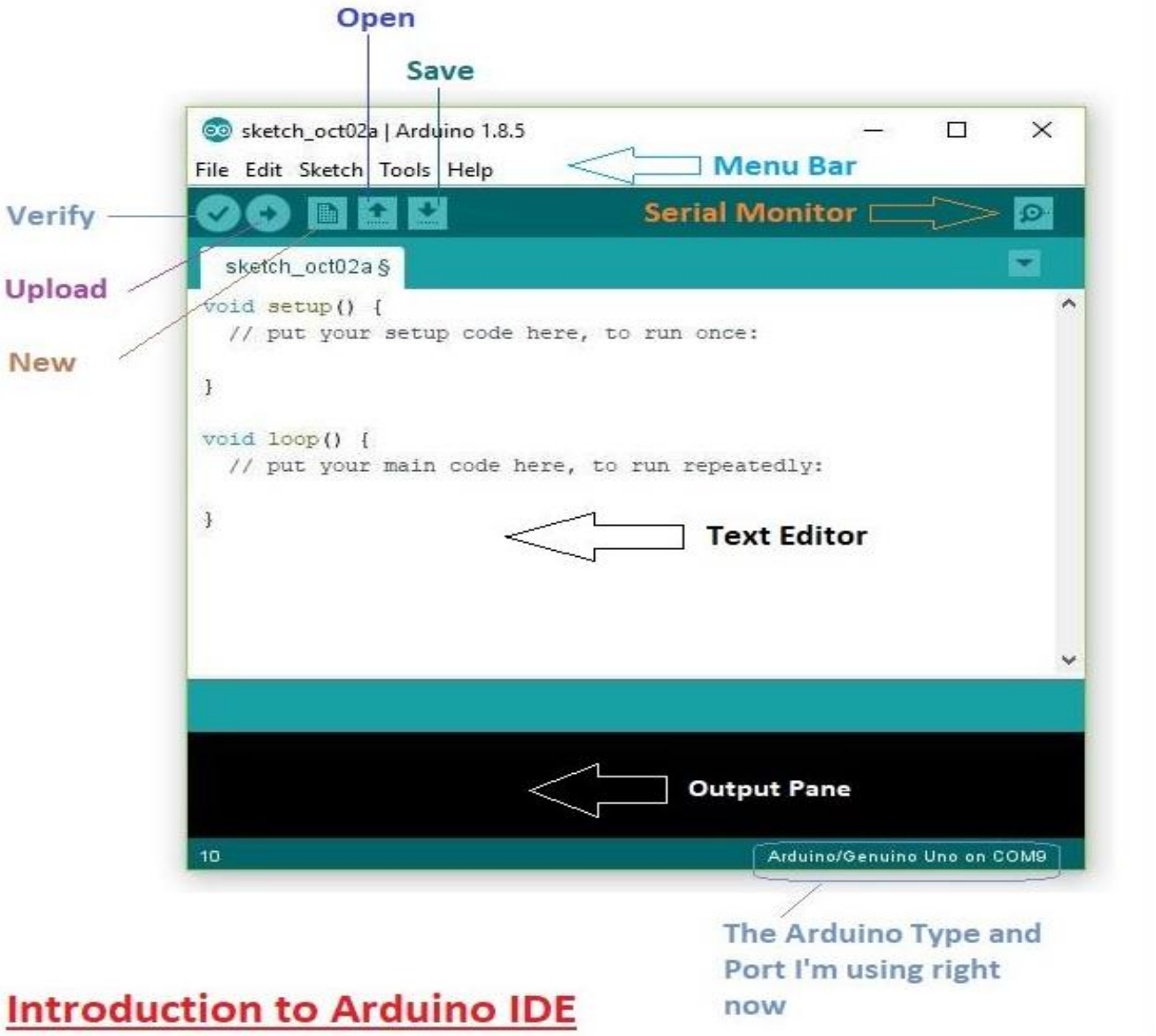
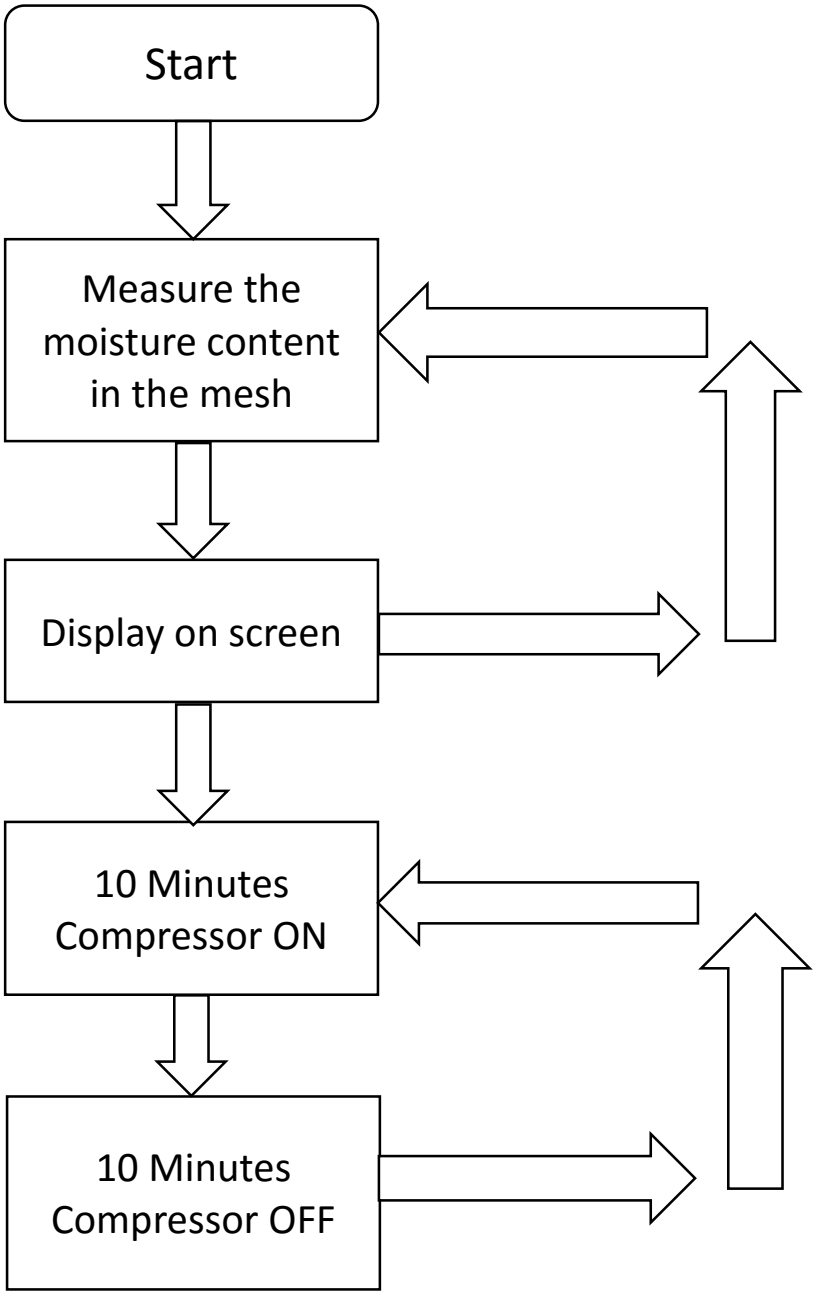


Fig No. 4.1 Image of Arduino IDE

4.1.1 Flow Chart of Programming



4.1.2 Programming

1. Moisture Sensor

```
#include <I2CSoilMoistureSensor.h>

int sensor_pin = A0;

int output_value ;

void setup() {

  Serial.begin(9600);

  Serial.println("Reading From the Sensor ...");

  delay(2000);

  }

void loop() {

  output_value= analogRead(sensor_pin);

  output_value = map(output_value,550,0,0,100);

  Serial.print("Mositure : ");

  Serial.print(output_value);

  Serial.println("%");

  delay(1000);

  }
```

2. Delay

```
void setup() {

  pinMode(LED_BUILTIN, OUTPUT);
}

void loop() {

  digitalWrite(LED_BUILTIN, HIGH);

  delay(60000);

  digitalWrite(LED_BUILTIN, LOW);

  delay(60000);

}
```

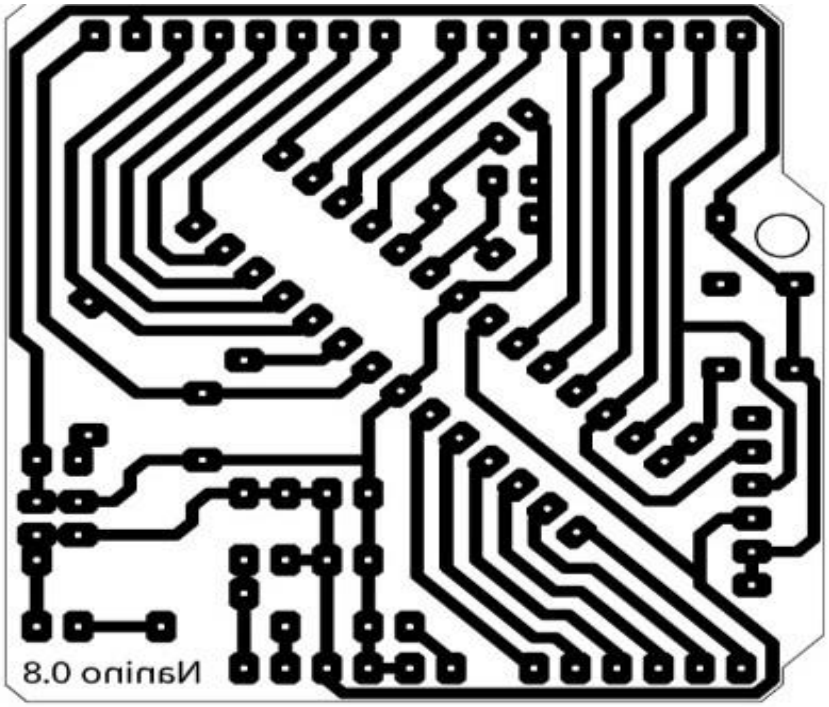
4.2 Express PCB

ExpressPCB software is a snap to learn and use. For the first time, designing circuit boards is simple for the beginner and efficient for the professional. ExpressPCB is a CAD (computer aided design) free program designed to help you create layouts for printed circuit boards on your Windows PC.

Laying out PCBs is easy, even for the first time user. Here are the steps:

1. Select the Components.
2. Position the Components.
3. Add the Traces.
4. Edit the Layout.
5. Order your PCBs.

4.2.1 PCB Layout



5. CONCLUSION

5.1 Conclusion

The main aim of this project is to help every urban, poor farmers and gardeners to manage their vertical garden by specifically notifying the issues. Progress has been rapid and results obtained in various countries have proved that this technology is thoroughly practical and has very definite advantages over conventional methods of crops production. People living in crowed city streets, without gardens, can grow fresh vegetables and barren and sterile, can be made productive at relatively low cost.

5.2 Advantages

- No soil needed.
- Make better use of space and location.
- Climate control.
- Water saving.
- Effective of nutrients.
- Better growth rate.
- Less use of insecticides and pesticides.

5.3 Disadvantages

- No supply from grid.
- Another risk of hydroponics farming is the danger of water based microorganisms.
- Keeping the delicate balance of a hydroponic garden in check can be stressful for some, even though the benefits are ultimately great.
- By far, the biggest disadvantage to hydroponics is the cost involved.

5.4 Applications

- Used to grow crops where there is no fertile soil.
- Water can be used for drinking purpose and domestic use.
- Used in farming.

5.5 Future Scope

Hydroponics is the fastest growing sector of agriculture, and it could very well dominate food production in the future. As population increases and arable land declines due to poor land management, people will turn to new technologies like hydroponics and vertical farming to create additional channels of crop production. Currently, arable land comprises only around 3 percent of the Earth’s surface, and the world population is around 6 billion people, resulting in round 1/5 hectare (2,000 square meters) of arable land per capital by 2050, scientists estimate that the Earth's population will increase to 9.2 billion, while land available for crop and food production will decline. To feed the increasing population, hydroponics will begin replacing traditional agriculture.

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