A

Report On

"Automated Hydroponics System"

A MEGA PROJECT REPORT

Submitted to

Shivaji University, Kolhapur

In the partial fulfilment award of the Requirement for the degree of

Final Year of B.Tech

(COMPUTER SCIENCE AND ENGINEERING)

Submitted by

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Under the guidance of

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Submitted at

KOLHAPUR INSTITUTE OF TECHNOLOGY'S
COLLEGE OF ENGINEERING (AUTONOMOUS), KOLHAPUR

YEAR 2023-24

CERTIFICATE

This is to certify that Rugved Dattatray Todkar (2122010049), Shivraj Umesh Patole (2021000286), Jayesh Sharad Mole (2021000715), Shreyas Prakash Shelar (2021000060), Anuj Dilip Kadam (2021000579) have completed the project phase – II on subject entitled **"Automated Hydroponics System"**, in the fulfilment of the requirement for the award of final year (Computer Science and Engineering) of **KIT'S College of Engineering, Kolhapur** in the academic year **2023-24.**

Date:

Place: Kolhapur

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DECLARATION

We hereby declare that the Project entitled, **"Automated Hydroponics System"** Phase-II project report submitted to **KIT's College of Engineering, Kolhapur, Maharashtra, INDIA** in the partial fulfilment of the requirement for the **"Computer Science and Engineering"** is a bona fide work carried out by us. The material contained in this Project has not been submitted to any University or Institution for the award of any degree.

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ABSTRACT

1. Abstract

With the advent of civilization, open field/soil-based agriculture is facing some major challenges; most importantly decrease in per capita land availability. In 1960 with 3 billion population over the World, per capita land was 0.5 ha but presently, with 6 billion people it is only 0.25 ha and by 2050, it will reach at 0.16 ha.

Due to rapid urbanization and industrialization as well as melting of icebergs (as an obvious impact of global warming), arable land under cultivation is further going to decrease. Again, soil fertility status has attained a saturation level, and productivity is not increasing further with increased level of fertilizer application. Besides, poor soil fertility in some of the cultivable areas, less chance of natural soil fertility build-up by microbes due to continuous cultivation, frequent drought conditions and unpredictability of climate and weather patterns, rise in temperature, river pollution, poor water management and wastage of huge amount of water, decline in ground water level, etc. are threatening food production under conventional soil-based agriculture. Under such circumstances, in near future it will become impossible to feed the entire population using open field system of agricultural production only.

Naturally, soil-less culture is becoming more relevant in the present scenario, to cope up with these challenges. In soil-less culture, plants are raised without soil. Improved space and water conserving methods of food production under soil-less culture have shown some promising results all over the World.

INTRODUCTION

2. Introduction

Soil is usually the most available growing medium for plants. It provides nutrients, air, water, support etc. for plant growth. However, at times, problems like presence of disease-causing organisms, unsuitable soil reaction, degradation due to erosion, lack of water supply, lack of maintenance can occur which can lead to bad and diseased crops. Due to these circumstances soil-less agriculture can be introduced. One of the main and successful types of soil-less agriculture is HYDROPONIC SYSTEM.

Hydroponics is an increasingly popular method of growing plants that uses a nutrient rich solution with water base, which means that soil isn't used at all in this system. Instead, the roots of the plants are supported by some substance such as peat moss, rockwool etc. The only requirement for this system is water supply which provides nutrients to plants. As this method is green and useful, we decided to create an automated version of this system. Using different types of sensors, we are going to build a fully AUTOMATED HYDROPONIC SYSTEM.

In present study, automated hydroponic system is controlled and monitored by different electronic sensors such as water level indicator, humidity sensor, temperature sensor etc. present works covers mechanical and electronics knowledge for agriculture application. All variables like temperature, humidity and water flow can be controlled and supplied precisely without manual interface by using automated system.

1.1 How Traditional Farming is done

Traditional farming is the age-old practice of cultivating crops in soil, relying on natural factors like sunlight, water, and soil nutrients. This method has been the backbone of global agriculture for centuries and is deeply rooted in traditional knowledge and practices. Here are some key aspects:

1. **Soil-Based Cultivation:** Traditional farming relies on the fertility of the soil. Farmers prepare the land by tilling, adding organic matter, and sometimes using fertilizers to enhance soil fertility.
2. **Reliance on Weather Patterns:** Traditional farming is heavily dependent on weather conditions. Crop growth and yield are subject to variations in rainfall, temperature, and other environmental factors. Adverse weather events like droughts, floods, or storms can significantly impact crop productivity.

3. **Crop Diversity:** Traditional farming often supports crop diversity. Farmers typically grow a variety of crops suited to the local climate and soil conditions. This diversity can help mitigate risks associated with pests, diseases, and market fluctuations.
4. **Environmental Impact:** Conventional farming practices, such as the use of chemical fertilizers and pesticides, can have adverse effects on soil health, water quality, and biodiversity. Additionally, traditional farming often requires substantial land use, leading to deforestation and habitat loss.

1.2 Hydroponics and it's Efficiency

Hydroponics is a modern agricultural technique that involves growing plants without soil, using nutrient-rich water solutions. This method offers several unique advantages and challenges compared to traditional farming:

1. **Soilless Cultivation:** In hydroponics, plants are grown in a controlled environment where their roots are submerged in nutrient solutions. This method allows for precise control over nutrient levels, pH, and other environmental factors, resulting in faster growth rates and higher yields compared to traditional farming.
2. **Water Efficiency:** Hydroponic systems are highly water-efficient since they recirculate water within the system, minimizing water wastage. Compared to traditional farming, which often relies on irrigation systems that can lead to water runoff and soil erosion, hydroponics can help conserve water resources.
3. **Space Utilization:** Hydroponic systems can be set up vertically or in limited spaces, making them ideal for urban agriculture or areas with limited arable land. This vertical farming approach maximizes space utilization and allows for year-round cultivation, independent of seasonal variations.
4. **Energy Consumption:** While hydroponic systems offer advantages in water efficiency and space utilization, they often require significant energy inputs for artificial lighting, climate control, and nutrient circulation. This reliance on energy can increase operational costs and environmental footprint, especially if sourced from non-renewable energy sources.

PRESENT THEORIES AND PRACTICES

3. Present Theories and Practices

3.1 Existing System

3.1.1 Other Agricultural Technologies:

1. **Aquaponics:** Aquaponics combines aquaculture (raising fish) with hydroponics. In this integrated system, fish waste provides nutrients for plants, while the plants filter and clean the water for the fish. It's a sustainable and efficient method that minimizes water usage and fertilizer inputs.
2. **Aeroponics:** Aeroponics involves growing plants in an air or mist environment without soil or a hydroponic medium. Nutrient-rich water is sprayed directly onto plant roots, allowing for optimal nutrient absorption and oxygenation. Aeroponic systems are known for their high yields and efficient use of space.
3. **Vertical Farming:** Vertical farming utilizes vertical space to grow crops in stacked layers, often in controlled indoor environments. This approach maximizes land use efficiency and allows for year-round cultivation, independent of external weather conditions. Vertical farms can incorporate various hydroponic or aeroponic systems for nutrient delivery.
4. **Precision Agriculture:** Precision agriculture employs technologies such as GPS, sensors, drones, and data analytics to optimize farming practices. By collecting real-time data on soil moisture, nutrient levels, and crop health, farmers can make informed decisions to maximize yields while minimizing inputs like water, fertilizers, and pesticides.

3.1.2 Hydroponics:

While each of these alternative technologies offers unique advantages, hydroponics often stands out as a preferred method for several reasons:

1. **Water Efficiency:** Hydroponic systems are incredibly water-efficient, as they recirculate water within the system, minimizing wastage. In regions facing water scarcity or drought conditions, hydroponics can significantly reduce water usage compared to traditional farming methods.
2. **Space Utilization:** Hydroponic systems can be designed to maximize space utilization, making them ideal for urban agriculture or areas with limited arable land. Vertical hydroponic farms, in particular, can produce high yields in compact spaces, addressing the challenge of land constraints.

3. **Nutrient Control:** Hydroponic systems allow for precise control over nutrient levels, pH, and other environmental factors. This level of control promotes optimal plant growth and minimizes nutrient deficiencies or imbalances, resulting in higher yields and better-quality produce.
4. **Year-Round Cultivation:** Hydroponic systems can be operated indoors or in controlled environments, enabling year-round cultivation regardless of seasonal variations or adverse weather conditions. This continuous production cycle ensures a steady supply of fresh produce and reduces reliance on seasonal harvests.
5. **Minimized Environmental Impact:** Compared to traditional farming practices, hydroponics can reduce environmental impacts such as soil erosion, water pollution from runoff, and habitat destruction. Additionally, hydroponic systems can be designed to minimize or eliminate the need for chemical pesticides and fertilizers, enhancing sustainability.
6. **Innovation and Adaptability:** Hydroponics continues to evolve with advancements in technology, materials, and techniques. Innovations such as vertical stacking, automated monitoring systems, and nutrient film techniques (NFT) contribute to increased efficiency, scalability, and profitability in hydroponic farming.

While hydroponics may not be a one-size-fits-all solution for every agricultural context, its combination of water efficiency, space utilization, nutrient control, and environmental sustainability makes it a highly attractive option for addressing the challenges of modern agriculture. As technology continues to advance and adoption grows, hydroponics is poised to play a pivotal role in ensuring food security, resource conservation, and agricultural resilience in the face of global challenges such as climate change and population growth.

‘

REVIEW OF LITERATURE

4. Review of Literature

[1] Zhang, He; Asutosh, Ashish; Hu, Wei (2018-11-27). "Implementing Vertical Farming at University Scale to Promote Sustainable Communities: A Feasibility Analysis". Sustainability. 10 (12): 4429. doi:10.3390/su10124429. ISSN 2071-1050.

The paper describes the authors' statistical concept modeling in determining the potential advantages of developing a vertical farm at Huazhong University of Science and Technology. While the figures are conservative and project the farm's profitability in 10 to 20 years, it is based on metadata and not direct observation.

[2] Hoagland, D.R.; Snyder, W.C. (1933). "Nutrition of strawberry plant under controlled conditions.

(a) Effects of deficiencies of boron and certain other elements, (b) susceptibility to injury from sodium salts". Proceedings of the American Society for Horticultural Science. 30: 288–294.

[3] Authored by Nisha Sharma, Somen Acharya, Kaushal Kumar, Narendra Singhand O.P. Chaurasia, in the Journal of Soil and Water Conservation 17(4): 364-371,OctoberDecember 2018 ISSN: 022-457X,

This article discuss various hydroponics structures viz. wick, ebb and flow, drip, deep water culture and Nutrient Film Technique (NFT) system; their operations; benefit and limitations; performance of different crops and water conservation by this technique. It also talks about the pHand electric conductivity required for organic soilless farming.

[4] Authored b y M s . Mamta D . Sardar , Ms . Shraddh a V. Adman, Assistant Professor, MIT Academy of Engineering, Alandi Pune, Maharashtra, India. ISSN:2319 – 1163, Vol 2 Issue 3,

This article discusses various technologies available for Soilless farming and comparison of the performance of various crop in soil and soilless cultivation

[5] Authored by Bikram Pradhan and Bandita Deo, published in Current Science, Vol.116, No. 5,

This paper discusses about the origin of soil less farming and its present form throughout the world. Also, discusses all the important parameters of soilless farming and its large-scale implementation 13

[6] Allen V. Barker, Margie L. Stratton, in Fruit Crops, 2020

In hydroponic crop production, nutrients are in solution, and the nutrient supply is balanced and concentrated to supply nutrients to provide nutrient-rich foods from plants. Nutrient supply is not confounded by factors that limit nutrient availability in soil, and nutrient accumulation hydroponically grown fruits can be high. Hydroponics is studied also as a tool to investigate effects of nutrients in a medium on their entry into leaves and fruits.

[7] Dominique Blancard, in Tomato Diseases (Second Edition), 2012

In hydroponic cultivation, observing the root system poses less of a problem although the roots may sometimes be more difficult to retrieve. Simply open a bag of substrate or clear a channel to view a portion of the roots. The health status of these will be representative of the other roots buried within the substrate (Photo 433). It may also be advisable to consider extracting some of the 'water roots'. In cultures in NFT (nutrient film technique), the absence of substrate makes observation easier. The condition of the stem base should also be examined.

[8] Mohammad Khajeh-Hosseini, Farnoush Fallahpour, in Saffron, 2020

In hydroponics, the plant roots are maintained in either a static, continuously aerated nutrient solution, or a discontinuously flowing nutrient liquid solution (Benton, 1983). In aeroponics, water and minerals are supplied to the plant via a mist that deposits fine droplets of nutrient solution on the roots (Souret and Weathers, 2000). Such soilless culture systems could be implemented as an alternative to the current field culture of saffron (Mollafilabi et al., 2013).

[9] Thomsen. "Environmental Impacts of Urban Hydroponics in Europe". A Case study in Lyon. Technical Report, Department of Environmental Science, Aarhus University, Frederiksberg 399, Postbox 358, DK 4000 Roskilde, Denmark,2018.

In hydroponic crop production, nutrients are in solution, and the nutrient supply is balanced and concentrated to supply nutrients to provide nutrient-rich foods from plants. Nutrient supply is not confounded by factors that limit nutrient availability in soil, and nutrient accumulation hydroponically grown fruits can be high. Hydroponics is studied also as a tool to investigate effects of nutrients in a medium on their entry into leaves and fruits. 14

[10] Ferentinos. “Neural network-based detection of mechanical, sensor and biological faults in deep-through hydroponics. Technical report”, Department of Biological and Environmental Engineering, Cornell University, Ithaca, NY 14853, USA,2003.

The paper describes the authors' statistical concept modelling in determining the potential advantages of developing a vertical farm at Huazhong University of Science and Technology. While the figures are conservative and project the farm's profitability in 10 to 20 years, it is based on metadata and not direct observation.

SYSTEM ANALYSIS

5. System Analysis

5.1 Hydroponics System

Automated Hydroponics System

Hydroponics, a soilless method of cultivating plants, has emerged as a transformative force in modern agriculture. Revolutionizing traditional farming practices, hydroponics offers a plethora of benefits ranging from enhanced resource efficiency to increased crop yields.

Principles of Hydroponics:

At its core, hydroponics relies on providing plants with essential nutrients dissolved in water, bypassing the need for soil. By directly delivering nutrients to plant roots, hydroponic systems optimize nutrient uptake, resulting in faster growth rates and higher yields. The key principles of hydroponics include:

1. **Nutrient Solution:** Hydroponic systems utilize nutrient-rich water solutions containing essential elements such as nitrogen, phosphorus, potassium, and micronutrients. These solutions are carefully balanced to meet the specific needs of different plant species and growth stages.
2. **Root Environment:** In hydroponics, plant roots are immersed in the nutrient solution or housed in inert growing mediums such as perlite, vermiculite, or rockwool. This provides roots with direct access to nutrients, oxygen, and water, promoting robust root development and optimal plant growth.
3. **Controlled Environment:** Hydroponic systems operate in controlled environments where environmental factors such as temperature, humidity, light intensity, and pH levels are carefully monitored and regulated. This precision control ensures optimal growing conditions year-round, independent of external weather fluctuations.

Types of Hydroponic Systems:

Hydroponic systems come in various configurations, each offering unique advantages and suited to different growing environments and crop types. Some common types of hydroponic systems include:

1. **Nutrient Film Technique (NFT):** In NFT systems, plants are grown in channels or gullies with a thin film of nutrient solution flowing over the roots. This continuous flow of nutrient solution ensures ample oxygenation and nutrient delivery to plant roots.

2. **Deep Water Culture (DWC):** DWC systems suspend plant roots in a reservoir of aerated nutrient solution. This method provides excellent oxygenation to roots while supporting fast growth and high yields.
3. **Ebb and Flow (Flood and Drain):** Ebb and flow systems periodically flood plant roots with nutrient solution before draining it away. This cyclic flooding action promotes oxygenation and prevents waterlogging, ensuring healthy root development.
4. **Drip Irrigation:** Drip systems deliver nutrient solution directly to plant roots through drip emitters or tubing. This method allows for precise control over nutrient delivery and is well-suited for large-scale commercial hydroponic operations.

5.2 Basic Block Diagram of Automated Hydroponics System

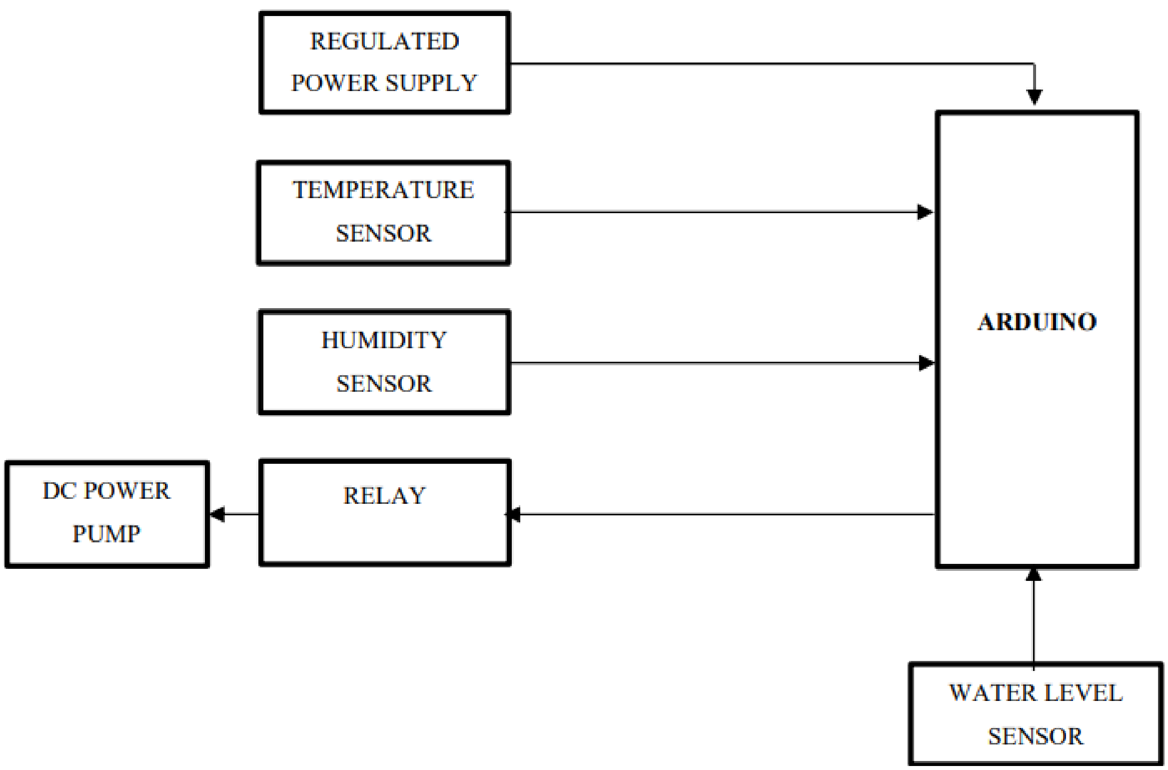


Figure 1: Block Diagram of Hydroponics

PROPOSED SYSTEM

6. Proposed System

6.1 Scope of Project

In India, the agriculture sector occupies a vital position in the overall economy of the country. However, the share of agriculture in national income has come down. Hence as an engineer, it is our responsibility to make developments in agriculture sector and maintain the economy. The main objective of this project is to make agriculture easier and produce high yields with less manual work.

6.2 Methodology: Block diagram for hydroponics:

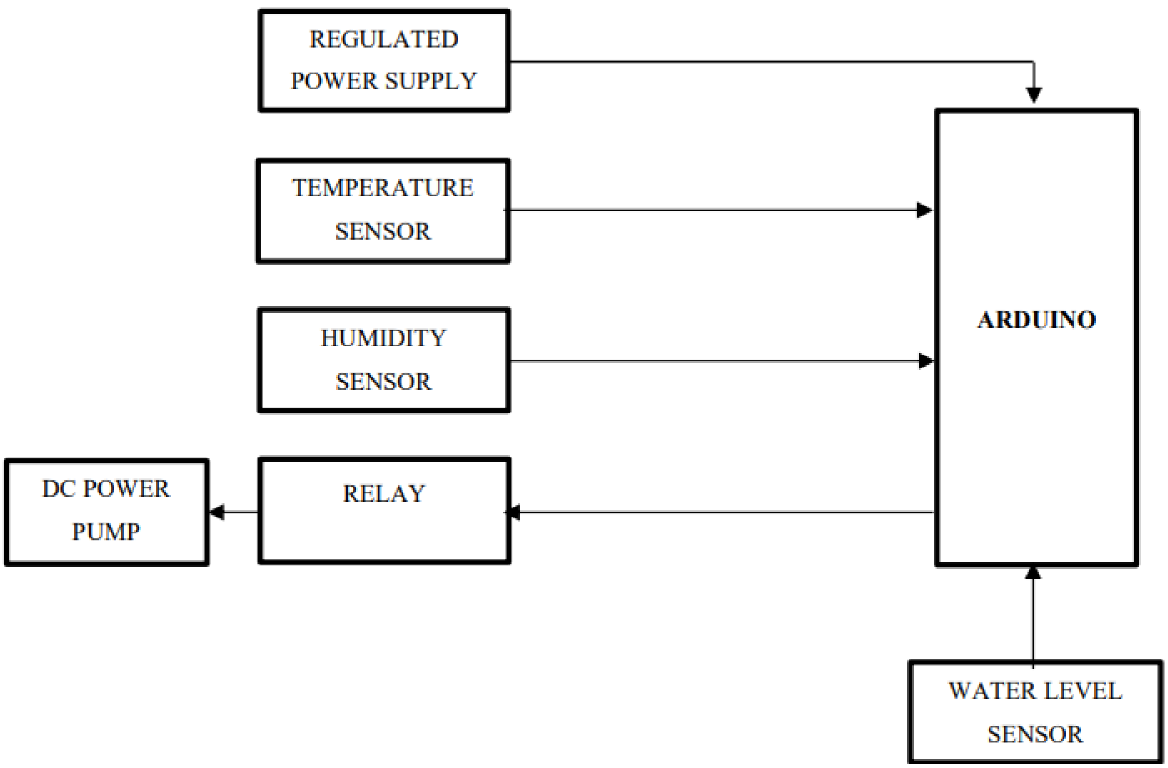


Figure 2: Block Diagram for Hydroponics

6.3 Proposed work

The project consists of following main sections –

1)Main Circuit

2)Power Supply

3)Relay Circuit

4)Temperature & Humidity Sensor

5)Water Pump

1) Main Circuit:

It consist of Arduino Uno, LCD 16x2 which is used to display parameters. Whereas Arduino acts as a brain of the entire system.

2) Power Supply:

Here, we are using 5V power supply. For this 7805 voltage regulator ICs are used. In this circuit, 230V AC supply is reduced by using 0V-5V-0V Centre tapped step down transformer whose secondary winding is connected to the rectifier circuit. Here we used capacitive filter to get pure DC output.

3) Relay Circuit:

A relay is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations.

4) Temperature & Humidity Sensor:

Humidity is the measure of water vapour present in the air. The level of humidity in air affects various physical, chemical and biological processes. So in semiconductor industries and control system industries measurement of humidity is very important. Humidity measurement determines the amount of moisture present in the gas that can be a mixture of water vapour, nitrogen or pure gas etc… Humidity sensors are of two types based on their measurement units. They are a relative humidity sensor and Absolute humidity sensor. DHT11 is a digital temperature and humidity sensor.

5) Water Pump:

Smaller electric water pumps, such as the kinds used in homes, usually have small DC motors. In the center of the motor is a rotor with coils around it. When the motor turns on, electricity runs through the coils, producing a magnetic field that repels the magnets around the rotor, causing the rotor to spin around 180 degrees. When the rotor spins, the direction of the electricity in the coils flips, pushing the rotor again and causing it to spin the rest of the way around. Through a series of pushes, the rotor continues to spin, driving the impeller and powering the pump.

REQUIREMENTS

7. Requirements

7.1 Major Components

1) Arduino Uno:

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

Features :-

• Microcontroller: Microchip ATmega328P

• Operating Voltage: 5 Volts

• Input Voltage: 7 to 20 Volts

• Digital I/O Pins: 14 (of which 6 can provide PWM output)

• UART: 1

• I2C: 1

• SPPI: 1

• Analog Input Pins: 6

• DC Current per I/O Pin: 20 mA

• DC Current for 3.3V Pin: 50 mA

• Flash Memory: 32 KB of which 0.5 KB used by bootloader

• SRAM: 2 KB

• EEPROM: 1 KB

• Clock Speed: 16 MHz

• Length: 68.6 mm

• Width: 53.4 mm

• Weight: 25 g

Arduino Uno Technical Specification:

Microcontroller	ATmega328P – 8 bit AVR family microcontroller
Operating Voltage	5V
Recommended Input Voltage	7-12V
Input Voltage Limits	6-20V
Analog Input Pins	6 (A0 – A5)
Digital I/O Pins	14 (Out of which 6 provide PWM output)
DC Current on I/O Pins	40 mA
DC Current on 3.3V Pin	50 mA
Flash Memory	32 KB (0.5 KB is used for Bootloader)
SRAM	2 KB
EEPROM	1 KB
Frequency (Clock Speed)	16 MHz

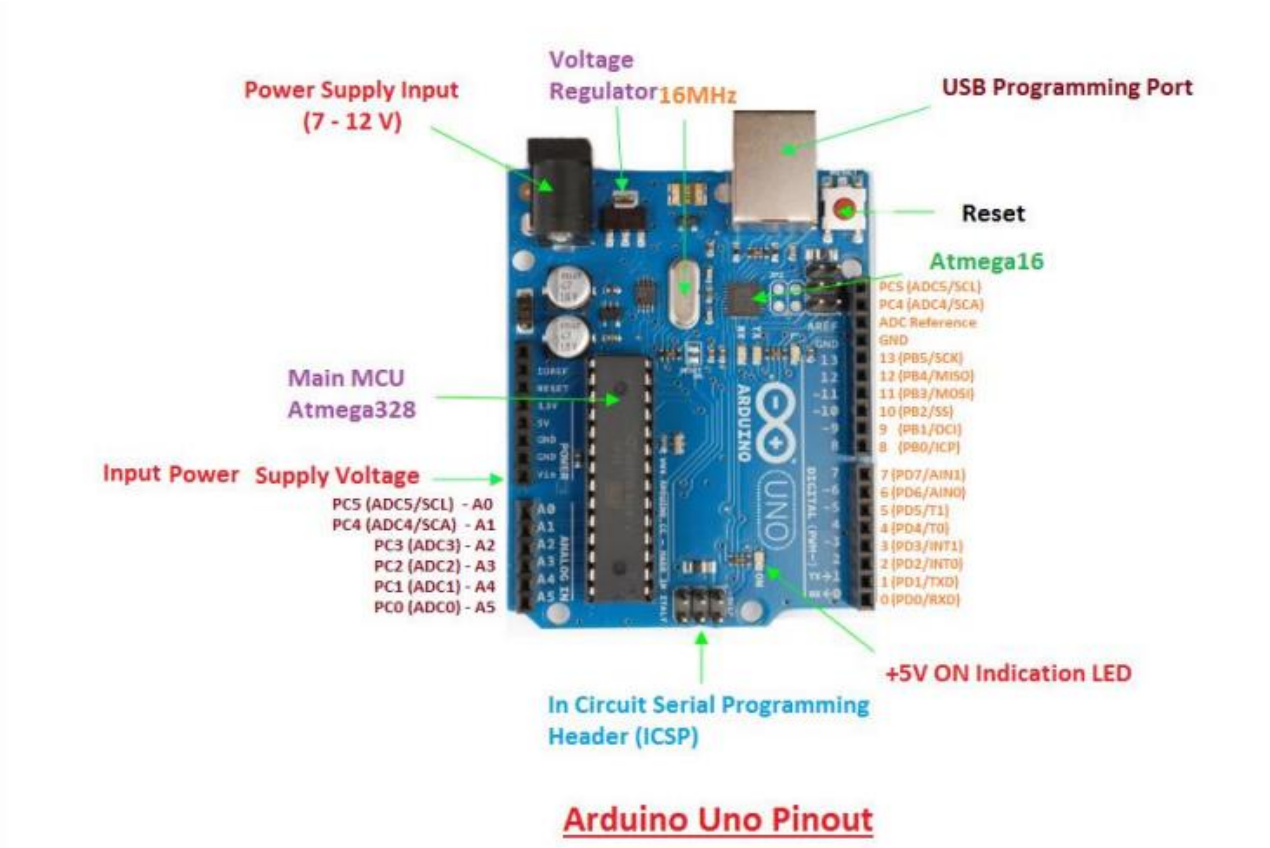


Figure 3: Pin Diagram

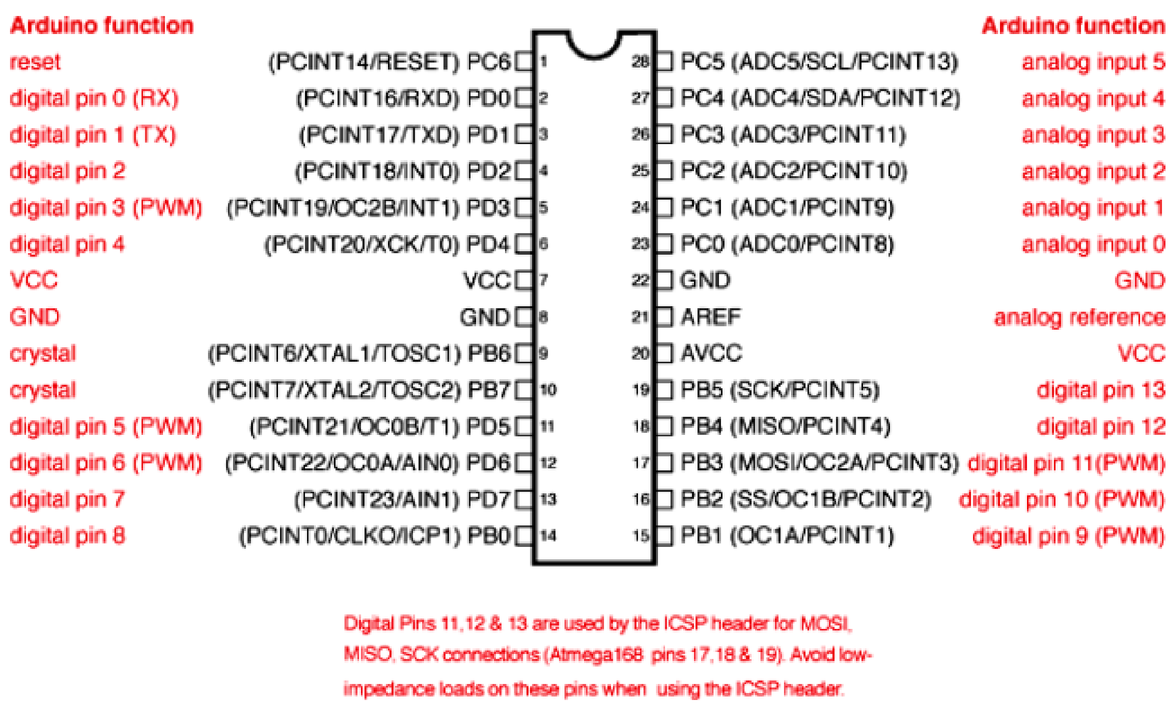


Figure 4: ATmega328 Pin Diagram

Pin Configuration:

Pin Category	Pin Name	Details
Power	Vin, 3.3V, 5V, GND	Vin: Input voltage to Arduino when using an external power source. 5V: Regulated power supply used to power microcontroller and other components on the board. 3.3V: 3.3V supply generated by on-board voltage regulator. Maximum current draw is 50mA. GND: ground pins.
Reset	Reset	Resets the microcontroller.
Analog Pins	A0 – A5	Used to provide analog input in the range of 0-5V
Input/Output Pins	Digital Pins 0 - 13	Can be used as input or output pins.
Serial	0(Rx), 1(Tx)	Used to receive and transmit TTL serial data.
External Interrupts	2, 3	To trigger an interrupt.
PWM	3, 5, 6, 9, 11	Provides 8-bit PWM output.
SPI	10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK)	Used for SPI communication.
Inbuilt LED	13	To turn on the inbuilt LED.
TWI	A4 (SDA), A5 (SCA)	Used for TWI communication.
AREF	AREF	To provide reference voltage for input voltage.

Arduino Uno is a microcontroller board based on 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button.

The 14 digital input/output pins can be used as input or output pins by using pinMode(), digitalRead() and digitalWrite() functions in arduino programming. Each pin operate at 5V and can provide or receive a maximum of 40mA current, and has an internal pull-up resistor of 20- 50 KOhms which are disconnected by default. Out of these 14 pins, some pins have specific functions as listed below:

• **Serial Pins 0 (Rx) and 1 (Tx):** Rx and Tx pins are used to receive and transmit TTL serial data. They are connected with the corresponding ATmega328P USB to TTL serial chip.

• **External Interrupt Pins 2 and 3:** These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.

• **PWM Pins 3, 5, 6, 9 and 11:** These pins provide an 8-bit PWM output by using analogWrite() function.

• **SPI Pins 10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK):** These pins are used for SPI communication.

• **In-built LED Pin 13:** This pin is connected with an built-in LED, when pin 13 is HIGH – LED is on and when pin 13 is LOW, its off.

Along with 14 Digital pins, there are 6 analog input pins, each of which provide 10 bits of resolution, i.e. 1024 different values. They measure from 0 to 5 volts but this limit can be increased by using AREF pin with analog Reference() function.

• Analog pin 4 (SDA) and pin 5 (SCA) also used for TWI communication using Wire library.

Arduino Uno has a couple of other pins as explained below:

• **AREF:** Used to provide reference voltage for analog inputs with analogReference() function.

• **Reset Pin:** Making this pin LOW, resets the microcontroller.

Programming Arduino:-

Once Arduino IDE is installed on the computer, connect the board with computer using USB cable. Now open the arduino IDE and choose the correct board by selecting Tools>Boards>Arduino/Genuino Uno, and choose the correct Port by selecting Tools>Port. Arduino Uno is programmed using Arduino programming language based on Wiring. To get it 26 started with Arduino Uno board and blink the built-in LED, load the example code by selecting Files>Examples>Basics>Blink. Once the example code (also shown below) is loaded into your IDE, click on the 'upload' button given on the top bar. Once the upload is finished, you should see the Arduino's built-in LED blinking. Below is the example code for blinking:

```
// the setup function runs once when you press reset or power the board
void setup()
{
      // initialize digital pin LED_BUILTIN as an output.
      pinMode(LED_BUILTIN, OUTPUT);
}

// the loop function runs over and over again forever
void loop()
{
digitalWrite(LED_BUILTIN, HIGH);        // turn the LED on (HIGH is the voltage level)
delay(1000);                            // wait for a second
digitalWrite(LED_BUILTIN, LOW);         // turn the LED off by making the voltage LOW
delay(1000);                            // wait for a second
}
```

2)LCD Display LM016L:

LCD modules are very commonly used in most embedded projects, the reason being its cheap price, availability and programmer friendly. Most of us would have come across these displays in our day-to-day life, either at PCO's or calculators. The appearance and the pinouts have already been visualized above now let us get a bit technical. 16×2 LCD is named so because; it has 16 Columns and 2 Rows. There are a lot of combinations available like, 8×1, 8×2, 10×2, 16×1, etc. but the most used one is the 16×2 LCD. So, it will have (16×2=32) 32 characters in total and each character will be made of 5×8 Pixel Dots.

Features :-

- Module size : 84W x 44H x 10.5T (max.) mm
- Effective display area : 61W x 15.8H mm
- Character size (5 x 7 dots) : 2.96W X 4.86H mm
- Character pitch : 3.55 mm
- Dot size : 0.56W x 0.66H mm
- Weight : about 35g

Figure 5: LCD Display

Contrast Control:

To have a clear view on the characters on the LCD, contrast should be adjusted. To adjust the contrast, the voltage should be varied. For this, a preset is used which can behave like a variable voltage device. As the voltage of this preset is varied, the contrast of the LCD can be adjusted.

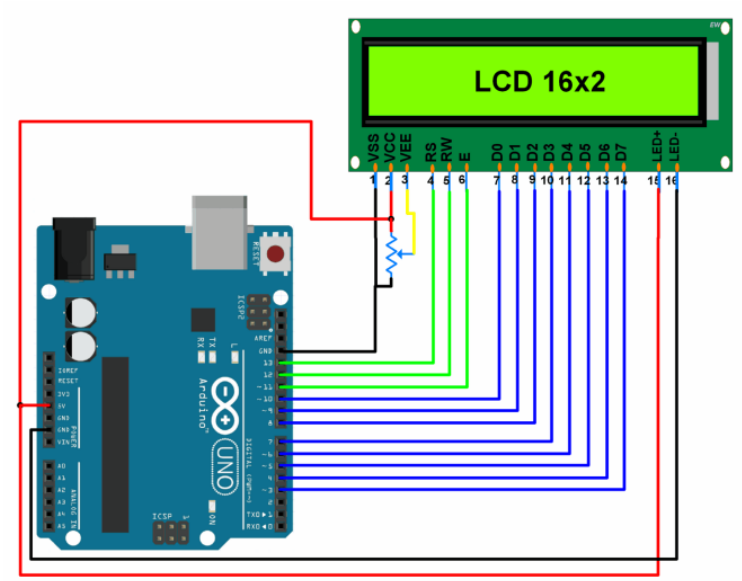


Figure 6: LCD Interfacing with Arduino

3)Humidity & Temperature Sensor:

Figure 7: DHT11 Sensor

Humidity is the measure of water vapour present in the air. The level of humidity in air affects various physical, chemical and biological processes. In industrial applications, humidity can affect the business cost of the products, health and safety of the employees. So, in semiconductor industries and control system industries measurement of humidity is very important. Humidity measurement determines the amount of moisture present in the gas that can be a mixture of water vapour, nitrogen, argon or pure gas etc… Humidity sensors are of two types based on their measurement units. They are a relative humidity sensor and Absolute humidity sensor. DHT11 is a digital temperature and humidity sensor.

Features :-

• Model: DHT11

• Operating Voltage: 3.5V to 5.5V

• Operating current: 0.3mA (measuring) 60uA (standby)

• Output: Serial data

• Temperature Range: 0°C to 50°C

• Humidity Range: 20% to 90%

• Resolution: Temperature and Humidity both are 16-bit

• Accuracy: ±1°C and ±1%

Pin#	Type	Parameters
Pin#1	Vcc	This pin is used for input purpose at this pin we apply 3.3 v to 5v input supply.
Pin#2	Data	By this pin we get output of temperature and humidity values, by serial transmission protocol.
Pin#3	N/C	Not Connected.
Pin#4	Ground	This pin is used for Ground (Connected to 0V or GND).

4) Relay:

A relay is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations thereof.

Features:

• Contact resistance: 100 mΩ max.

•Operate time: 10 ms max.

• Release time: 5 ms max.

• Max. switching frequency Mechanical: 18,000 operations/hr Electrical: 1,800 operations/hr at rated load

• Insulation resistance: 100 MΩ min. (at 500 VDC)

• Dielectric strength: 2,000 VAC, 50/60 Hz for 1 min between coil and contacts 750 VAC, 50/60 Hz for 1 min between contacts of same polarity.

• Impulse withstand voltage: 4,500 V (1.2 50 µs) between coil and contacts

• Vibration resistance Destruction: 10 to 55 to 10 Hz, 0.75-mm single amplitude (1.5-mm double amplitude)

• Malfunction: 10 to 55 to 10 Hz, 0.75-mm single amplitude (1.5-mm double amplitude)

• Shock resistance Destruction: 1,000 m/s2

• Malfunction: 100 m/s2

• Endurance Mechanical: 10,000,000 operations min. (at 18,000 operations/hr)

• Electrical: 100,000 operations min. (at 1,800 operations/hr)

• Ambient temperature Operating: −25°C to 85°C (with no icing)

• Ambient humidity Operating: 5% to 85%

Figure 8: Relay Module

5)Water Pump:

Smaller electric water pumps, such as the kinds used in homes, usually have small DC motors. The DC motor is contained in a sealed case attached to the impeller and powers it through a simple gear drive. In the center of the motor is a rotor with coils around it. Around those coils are magnets, which create a permanent magnetic field that flows through the rotor. When the motor turns on, electricity runs through the coils, producing a magnetic field that repels the magnets around the rotor, causing the rotor to spin around 180 degrees. When the rotor spins, the direction of the electricity in the coils flips, pushing the rotor again and causing it to spin the rest of the way around. Through a series of pushes, the rotor continues to spin, driving the impeller and powering the pump.

Features:-

• Driven method: Advanced BLDC Motor driving technology without any leakage.

• Life: long life span more than 15,000 hours .

• Duty work: It can sustain continuous 24hours work.

• Power supply: Motor designed suitable for battery, Power supplying.

• Working Fluids: Can be used to pump water, Antifreeze oil, acid and alkali solution.

• FG signal output

• Speed control way: PWM/Manual speed control function [optional].

• IP protection level: IP67.

• Blocked protection, Locked-rotor protection, Dry-running protection.

Figure 9: Water Pump

6) Power Supplu:

A 5V power supply is a device or circuit that provides a stable output voltage of 5 volts. This voltage level is commonly used in a wide range of electronic devices, circuits, and systems, serving as a standard power source for many components, including microcontrollers, sensors, LEDs, and integrated circuits.

Here's a detailed overview of a typical 5V power supply:

1. Voltage Regulation:

- A crucial aspect of a 5V power supply is its ability to maintain a constant output voltage of 5 volts, regardless of variations in input voltage or load conditions. This is achieved through voltage regulation mechanisms, often implemented using voltage regulators or voltage reference circuits.

2. Input Voltage Range:

- The input voltage range specifies the range of voltages that the power supply can accept as its input. For many 5V power supplies, this range typically extends from around 7 volts to 30 volts, although this can vary depending on the specific design and intended application.

3. Output Current Capacity:

- The output current capacity indicates the maximum amount of current that the power supply can deliver at its output while maintaining the specified output voltage of 5 volts. This parameter is crucial for determining the suitability of the power supply for driving various loads or components.

4. Efficiency:

- Efficiency refers to the ratio of output power to input power and is expressed as a percentage. A higher efficiency rating indicates that the power supply wastes less energy in the form of heat and is therefore more energy-efficient. Modern 5V power supplies often incorporate efficient switching regulator topologies to achieve high efficiency levels.

5. Output Ripple and Noise:

- Output ripple and noise represent variations or fluctuations in the output voltage of the power supply, typically caused by switching operations or other sources of interference. Minimizing ripple and noise is essential for ensuring stable and reliable operation of connected electronic devices.

6. Protections:

- Many 5V power supplies incorporate various protection features to safeguard against potentially damaging conditions, such as overvoltage, overcurrent, and short circuits. These protections help prevent damage to both the power supply itself and the connected electronic components.

7. Form Factor and Mounting Options:

- 5V power supplies are available in a variety of form factors, including wall adapters, desktop power supplies, and PCB-mounted modules. The choice of form factor depends on factors such as the intended application, space constraints, and mounting preferences.

8. Certifications and Standards:

- Depending on the intended use and market requirements, 5V power supplies may undergo certification testing to comply with industry standards and regulations, such as safety standards (e.g., UL, CE) and energy efficiency requirements (e.g., ENERGY STAR).

Figure 10: Power Supply

CIRCUIT DIAGRAM

8. Circuit Diagram

8.1.1 Circuit Diagram for Hydroponics

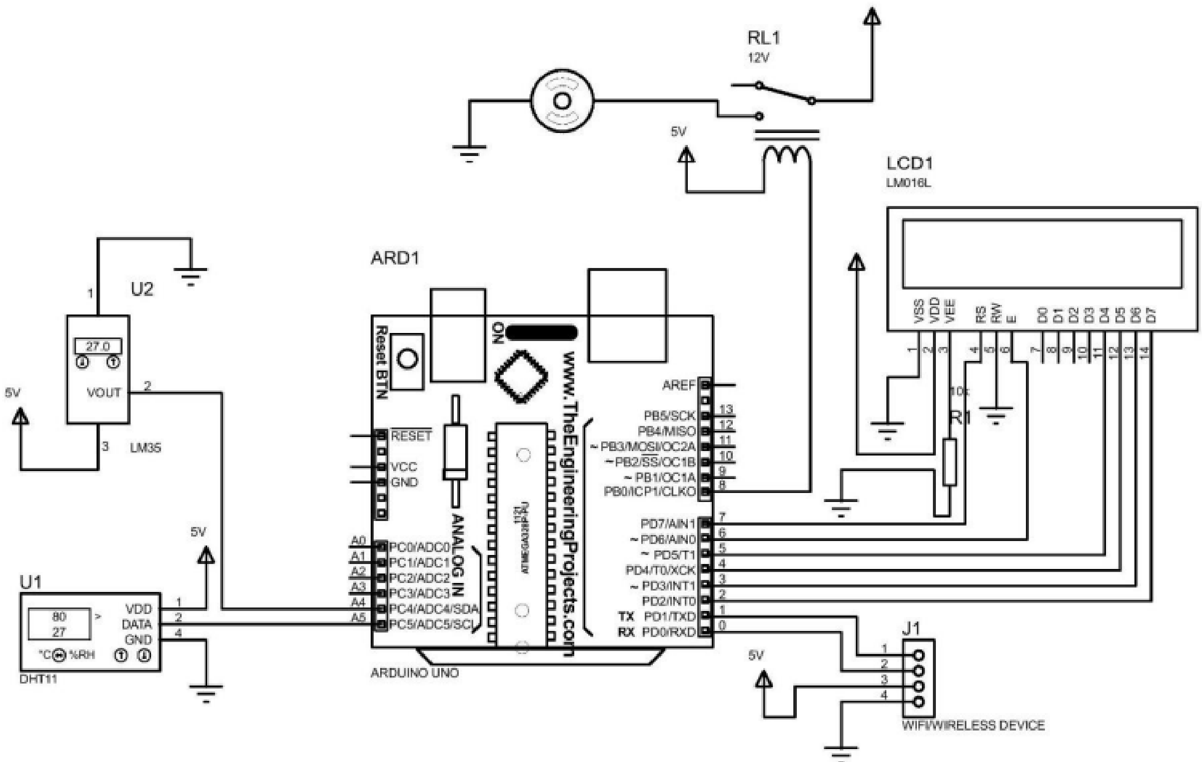
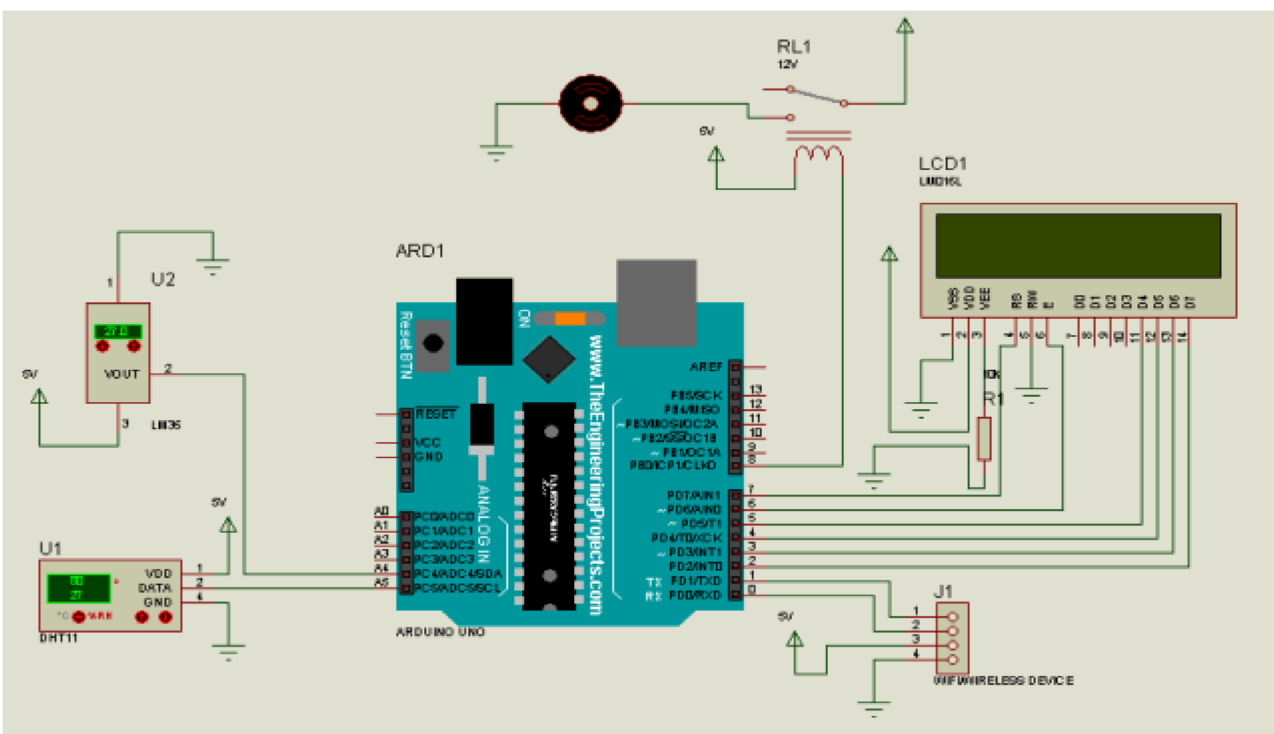


Figure 11: Circuit Diagram



IMPLEMENTATION

9. Implementation

9.1 Software Implementation:

9.1.1. Software used and its features:

1) Arduino IDE:

The Arduino IDE is an open-source software, which is used to write and upload code to the Arduino boards. The IDE application is suitable for different operating systems such as Windows, Mac OS X, and Linux. It supports the programming languages C and C++. Here, IDE stands for Integrated Development Environment.

Features:

•The Functions window gives fast access to the functions in each C/C++ source code module.

•The Code Completion list and Function Parameter information helps you to keep track of symbols, functions, and parameters.

•Dynamic Syntax Checking validates the program syntax while you are typing and provides real-ime alerts to potential code violations before compilation.

2) Proteus:

The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards.

Features:

• Runs on Windows 98/Me/2k/XP and later.

• Automatic wire routing and dot placement/removal.

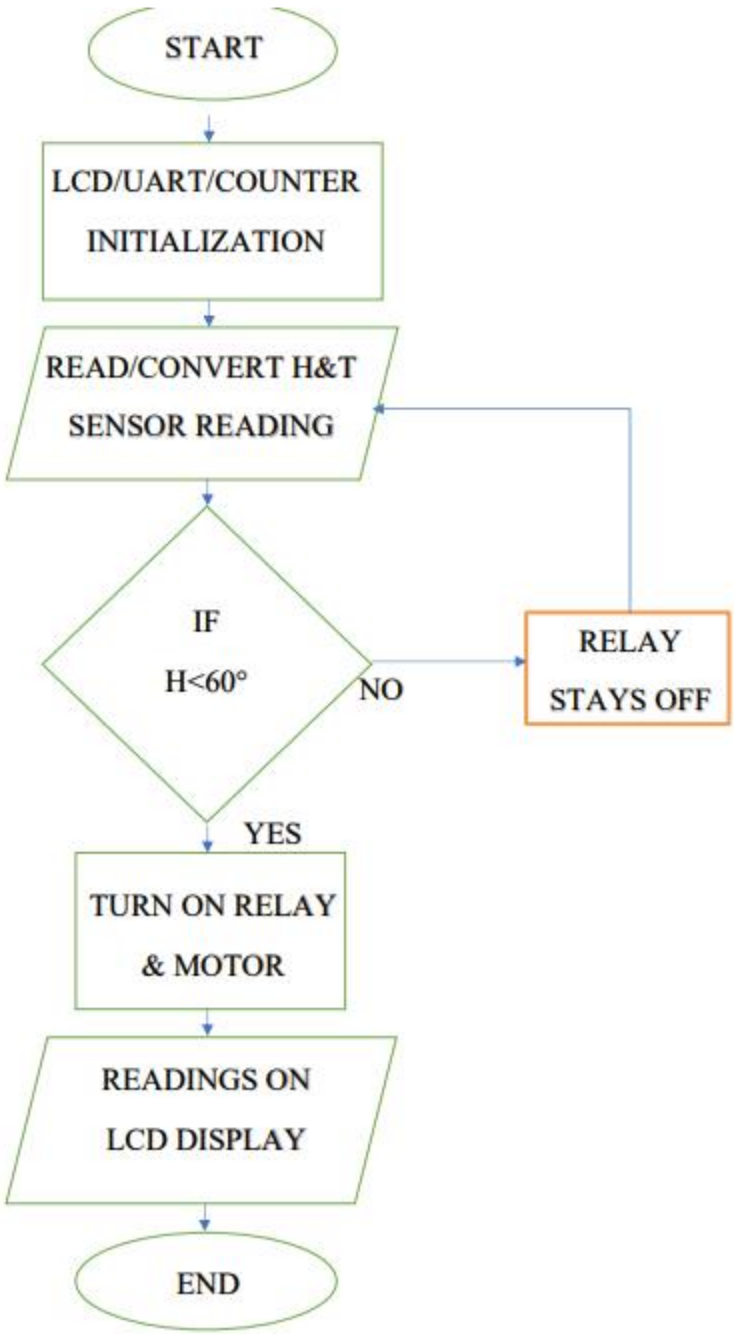
• Powerful tools for selecting objects and assigning their properties.

• Total support for buses including component pins, inter-sheet terminals, module ports and wires.

• Bill of Materials and Electrical Rules Check reports.

• Netlist outputs to suit all popular PCB layout tools.

9.1.2. Flowchart:

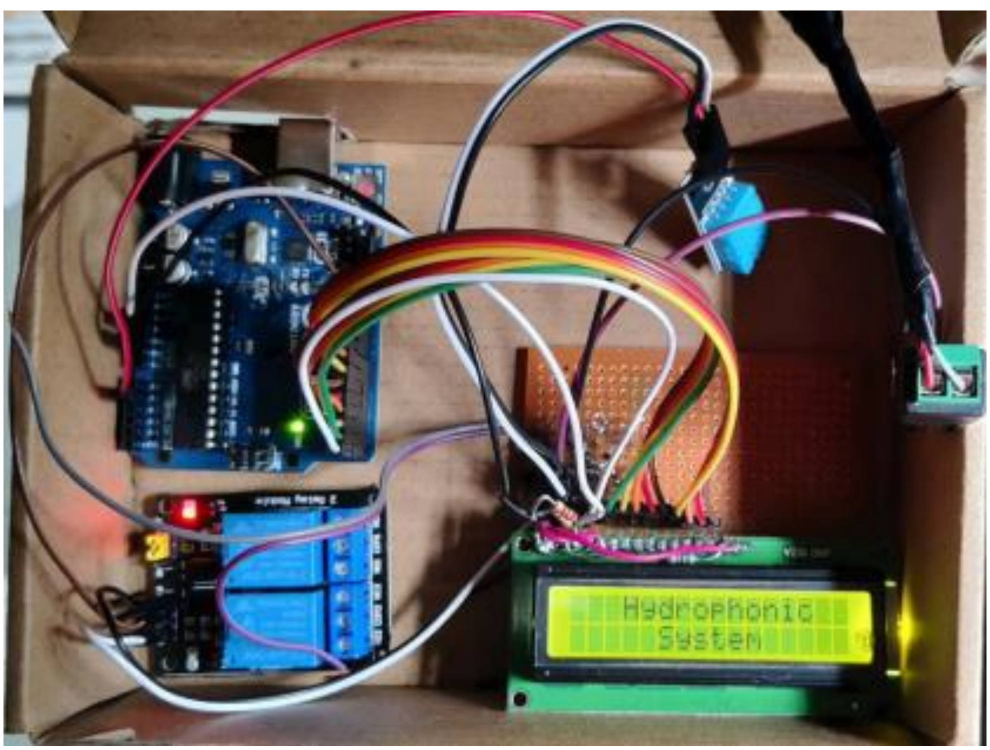


9.1.3. Software Testing:

We used Proteus for simulation purpose and Arduino IDE for programming of the Microcontroller. The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards. The Arduino IDE is an open-source software, which is used to write and upload code to the Arduino boards. The IDE application is suitable for different operating systems such as Windows, Mac OS X, and Linux. It supports the programming languages C and C++. Here, IDE stands for Integrated Development Environment

9.2. Hardware Testing:

We were successfully able to complete the hardware connection of the proposed work. We mounted the components neatly and tested them one by one for our project scenario and they found out to be in good working condition. We mounted the components on broad cardboard paper for the stable access to the project.



9.3 Results:

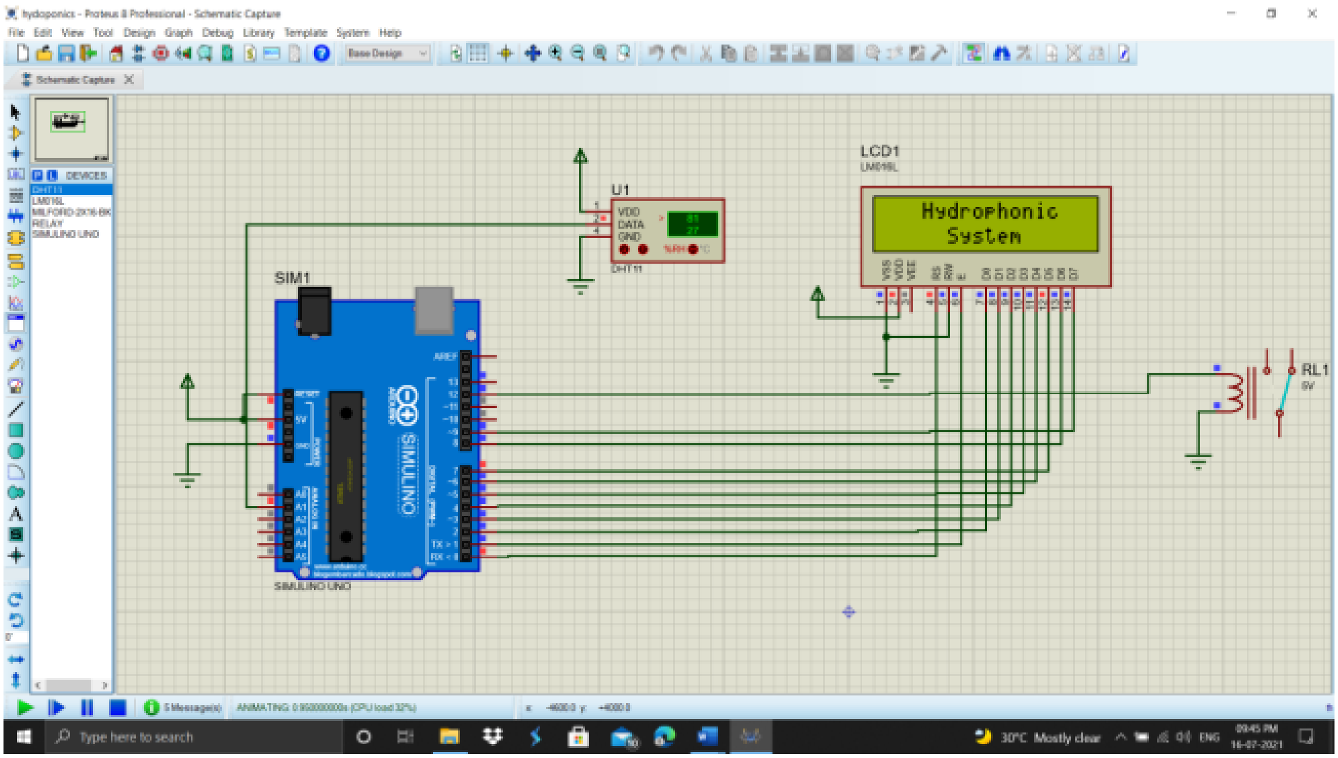
In this system we are using a Temperature & Humidity sensor for output. Output of the H&T sensor is digital. . It has humidity sensor and thermistor in it. There is a basic chip inside that does some analog to digital conversion and spits out a digital signal with the temperature and humidity. There is a 16×2 LCD which is also connected to the controller. We can show humidity and temperature on it. From the output of the sensor Arduino decides to switch on or to switch off the water pump by a relay.

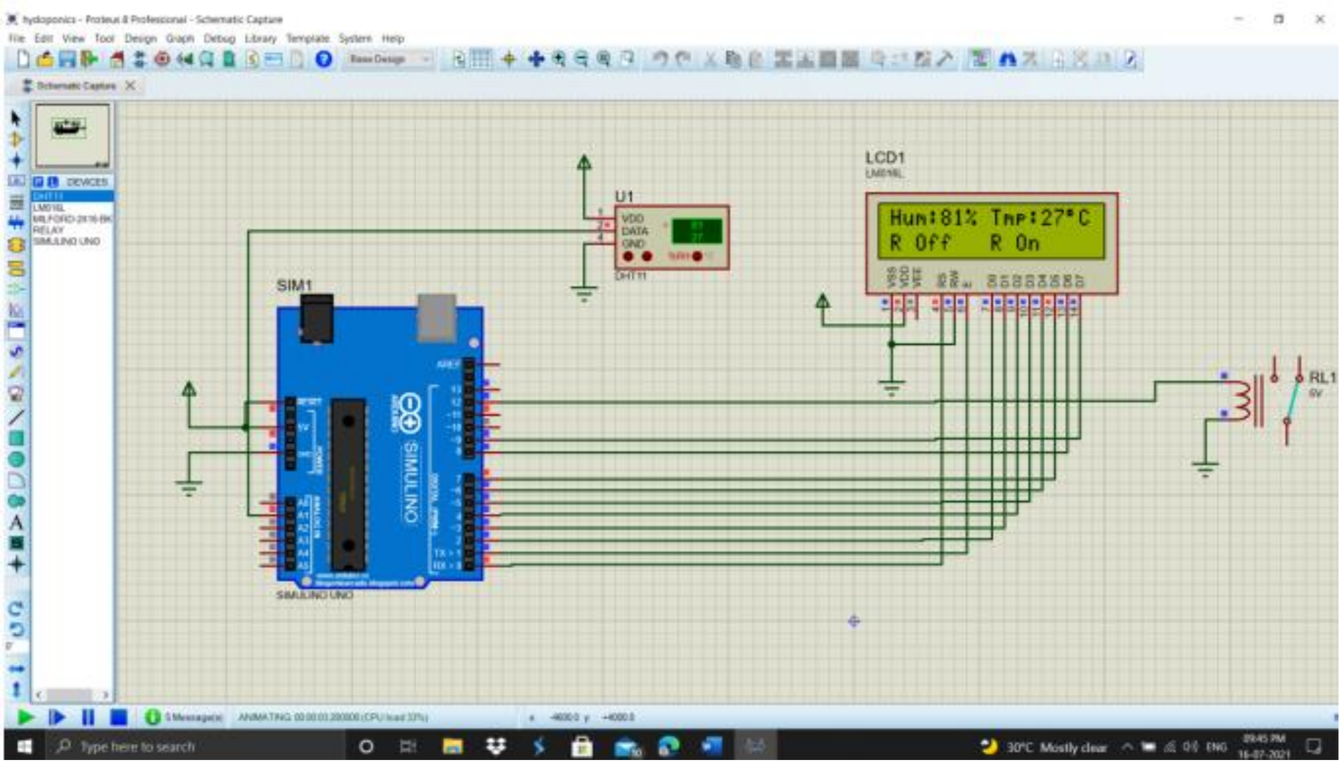
Generally, plants require five essential things: sunlight, proper temperature, moisture, air and nutrients. We can provide everything in this hydroponics system. We will see that this hydroponic plant will grow well with proper water and nutrient usage because it is controlled with an automatic system. The rate of hydroponic plant growth was faster when compared to plants with soil-grown systems.

The sensor will detect if there is a decrease in the water level in hydroponic nutrition tube. If the water level has decreased, then the sensor will report the results and automatically the water pump will be turned on to increase the water level on the hydroponic nutrient tube. Hence this system will benefit in every possible way. The main advantage of this system is that we can implement this system anywhere(outdoor/indoor) and the manual labour required will be from less to zero for large scale and small scale respectively.

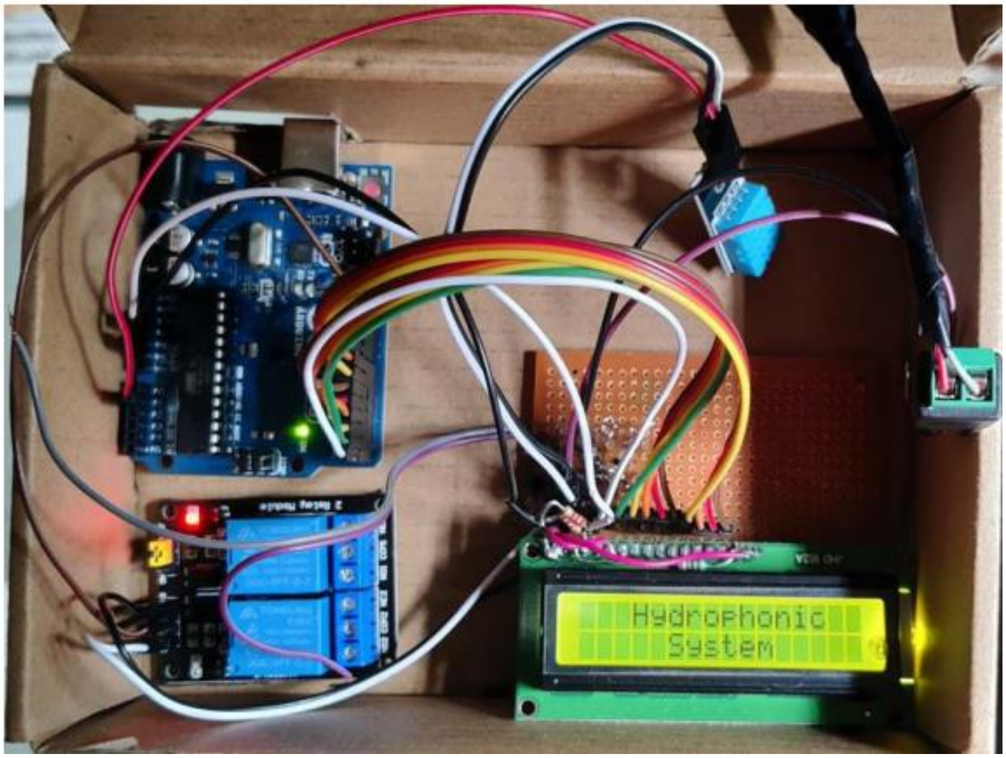
9.3.1 Simulation Results:

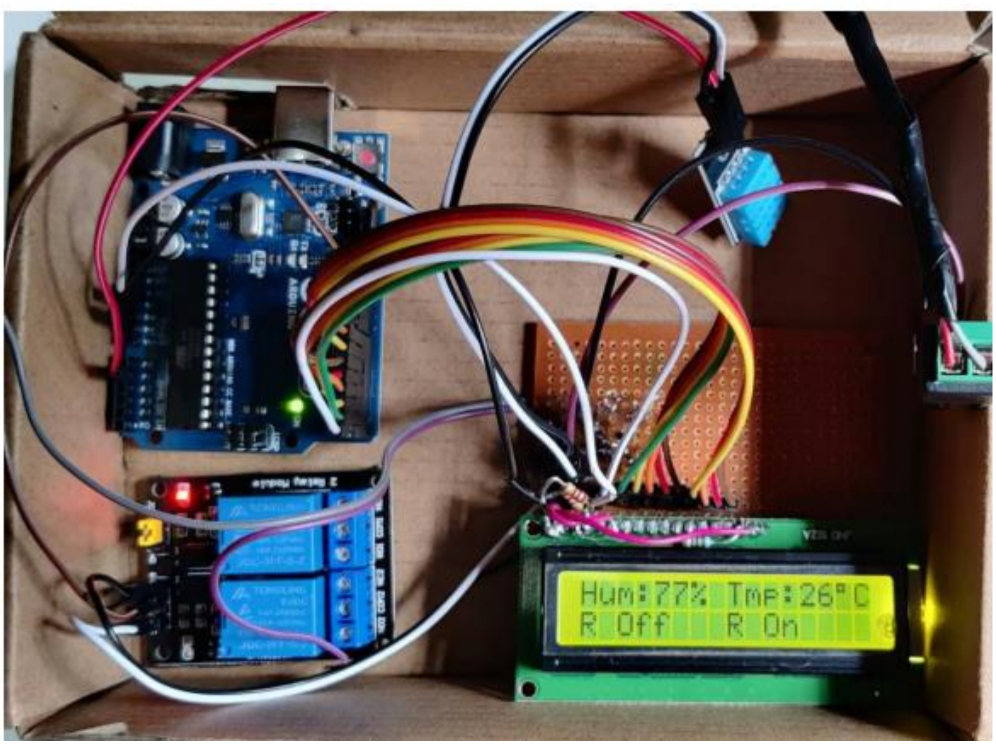
In these snapshots, we have simulated the outputs of DHT11 on the LCD. It is connected to the digital output ports of the Arduino Uno. It will show the temperature and humidity readings on it, and also the state of the relay & motor. Temperature and humidity are inversely proportional so if the temperature rises, humidity will decrease & vice versa. This will decide whether the relay and motor will be turn on or off

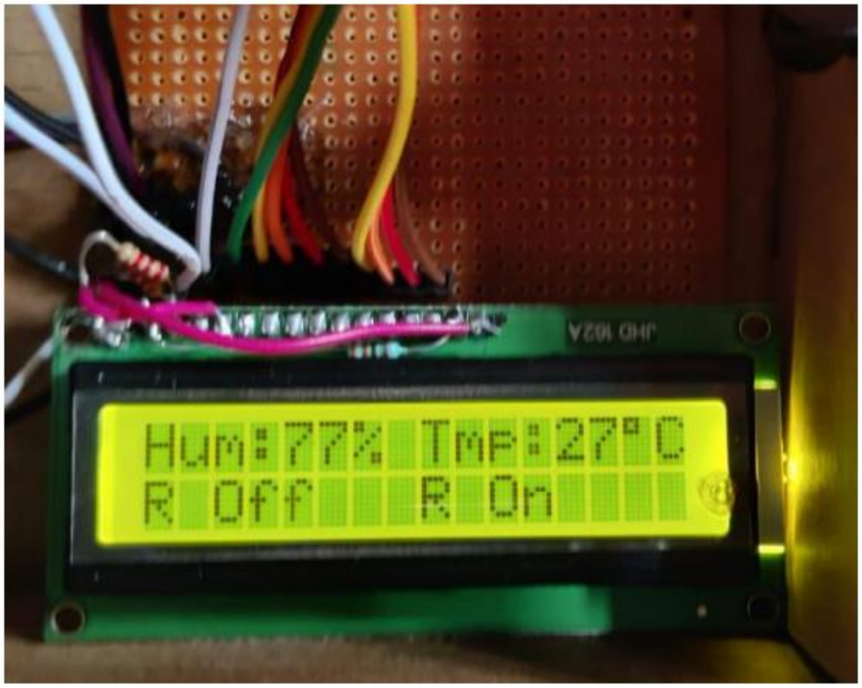

LCD1
Hydrophonic
System
U1
SIM1
RL1
SIMULINO UNO

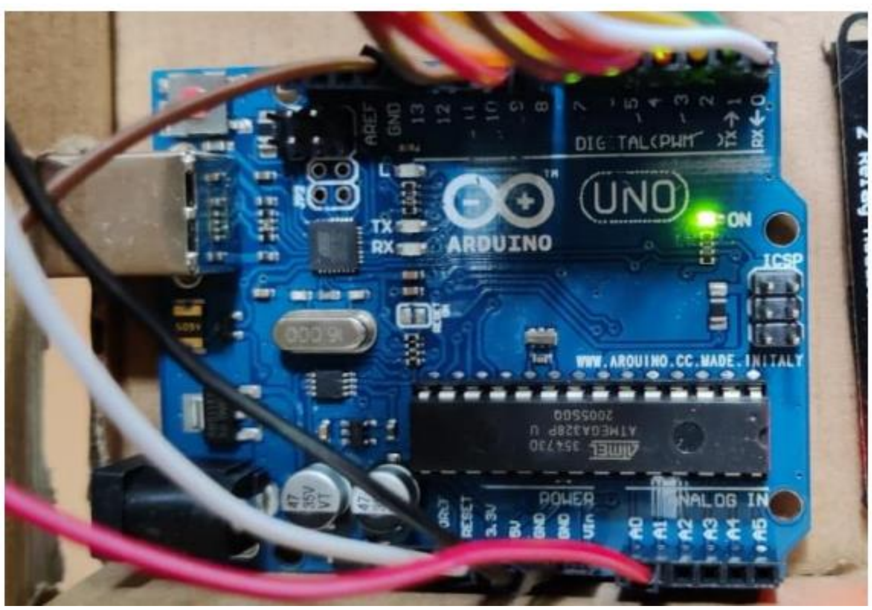

LCD1
Hum:81% Tmp:27°C
R Off R On
U1
SIM1
RL1
SIMULINO UNO

9.3.2 Working Circuit:






JHD 162A
Hum:77% Tmp:27°C
R Off R On


UNO
ARDUINO
DIGITAL(PWM~)
ON
ICSP
WWW.ARDUINO.CC.MADE.INITALY
POWER
ANALOG IN

CONCLUSION

10. Conclusion

The industry is expected to grow exponentially also in future, as conditions of soil growing is becoming difficult. Specially, in a country like India , where urban concrete conglomerate is growing each day , there is no option but adopting soil-less culture to help improve the yield and quality of the produce so that we can ensure food security of our country. However, Government intervention and Research Institute interest can propel the use of this technology

10.1 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 aeroponics to create additional channels of crop production. To get a glimpse of the future of hydroponics, we need only to examine some of the early adopters of this science. In Tokyo, land is extremely valuable due to the surging population. To feed the citizens while preserving valuable land mass, the country has turned to hydroponic rice production. The rice is harvested in underground vaults without the use of soil. Because the environment is perfectly controlled, four cycles of harvest can be performed annually, instead of the traditional single harvest.

Hydroponics also will be important to the future of the space program. NASA has extensive hydroponics research plans in place, which will benefit current space exploration, as well as future, long-term colonization of Mars or the Moon. As we haven't yet found soil that can support life in space, and the logistics of transporting soil via the space shuttles seems impractical, hydroponics could be key to the future of space exploration. The benefits of hydroponics in space are two-fold: It offers the potential for a larger variety of food, and it provides a biological aspect, called a bio-regenerative life support system. This simply means that as the plants grow, they will absorb carbon-di-oxide and stale air and provide renewed oxygen through the plant's natural growing process. This is important for long-range habitation of both the space stations and other planets.

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