A Project Report on

Vertical Farming using Aeroponics

Domain
Embedded System

Submitted to
Savitribai Phule Pune University
In Partial Fulfillment of the Requirement for the Award of

BACHELOR'S DEGREE IN
ELECTRONICS AND TELECOMMUNICATION ENGINEERING

Submitted By

RITU SINGH (GR. No. U1610151)
SIDDHI TONMARE (GR. No. U1610478)
NIPUN JAISWAL (GR. No. U1510544)

Under the guidance of
Prof. Pravin G. Gawande

Department of Electronics and Telecommunication Engineering
VISHWAKARMA INSTITUTE OF INFORMATION TECHNOLOGY, PUNE
(An Autonomous Institute Affiliated to Savitribai Phule Pune University)

MAY 2020

Abstract

Vertical farming had become a hot topic among peak development countries.However vertical farming is tough to practise because minor changes on encompassing would go away big impact to the productivity and quality of farming activity.Thus,aim of this project is to supply vertical farming monitoring system to assist keeping track on the physical conditions of the crops.In this system variety of sensors are used to detect current physical conditions and send the data to Arduino microcontroller either in analog or digital form.Then the data is processed by Arduino.Furthermore,the moisture,humidity,temperature of the coco peat is measured and monitored for the selected crops.The system also provides basic remote functions so that user can turn on/off the watering system.Web based application is used to display the gathered data. With the development implemented in the vertical farming,productivity and yield of the crops is increased significantly by 80 percent as compared to the traditional farming.

Contents

List of Tables

List of Figures

Enclosed CD with complete details of projects.
(*Seminar report document, seminar reprort ppt, Project reort and ppt, design layouts, PCB layouts, program simulations, working videos, datasheets*)

Chapter 1

Introduction

“We live vertically, so why can’t we farm vertically?”[1] Thanks to the limited access to land for farming, there’s a requirement for sustaining farming tasks so on pave the way for adding to food needs[2]. Many aspects continue food industry and processing such as: growth of population and its growing needs accordingly, reduction of natural sources because of growing cities, earth erosion, different forms of contamination, advent of biofuels, restrictions imposed on food production techniques suffering from customers and rule providers which needs better quality, less use of chemicals and lots of useful environmental attempts ‘from farm to fork’[3]. Recently, environmental obsessions are mixed with rising obsession with health as architecture design cares. Therefore, it’s led to more interest in providing healthy food and incorporating it within the sustainable development project[4]. The answer to those issues is Vertical Farming (VF). VF has grown as a project which combines the design of building and farms all together in a high-rise building. VF may be a system of growing crops in skyscrapers, to maximize the utilization of land by having a vertical design whereby plants, animals, fungi and other life forms are cultivated for food, fuel, fiber by artificially stacking them vertically above each other. Vertical farms are now used in a lot of countries. At present, these farms are largely grown and produce differing types of crops inside cities.

There are an excellent many publications on farming in cities and VF. However, little has been published on the technology of VF. So far, there has been no systematic analysis the design of the VF[5].

1.1 Literature survey

Vertical farming is that the practice of manufacturing food in vertically stacked layers, like during a skyscraper, used warehouse, or shipping container. The modern ideas of vertical farming use indoor farming techniques and controlled-environment agriculture (CEA) technology, where all environmental factors are often controlled. These facilities utilize artificial control of sunshine, environmental control (humidity, temperature, gases...) and fertigation. No General Structure of Vertical Farming. The vertical farms differ from one city to another [6]. Aeroponics is a technological leap forward from traditional hydroponics. An aeroponic system is defined as an enclosed air and water/nutrient ecosystem that fosters rapid plant growth with little water and direct sun and without soil or media [7]. The word aeroponics derived from Latin word aero (air) and ponic (work)[8]. The major determinants driving the growth of the market are the rising need for high-quality and large volumes of food, reduced environmental impact, and lack of availability of cultivable land area. Vertical farming enables the cultivation of food in great quantity during a limited acreage, thus overcoming the crucial challenge of catering to the rising global demand for food.The aeroponics is the agriculture with non-stop production cycle[9][10][11].

1.2 Objectives

- **Objective 1** It offers a plan to handle future food demands.
- **Objective 2** It allows crop to grow year-round
- **Objective 3** Less use of water in cultivation.
- **Objective 4** Not affected by unfavourable weather conditions.
- **Objective 5** Human and environmentally friendly

1.3 Motivation

Recently, the application of Vertical Farming into cities has increased. Vertical farming is a cultivating vegetable vertically by new agricultural methods, which combines the design of building and farms all together in a high-rise building inside the cities. This technology needs to be manifest both in the agricultural technique and architectural technology together, however, little has been published on the technology of Vertical Farming. In this study, technology as one of the important factor of Vertical farming is discussed and reviewed by qualitative approach. In the first, identifying existing and future VF projects in Europe, Asia, and America from 2009 to 2016. Then a comprehensive literature reviewed on technologies and techniques that are used in VF projects. The study resources were formed from 62 different sources from 2007 to 2016. The technologies offered can be a guide for implementation development and planning for innovative and farming industries of Vertical Farming in cities. In fact, it can act as a basis for evaluating prospective agriculture and architecture together. The integration of food production into the urban areas have been seen as a connection to the city and its residents. It simultaneously helps to reduce poverty, adds to food safety, and increases contextual sustainability and human well-being..

1.4 Circuit diagram of Power Supply

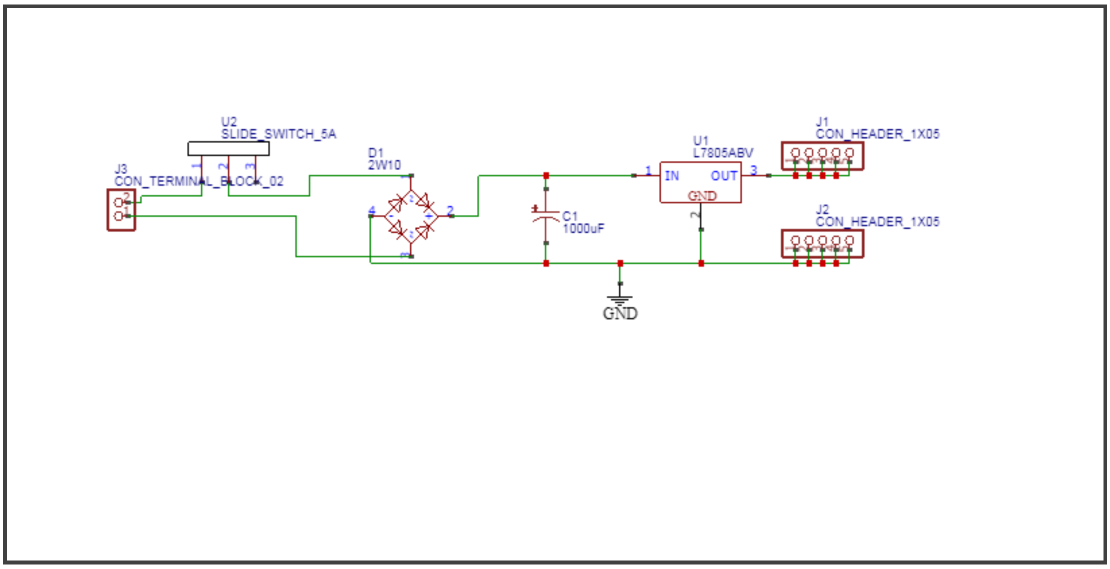


Figure 1.1: Circuit diagram of power supply

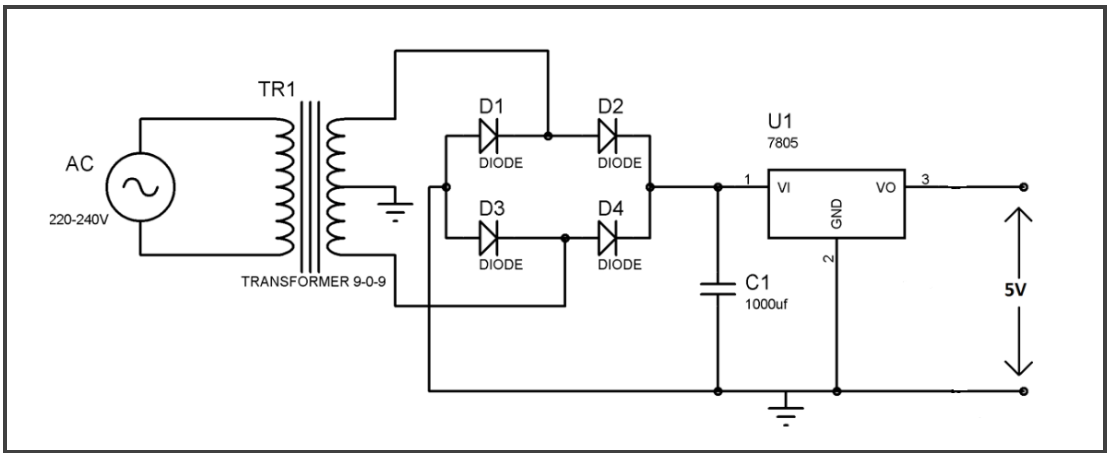


Figure 1.2: Circuit diagram of supply circuit

1.4.1 Working / operation of circuit

1. Step down AC voltage

As we are converting 230V AC into a 5V DC, first we need a step-down transformer to reduce such high voltage. Here we have used 9-0-9 1A step-down transformer, which convert 230V AC to 9V AC. In transformer there are primary and secondary coils which step up or step down the voltage according to the no of turn in the coils.Selection of proper transformer is very important. Current rating depends upon the Current requirement of Load circuit (circuit which will use the generate DC). The voltage rating should be more than the required voltage. Means if we need 5V DC, transformer should at least have a rating of 7V, because voltage regulator IC 7805 at least need 2V more i.e. 7V to provide a 5V voltage.

2. Rectification

Rectification is the process of removing the negative part of the Alternate Current (AC), hence producing the partial DC. This can be achieved by using 4 diodes. Diodes only allow current to flow in one direction. In first half cycle of AC diode D2 D3 are forward biased and D1 and D4 are reversed biased, and in the second half cycle (negative half) Diode D1 and D4 are forward biased and D2 and D3 are reversed biased. This Combination converts the negative half cycle into positive.A full wave bridge rectifier component is available in the market, which consist that combination of 4 diode internally

3. Filtration

The output after the Rectification is not a proper DC, it is oscillation output and has a very high ripple factor. We don't need that pulsating output, for this we use Capacitor. Capacitor charge till the waveform goes to its peak and discharge into Load circuit when waveform goes low. So when output is going low, capacitor maintains the proper voltage supply into the Load circuit, hence creating the DC.Here is the formulae:

C = I * t / V

C= capacitance to be calculated

I= Max output current (let's say 500mA)

t= 10ms,

We will get wave of 100Hz frequency after converting 50Hz AC into DC, through full wave bridge rectifier. As the negative part of the pulse is converted into positive, one pulse will be counted two. So the Time period will be 1/100= .01 Second= 10ms

V = Peak voltage – voltage given to voltage regulator IC (+2 more than rated means

5+2=7)

9-0-9 is the RMS value of transforms so peak voltage is Vrms * 1.414= 9* 1.414= 12.73v

Now 1.4v will be dropped on 2 diodes (0.7 per diode) as 2 will be forward biased for half wave.

So 12.73 – 1.4 = 11.33v

When capacitor discharges into load circuit, it must provide 7v to 7805 IC to work so finally V is:

V = 11.33 – 7= 4.33v

So now C = I * t / V

C = 500mA * 10ms / 4.33 = .5 * .01 / 4.33 = 1154uF 1000uF

Chapter 2

Block diagram and Design

2.1 Block diagram of Aeroponics System

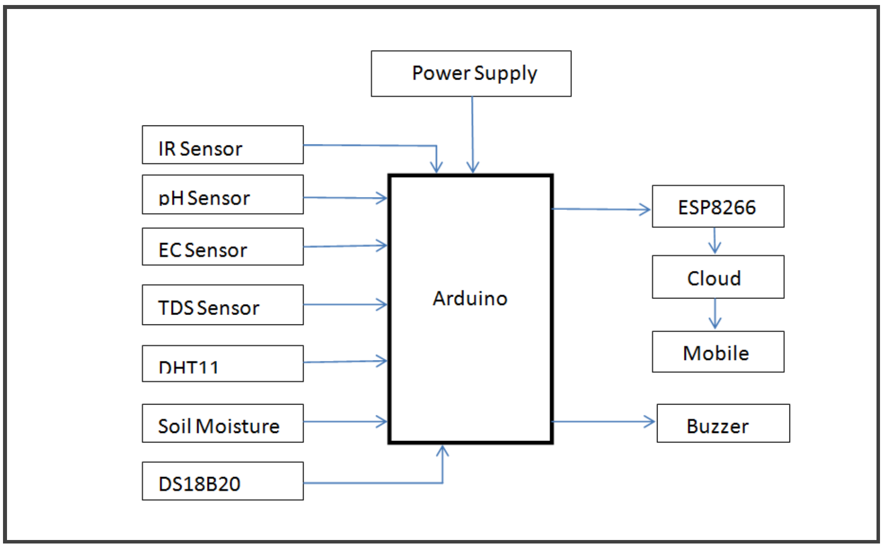


Figure 2.1: Block diagram of Aeroponics System

2.2 Description of Block diagram

1. Controller: In this project we use arduino controller for processing of data collected by sensors and display the message containing information about nutrients content in the plant and parameters like temperature, humidity, pH sensor on the user's mobile using Wi-Fi technology.
2. DHT11 Sensor: DHT11 sensor is used for measuring the temperature and humidity of the surroundings in which the crop is grown. So, it will give information about temperature and humidity of the crops.
3. Moisture sensor: Moisture Sensor will measure the amount of moisture present in coco peat at initial stage of growth. After the roots of the crops have grown it will be shifted to vertical pipe where water will be sprinkled and moisture content

will be measured.
4. pH sensor: pH condition is important parameter because it affects the growth of crops. pH optimum has range 5.8-6.5. So, pH sensor is used in system to monitor the pH of the nutrition water prepared for the crops.
5. Electrical Conductivity sensor: This sensor will measure the electrical conductivity of the nutrition water as it affects the growth of the crops.
6. IR Sensor: To measure the level of crop growth.
7. Esp8266 Wi-Fi Module: The data collected by various sensors will be sent to the cloud using Wi-Fi module, which will be available to the users.
8. LCD: LCD is used for displaying measured values of parameter.

2.3 Circuit design

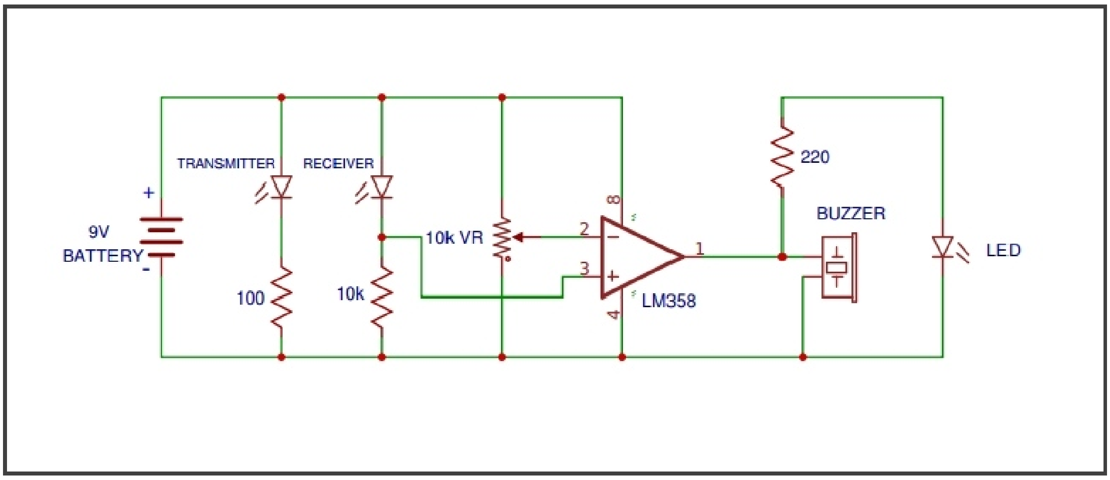


Figure 2.2: Circuit diagram of Power Supply

2.4 Power Supply requirement

write down power requirement for ckt power budget

Table 2.1: Circuit Power Budget

Sr. No.	Name of components	Voltage	Current	Power=VI
1	DHT11	5V	0.3mA	1.5mW
2	LM7805	5V	1A	5W
3	LCD	5V	1mA	5mW
4	Soil Moisture	5V	0.3mA	1.5mW
5	DS18B20	5V	1.5mA	7.5mW
6	ESP8266	3.3V	12mA	39.6mW
7	Relay	5V	70mA	350mW
8	Buzzer	4V	30mA	120mA
9	IR	5V	20mA	100mA
	Total Power Consumption			5.625W

2.5 Selection of components/devices

1.Controller

Parameters	8051	AVR	PIC
Bus width	8 bit	32 bit	8,16,32 bit
Speed	12clks/instruction	1clk/instruction	4clks/instruction
Memory	ROM,SRAM,FLASH	FLASH,SRAM,EEPROM	SRAM,FLASH
Architecture	Von-neuman	Modified	Harvard
Power consumption	Average	Low	Low
ISA	CISC	RISC	Same fetures of RISC
Cost	Low	Average	Average

2.Temperature Sensor

Parameter	DHT11	LM35	TMP36
Operating temperature range	-55 to 150 °C	-40 to 125 °C	0 to 50°C
Maximum current intensity	150 μA	60μA	50μA
Voltage level	3 - 5.5 V	4 – 30 V	2.7 – 5.5V
Linearity	Humidity 1% Temprature 0.1°C	+10mV/°C	+10mV/°C
Maximum error measurement	2 °C	0.5 °C	2 °C

3.Wifi Modules

Parameter	ESP8266	Zigbee	Node MCU
Operating voltage	2.5 – 3.6 V	1.8 – 3.9 V	3 – 3.6 V
Operating current	80 mA	18.5 mA	50 mA
Temperature range	-40 – 125 °C	-50 – 150 °C	-40 – 150 °C
Peripheral interface	URAT,SPI,I2C	UART,SPI	Inbuilt ESP8266
Protocol	802.11	802.15.4	802.11
Network protocol	IPv4,TCP/UDP/HTTP	PAN,WPAN	IPv4,TCP/UDP

4.Light Intensity Modules

Parameter	LDR	Photodiode
Cell resistance	400 Ω	10 – 1000 Ω
Voltage AC/DC	320 V	60 V
Current	75 mA	50 uA
Temperature	-60 - 75 °C	-40 – 100 °C
Power dissipation	100 mW	215 mW

2.6 Electronic Component list and specifications

Following are the various electronics components are use as shown in 2.2

Table 2.2: List of components

Sr. No.	Name of components	Description / Type	Name/ Specifications	Designator	Quantity
1	DHT11	Temperature and Humidity	0C to 50C	DHT11	1
2	LM7805	Voltage Regulator	5V	LM 7805	1
3	W10	Bridge Rectifier	low frwd vltg drop	W10	1
4	Resistor	CFR	1k	R1	1
5	Capacitor	Disc	1000uf	C1	1
6	ESP8266	Wifi Module	2.5V-3.5V	ESP8266	1
7	LCD	16X2	4.7V to 5.3V	LCD	1
8	Soil Moisture Sensor	Contain of water in soil	3.3V to 5V	S1	1
9	Relay	1-channel	5V	Relay	1
10	Connector	Male and Female	1X20,1X20	P1	40
11	DS18B20	Temperature sensor	-55to125	D1	1
12	Buzzer	Beeper	mini buzzer 5V	B1	1
13	IR sensor	Tx and Rx	5*5mm	IR	1
	Total number of components				53

Chapter 3

EDA tools for schematic and PCB design

The Electronic Design Automation (EDA) industry develops software to support engineers in the creation of new integrated-circuit (IC) designs. Due to the high complexity of modern designs, EDA touches almost every aspect of the IC design flow, from high-level system design to fabrication. EDA addresses designers' needs at multiple levels of electronic system hierarchy, including integrated circuits (ICs),multi-chip modules (MCMs), and printed circuit boards (PCBs).

Discus about Uses and Applications of EDA tools .

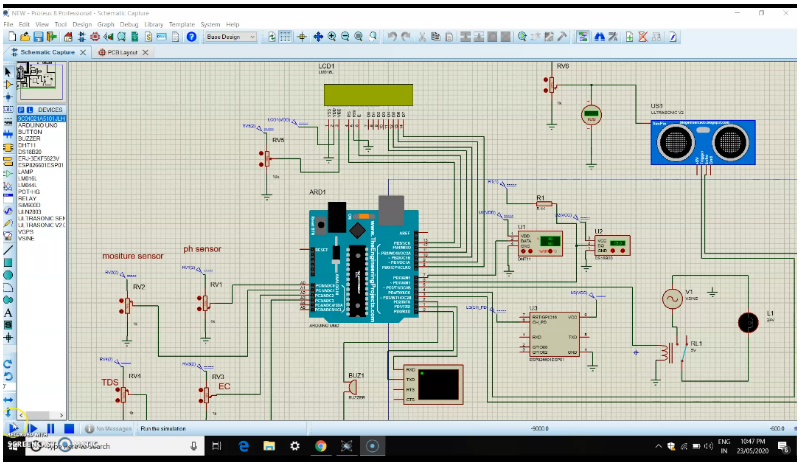
3.1 Various types EDA Tools

Various EDA tools are

- **Proteus**
- **Easy EDA**
- **Arduino**

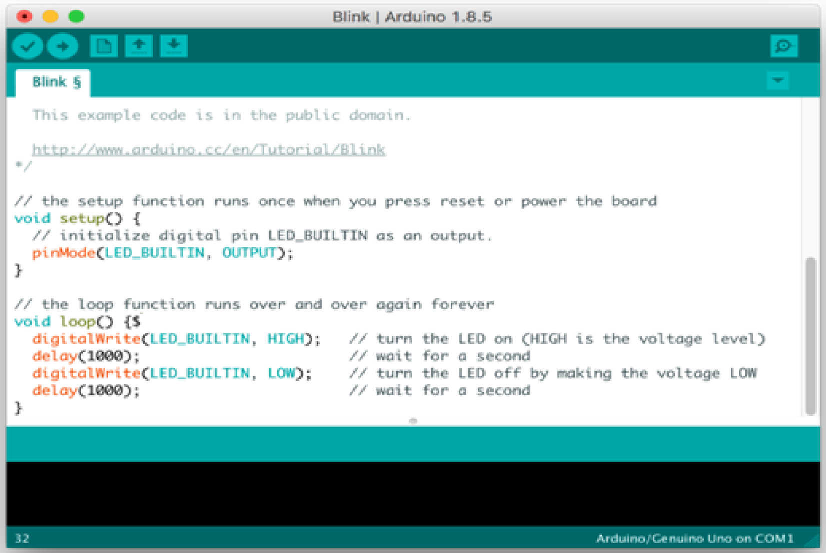
3.1.1 Proteus

The first version of what is now the Proteus Design Suite was called PC-B and was written by the company chairman, John Jameson, for DOS in 1988. Schematic Capture support followed in 1990, with a port to the Windows environment shortly .Mixed mode SPICE Simulation was first integrated into Proteus in 1996 and micro-controller simulation then arrived in Proteus in 1998. Proteus is a software tool used for electronic design automation .It is used for making schematic and gives the idea about how your design will work .It also creates electronic prints for manufacturing printed circuit boards.There are various libraries for different components.



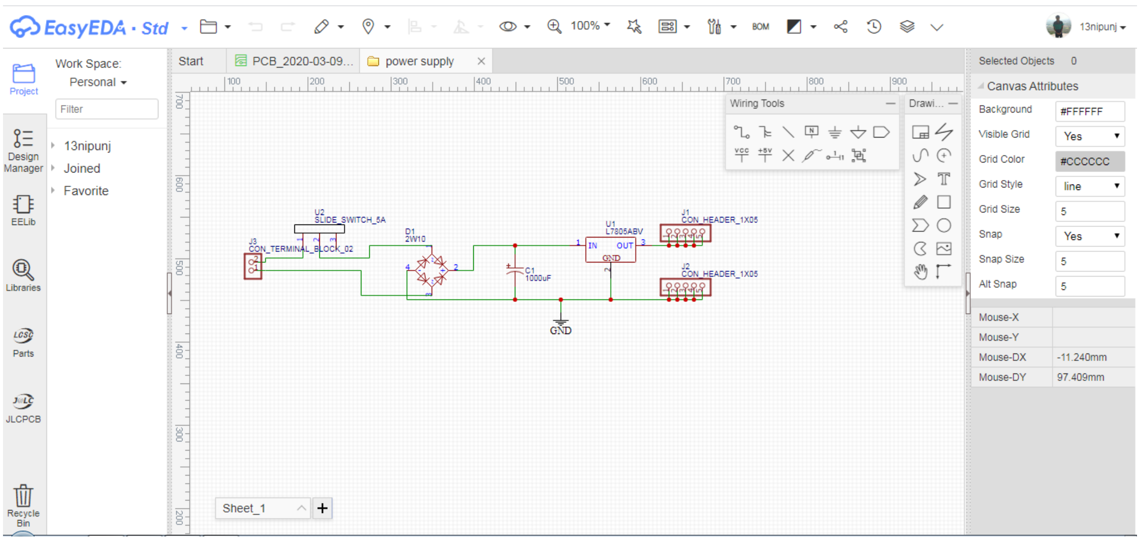
3.1.2 Arduino

The Arduino IDE is a cross-platform application written in Java, and is derived from the IDE for the Processing programming language and the Wiring project. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and is also capable of compiling and uploading programs to the board with a single click. There is typically no need to edit make files or run programs on a command-line interface. Although building on command-line is possible if required with some third-party tools such a Uno. The Arduino IDE comes with a C/C++ library called "Wiring" (from the project of the same name), which makes many common input/output operations much easier. Arduino programs are written in C/C++.



3.1.3 Easy EDA

EasyEDA is a web-based EDA tool suite that enables hardware engineers to design, simulate, share - publicly and privately - and discuss schematics, simulations and printed circuit boards. Other features include the creation of a bill of materials, Gerber files and pick and place files and documentary outputs in PDF, PNG and SVG formats. EasyEDA allows the creation and editing of schematic diagrams, SPICE simulation of mixed analogue and digital circuits and the creation and editing of printed circuit board layouts and, optionally, the manufacture of printed circuit boards.Subscription-free membership is offered for public plus a limited number of private projects. The number of private projects can be increased by contributing high quality public projects, schematic symbols, and PCB footprints and/or by paying a monthly subscription. Registered users can download Gerber files from the tool free of charge but for a fee, EasyEDA offers a PCB fabrication service. This service is also able to accept Gerber file inputs from third party tools



3.2 Circuit diagram for Vertical Farming using Aeroponics

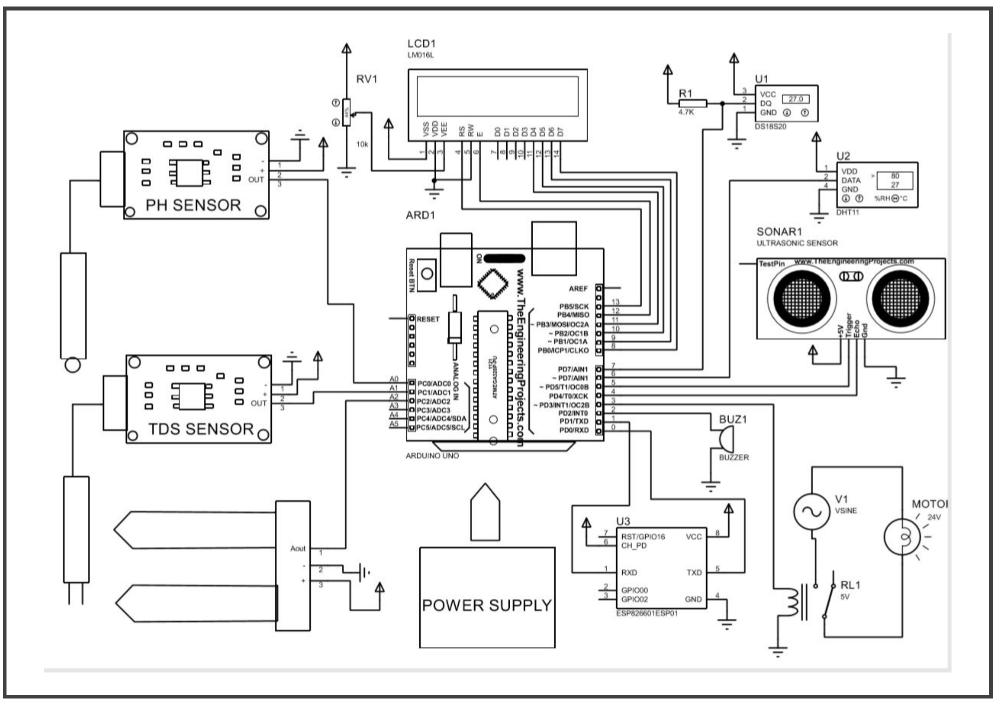


Figure 3.1: Circuit diagram for vertical farming using Aeroponics

3.3 Circuit Simulation

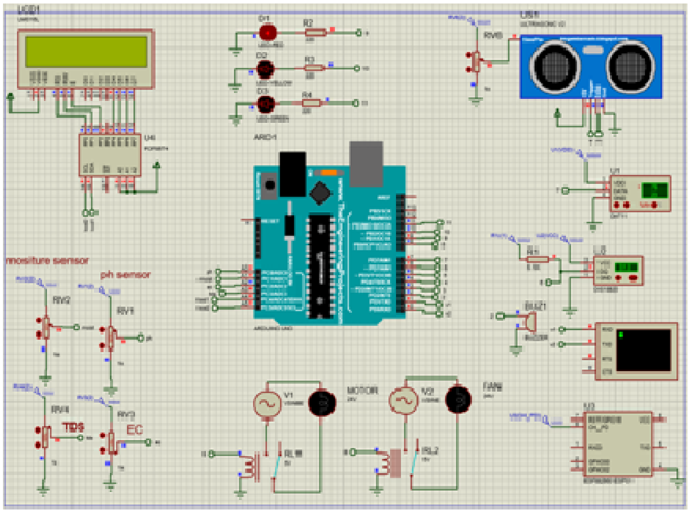


Figure 3.2: Simulation using Proteus

3.3.1 Result for Simulation

1)If the pH falls below 5.5 or increases above 6.5 then this will be indicated by red LED.

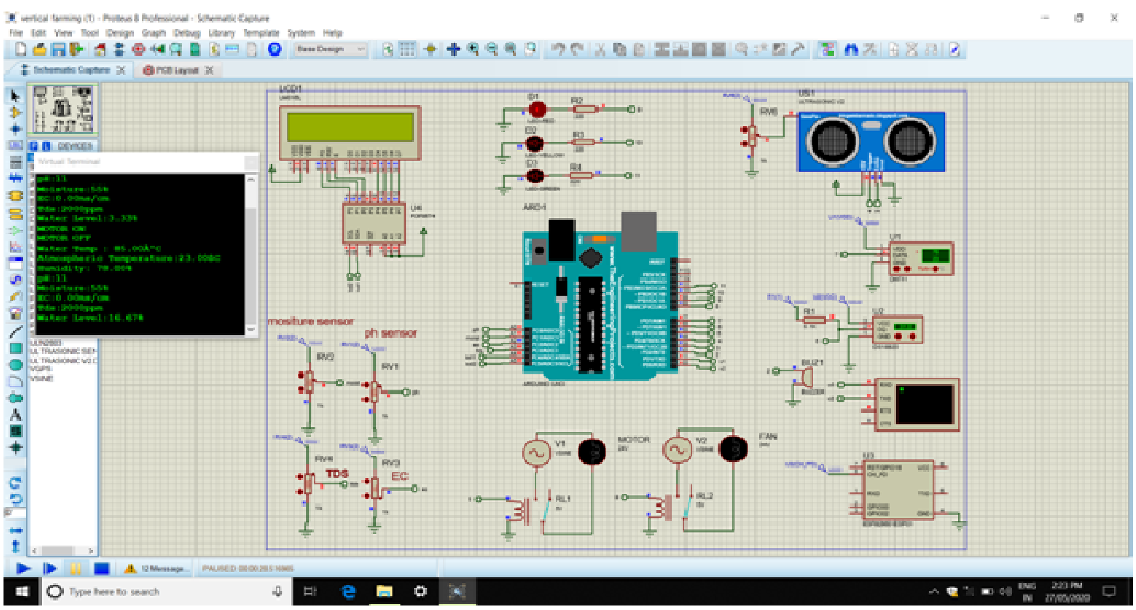


Figure 3.3: Indication for pH range

2)If TDS falls below 1260 or increases above 1610 then this will be indicated by yellow LED.

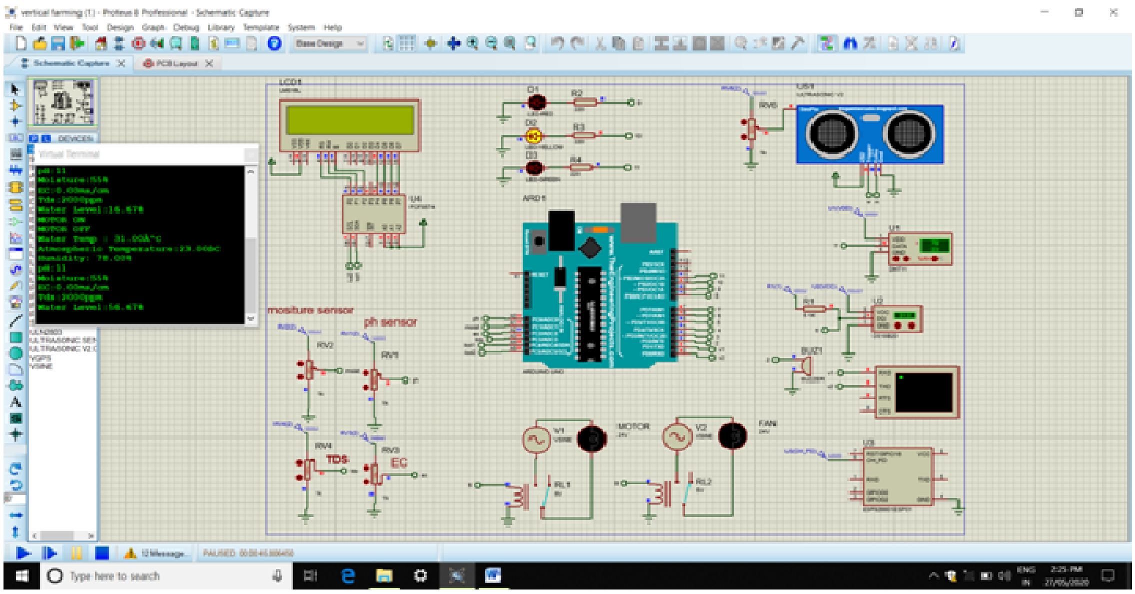


Figure 3.4: Indication for TDS range

3)If EC falls below 1.8 or increases above 2.3 then this will be indicated by green LED.

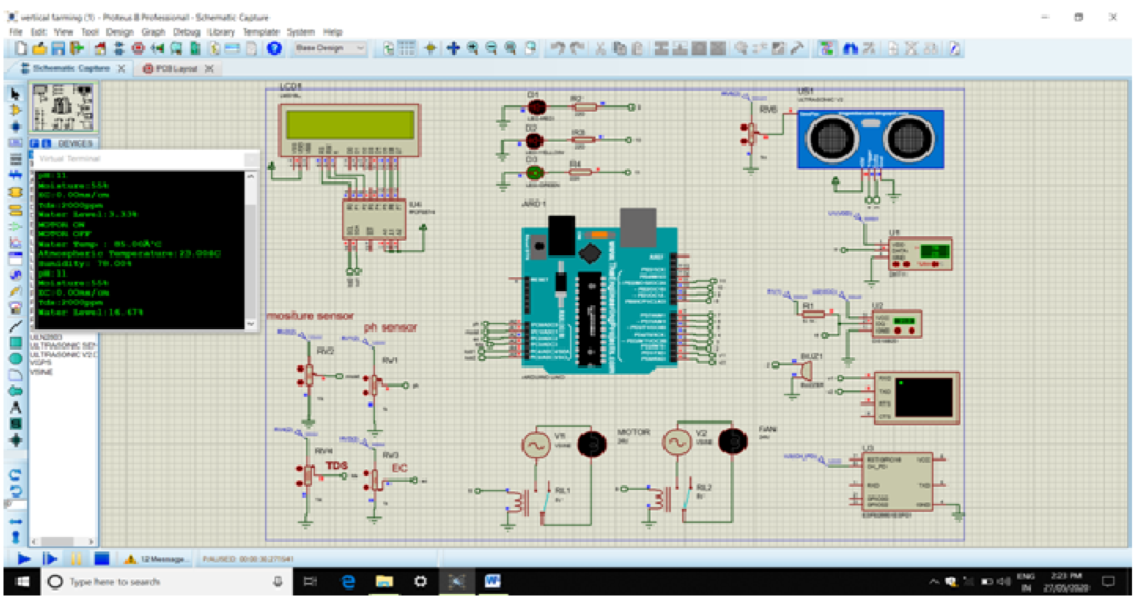


Figure 3.5: Indication for EC range

4)If temperature falls below/above 16C-25C or humidity falls below/above 65-70 percentage,then motor will get ON.

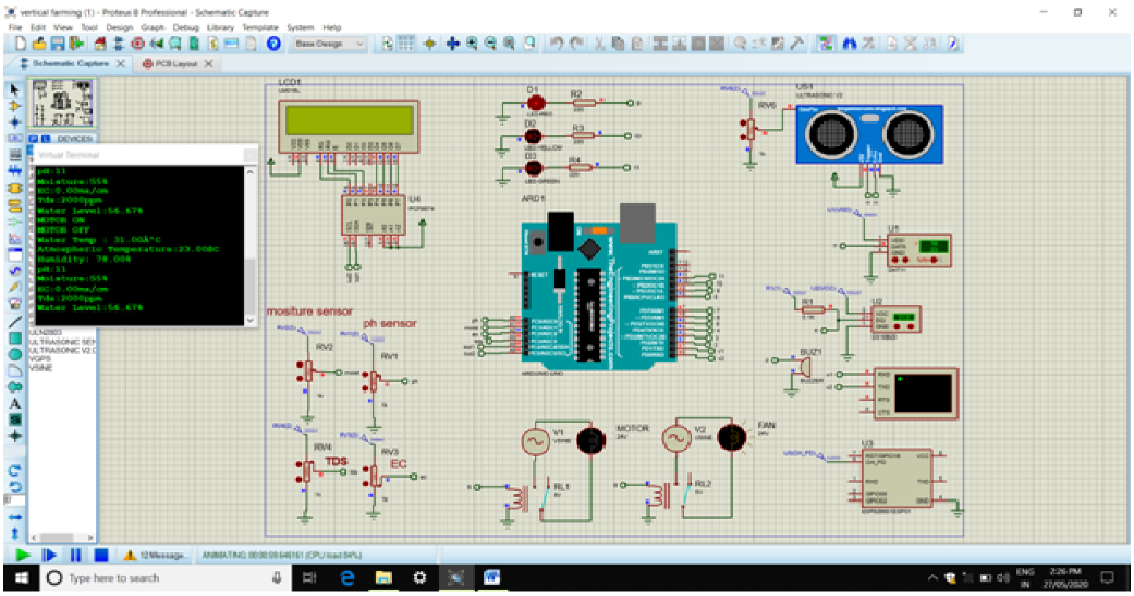


Figure 3.6: Indication for Temperature/Humidity range

5)Turning ON the motor to supply water to the system

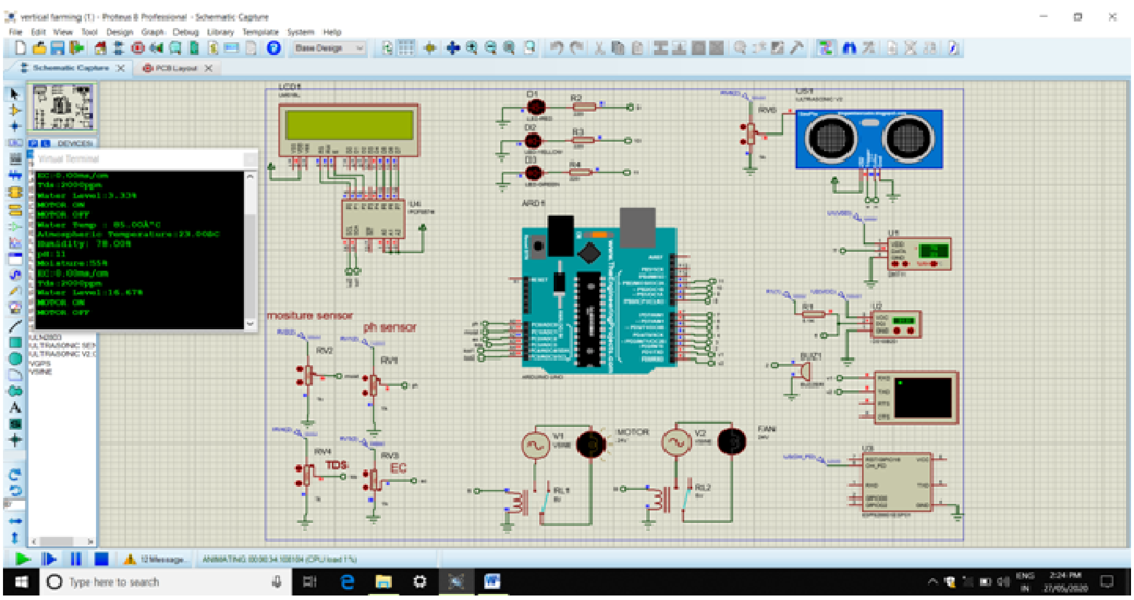


Figure 3.7: Indication of turning ON motor

Chapter 4

Implementation of PCB using EDA tool

The EDA tool used for PCB implementation is EasyEDA

4.1 Rules specified for PCB design

1) Create your board frame on a 0.05” grid. Make the lower left corner start at 0,0.
2) Usually the board frame is rectangular. For specific reasons you could also do other types of shapes such as polygons.
3) Stick parts on a 0.05” grid. You should not break this rule unless you have a very good reason.
4) Any LED should be labeled with its purpose (power, status, D4, Lock, etc).
5) Idem for connectors: e.g Vin, Port1, Batt, 5V, etc.
6) Idem for pins where applicable: e.g TX, Power, +, -, Charge, etc.
7) Idem for switches and switch states: eg. On, Off, USB etc.
8) Group components together. For example the resistors surrounding a transistor in your schematic will also be grouped together on the PCB.
9) Minimum drill size should be 15 mil.
10) Minimum annular ring size should be 7 mil.
11) 7 mil is the minimum size for traces. 8mil is acceptable. When possible try to keep the traces size to 10mil.
12) Use thicker traces for power lines. 12mil=100mA max, 16mil=500mA max etc.
13) 7mil between traces and space is reasonable.
14) Avoid 90 degree corners. Straight lines with 45 degree corners are preferable.
15) Where applicable use a ground pour on top/bottom layers.
16) To prevent pours from shorting to traces make sure you use a 10mil isolation setting on any of the ground pour.

4.2 Top layer (Image of component layer)

Write importance of top layer.

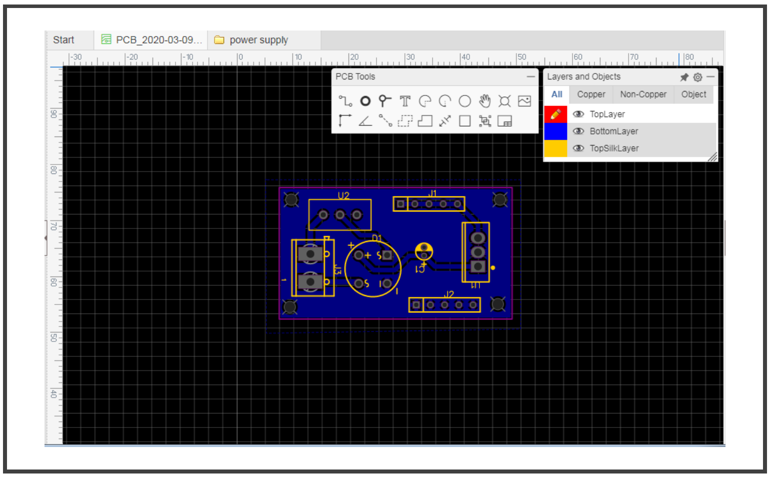


Figure 4.1: Top layer (Image of component layer)

4.3 Bottom layer (Image of Copper layer)

Write importance of Bottom layer.

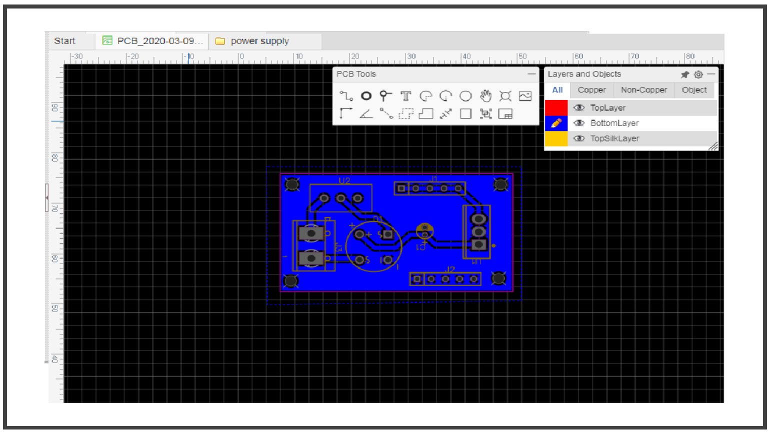


Figure 4.2: Bottom layer (Image of Copper layer)

4.4 3D view of PCB design

Write importance of 3D view.

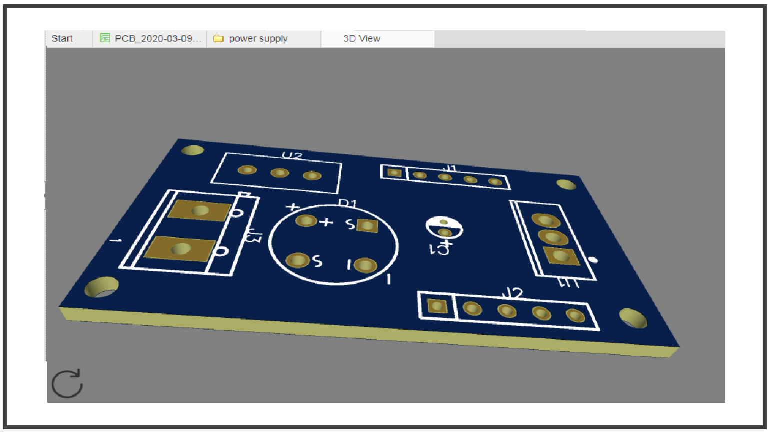


Figure 4.3: 3D View of PCB design

4.5 PCB Information

1) The track width for the pcb is 0.5mm.

2) The clearance used is 0.4mm.

3) Its Via diameter for the pcb is 0.61mm.

4) Via Drill diameter for the pcb is around 0.35mm.

5) The length of the pcb is 41.912mm and the breadth is 23.495mm.

6) It is a single layer pcb.

7) The components used overall in pcb design is 7.

8) The Plated Through Hole pads used is 24.

9) Holes present in the pcb is 7.

10) Length of the track is 71mm.

4.6 PCB Development Process

1) Initially design engineer will create the require schematic.
2) Schematic involves placing of components in the schematic and then connecting the pins of those components together.
3) Then next is to simulate the circuits and remove all the errors occurred.
4) Afterwards design your printed circuit board layout depending upon the schematic and this will help to create the footprint of the components.
5) The final step is manufacturing the pcb ie placing of components.
6) Various type of PCB are Single-layer PCBs, Double-layer PCBs, Multi-layer PCBs, Rigid PCBs, Flexible PCBs, Rigid-Flex PCBs, High-frequency PCBs, Aluminum-backed PCBs

4.7 Troubleshooting procedure

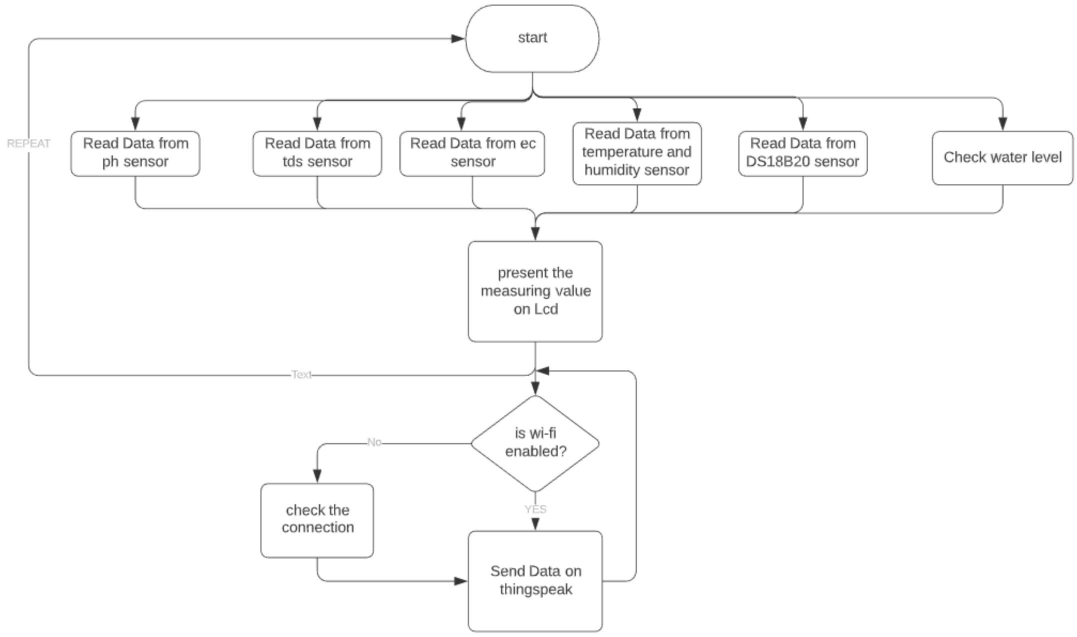
1) Inspect all the solder joint properly it might need some additional solder for better continuity.
2) Resistor should be properly placed so that there should be proper functional for the circuit.
3) Components should be placed with proper polarity(+/-).
4) A desoldering iron, "Solder Sucker", can be used to correct improper connections or removal of extra solder.

Chapter 5

Software requirement for developing program

1. Interface Arduino with sensors.
2. Upload the code into Arduino.
3. Define pins to various sensors on Arduino.
4. Values of various sensors is displayed on serial monitor as well as LCD.
5. If the water level goes below 30 percentage the buzzer will be ON indicating it.
6. The pH sensor will read the pH value, if the pH value is not in the range 5.5 to 6.5, red LED will glow.
7. The DHT11 sensor will read the value of atmospheric temperature and humidity, if the temperature is above 25 degree Celsius or humidity is greater than 70 percentage, the fan will turn ON.
8. The TDS sensor will give the TDS value, if this value is not between 1260 - 1610ppm, the yellow LED will glow.
9. The EC meter will show the EC level of water, if the EC value is not in the range 1.5-2.5 , the green LED will glow.
10. The motor will turn ON for 5 sec after every 5 min of time.
11. The DS18b20 sensor will indicate the water temperature, the temperature pf water will be between 16-26 degree Celsius.
12. All the data of various sensors will be continuously sent to the cloud using ESP8266 module and data will be continuously monitored.

Flow-Chart

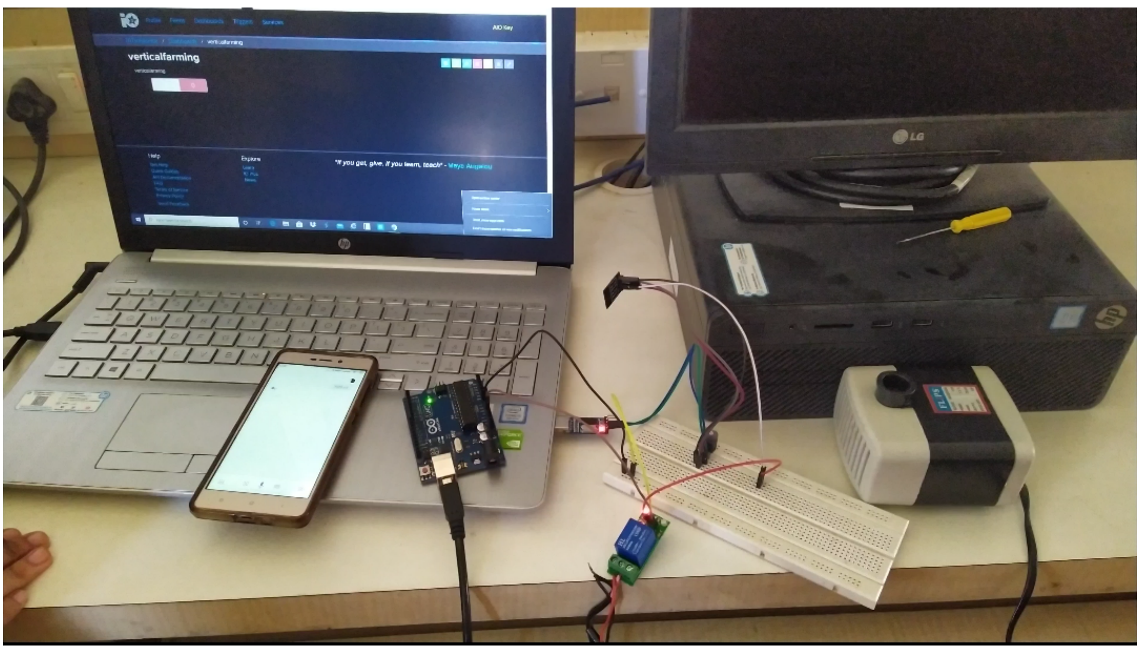

start
REPEAT
Read Data from ph sensor
Read Data from tds sensor
Read Data from ec sensor
Read Data from temperature and humidity sensor
Read Data from DS18B20 sensor
Check water level
present the measuring value on Lcd
Text
is wi-fi enabled?
No
check the connection
YES
Send Data on thingspeak

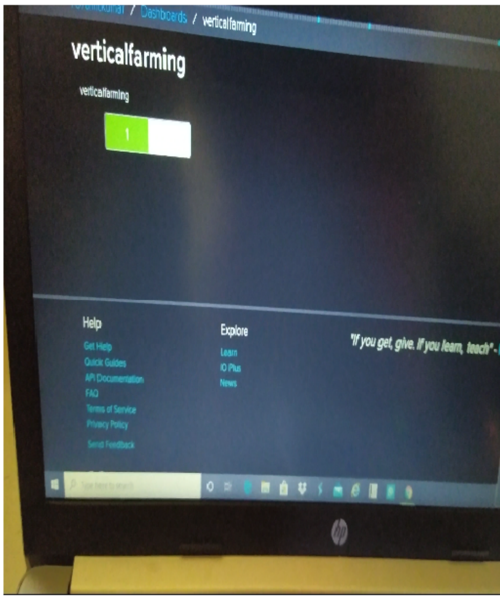
Chapter 6

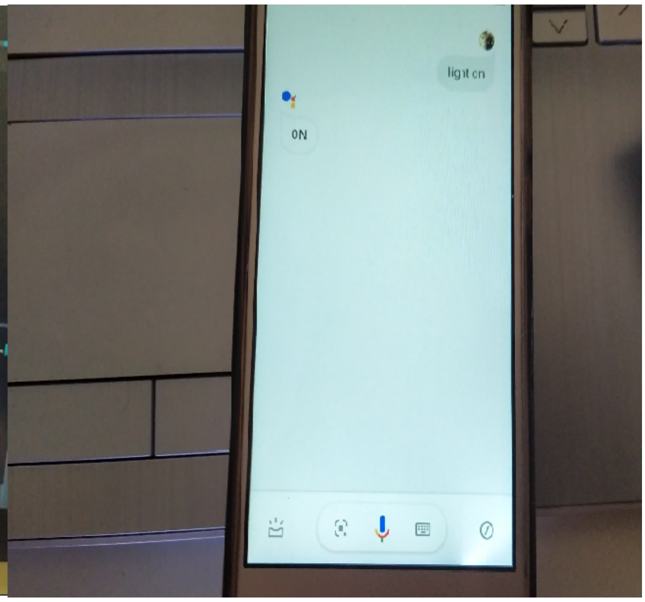
Result Analysis and Discussion

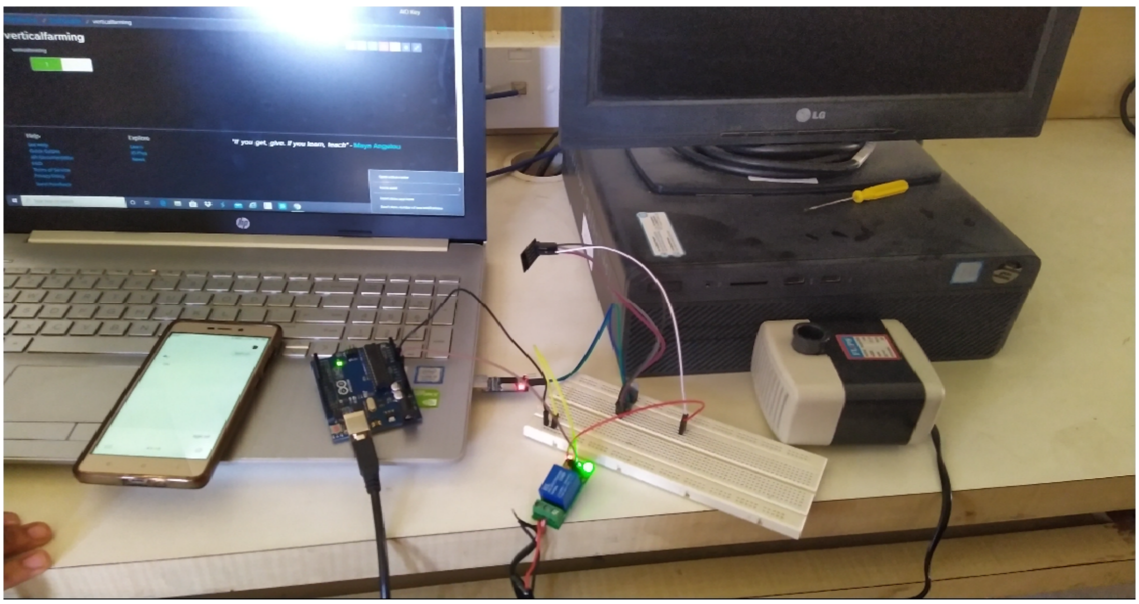
write down result analysis and description

1) Here we are controlling the water pump motor with the help of google assistance ,relay 5V 1channel ,arduino,PPL converter(3.3V) needed for ESP8266 to work. For ESP8266 to work we connected to a hotspot which was same for the mobile and laptop as well for google assistance to work.Initially as we can see the red button(ie OFF) on the laptop screen as well as we can observed the relay light is turned red.

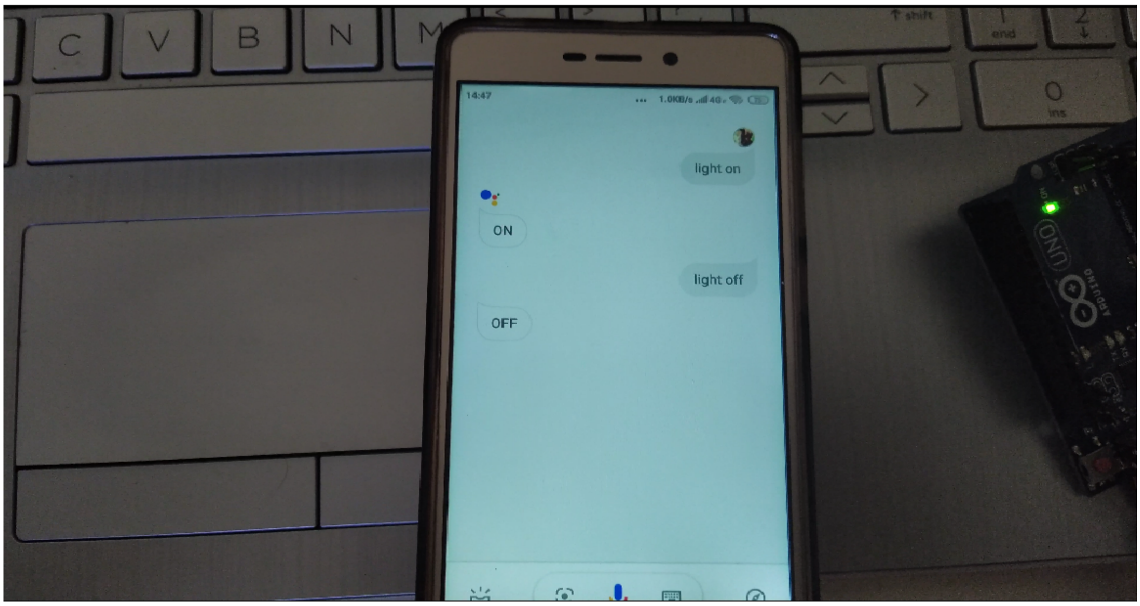


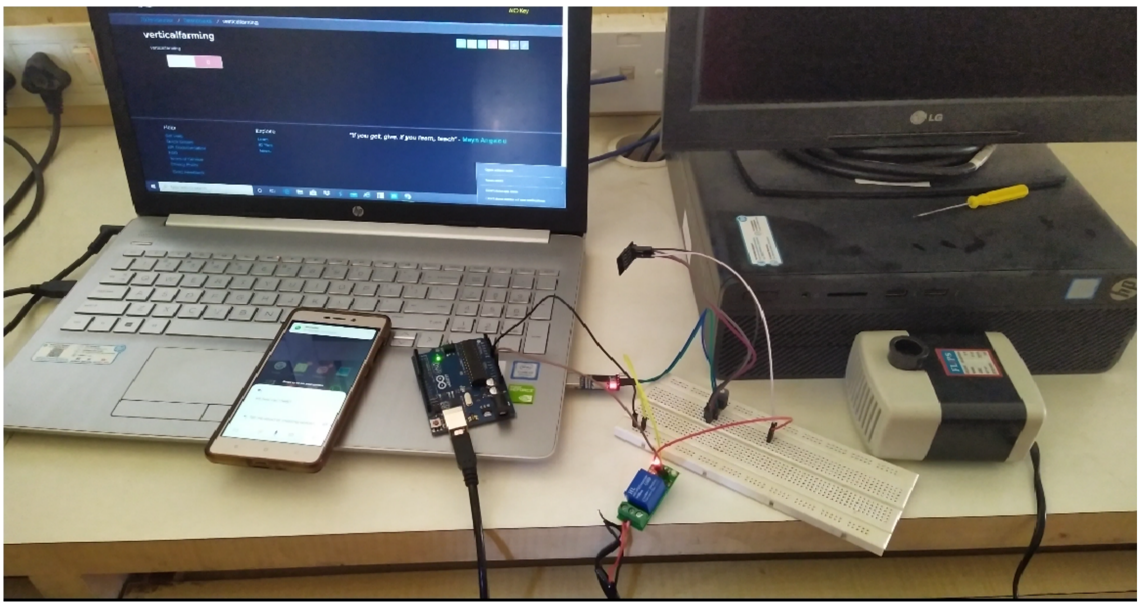






2)Then we gave the command "light on" on google assistance for turning on the relay as well as the water pump the motor as you observed the laptop screen button turn into green color and in mobile you can observe the command "light on" and "on" respectively.





3)At lastly we gave the command light off via google assistance for turning off the pump motor.You can observe on the mobile as well.

Sr. No	Parameter	Effect(In Simulation)	Effect(In Real-time)
1	ph	Range:5.5-6.5 If the ph increases above 6.5 or falls below 6.5 then the red LED will glow.	Range:5.5-6.5 In the real time if the ph increases above 6.5 concentration of H ions will increase mean its tending forward base, so will add acid like lemon juice.
2	EC	Range:1.8-2.3 If EC increase above 2.3 or falls below 1.8 then, the green LED will glow.	Range:1.8-2.3 If EC falls below/above threshold then accordingly we will need to add some water/nutrients.
3	TDS	Range:1260-1610 If TDS falls/increase in the threshold, then yellow LED will glow.	Range:1260-1610 In real time, EC & TDS are interdepent, so it will be done accordingly.
4	Temperature & Humidity	Range: 16°C-25°C/65%-70% If the temperature humidity falls below/above threshold then fan will be turned on.	Range: 16°C-25°C/65%-70% Fan for cooling will be turned on if the level falls above/below the threshold.

Figure 6.1: For Spinach Plant

Chapter 7

Enclosure Design

1) Enclosure design is generally used for the protection of our electronic circuit or it can be used for the project that we want to demo to the outside world.
2) It can be made by 3-D printing at low resolution as well as it can be made from the scrap of metal or wood.
3) There are various step involved for the enclosure design.They are as follows:
STEP 1:Depending on our use we have to decide the context of use.
STEP 2:Materials and technique we need to choose for our design.Materials like scrap from wood, metal or plastic.The technique involved in this process is laser cutting or 3-D painting.Laser cutting involved CNC as well as CAD file typically made in corel draw.3-D printing take time and patience as well as material
STEP 3:After deciding the materials now we have to measure the components.Digital caliper is the easiest way and accurate to measure the size of components in millimeter.As measurement are taken roughly sketch out the board and other components and add some room for cable to travel.
STEP 4:Sketching the design on paper typically found helpful.Keep all the measurements you recorded and sketch each layer, panel or side plugging.Try to add every detail like mounting holes, hardware or room inside for padding or batteries.
STEP 5:Finally design files into appropriate CAD software,2D or 3D and render the files.Corel Draw are usually the software choices that interface with laser cutters.
STEP 6:Final step is to scrap together all the components.

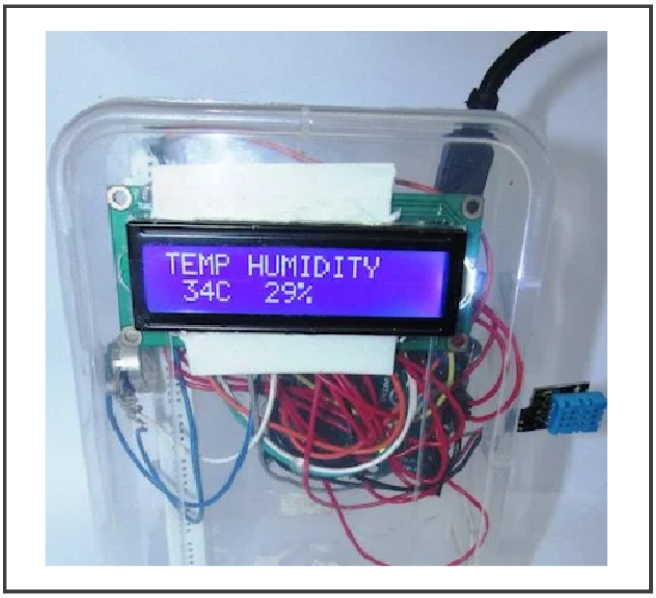


Figure 7.1: Enclosure top view

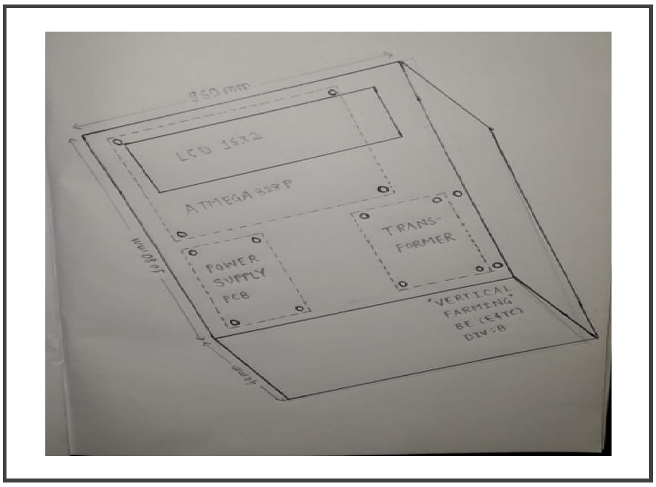


Figure 7.2: Enclosure Circuit Design

Chapter 8

Budget

Following table shows approximate budget of the project.

Table 8.1: Project budget

Sr. No.	**Name of components**	**Quantity**	**Price**
1	Transformer(9-0-9,1A)	1	Rs.145
2	LM7805	1	Rs.10
3	W10	1	Rs.10
4	Resistor	3	Rs.3
5	Capacitor	3	Rs.6
6	Pump Motor	1	Rs.190
7	Pipe	1	Rs.350
8	Tube	1	Rs.100
9	DHT11	1	Rs.100
10	Ph sensor	1	Rs.2138
11	Seeds	3	Rs.90
12	Coco peat	2	Rs.50
13	Pots	40	Rs.400
14	Bucket	1	Rs.75
15	Sprinkler	1	Rs.20
16	MCL	1	Rs.40
17	Soil moisture sensor	1	Rs.65
18	ESP8266	1	Rs.300
19	DS18b20	1	Rs.185
20	Relay 5V	40	Rs.60
21	Connector	1	Rs.185
22	PCB Board design	1	Rs.100
23	LCD 16X2	1	Rs.105
24	Buzzer	1	Rs.20
25	IR	1	Rs.40
	Total price of components		Rs.4687

Chapter 9

Applications and Conclusion

9.1 Applications

1. Agricultural Application.
2. Modular Farm.
3. Real time information measurement.
4. Home based application.
5. Boost crop quality of the produced plants.
6. Yearly crop cultivation of plants.

9.2 Conclusion

Vertical Farming using aeroponics is relatively new phenomenon in urban area but the intersect in growing plants indoor is slowly gaining momentum.The land productivity is twice as high as traditional agriculture.The cultivation of the crop is year around.There is less use of land,water as compared to traditional one.Here the use of pesticides can be totally avoided.The quality of the plants also improves.Mostly it is independent of the weather and protected from extreme weather condition as well.

Bibliography

[1] P. Platt, "Vertical Farming: An Interview with Dickson Despommier," Gastronomica, vol. 7, no. 2, pp. 80–87, 2007.
URL: https://www.academia.edu/34867546/A_Review_of_Vertical_Farming_Technology_A_Guide_for_Implementation_of_Building_Integrated_Agriculture_in_Cities

[2] L. Ahlström and M. Zahra, "Integrating a Greenhouse in an Urban Area," (Unpublished Master's Thesis). Chalmers University of Technology, Goteborg, Sweden., 2011.
URL:https://www.researchgate.net/publication/320339851_A_Review_of_Vertical_Farming_Technology_A_Guide_for_Implementation_of_Building_Integrated_Agriculture_in_Cities

[3] R. Albajes, C. Cantero-Martínez, T. Capell, P. Christou, A. Farre, J. Galceran, F. LópezGatius, S. Marin, O. Martín-Belloso, M.-J. Motilva, C. Nogareda, J. Peman, J. Puy, J. Recasens, I. Romagosa, M.-P. Romero, V. Sanchis, R. Savin, G. A. Slafer, R. Soliva-Fortuny, I. Viñas, and J. Voltas, "Building bridges: an integrated strategy for sustainable food production throughout the value chain," Mol. Breed., vol. 32, no. 4, pp. 743–770, Dec. 2013.
URL:https://www.deepdyve.com/lp/springer-journals/building-bridges-an-integrated

[4] S. C. M. Hui, "Green roof urban farming for buildings in high-density urban cities," in World Green Roof Conference, 2011, no. 18–21 March, pp. 1–9.

URL:https://hub.hku.hk/bitstream/10722/140388/1/Content.pdf?accept=1 [5] M. Al-Chalabi, "Vertical farming: Skyscraper sustainability?" Sustain. Cities Soc., vol. 18, pp. 74–77, Nov. 2015.
URL:https://www.sciencedirect.com/science/article/abs/pii/S2210670715000700

[6] C. Abel, "The vertical garden city: towards a new urban topology," CTBUH J., no. 2, pp. 20– 30, 2010.
URL:https://www.academia.edu/11705179/The_Vertical_Garden_City_Towards_a_New

[7] Cooper, D. Grow Cube promises to grow food with ease indoors (hands-on). Engaget, 8 November 2013.
URL:https://www.engadget.com/2013-11-08-insert-coin-growcubes-hands-on.html

[8] Farran I, Mingo-castel AM. 2006. Potato minituber production using aeroponics: Effects of density and harvest intervals. Am. J. Potato Res. 83(1):47-53.
URL:https://www.researchgate.net/publication/220037890_Potato_minituber_producton_using_aeroponics_Effect_of_plant_density_and_harvesting_intervalshttps://www.researchgate.net/publication/220037890_Potato_minituber_producton_using_aeroponics_Effect_of_plant_density_and_harvesting_intervals

[9] Abdullateef. S., M.H. Bohme and I. Pinker. Potato Minituber Production at Different Plant Densities Using an Aeroponic System. Acta Hort. 927, ISHS 2012. Proc. XXVIIIth IHC – IS on Greenhouse 2010 and Soilless Cultivation.
URL:https://www.ishs.org/ishs-article/927_53

[10] Komosa. A, Tomasz Kleiber, Bartosz Markiewicz. 2014. The effect of nutrient solutions on yield and macronutrient status of greenhouse tomato (Lycopersicon esculentum Mill.) grown in aeroponic and rockwool culture with or without recirculation of nutrient solution. Acta Sci. Pol., Hortorumcultus 13(2), 163-177.
URL:https://www.researchgate.net/publication/287645710_The_effect_of_nutrient_solutions_on_yield_and_macronutrient_status_of_greenhouse_tomato_Lycopersicon_esculentum_Mill_grown_in_aeroponic_and_rockwool_culture_with_or_without_recirculation_of_nutrient_s

[11] Nir. I. 1981. Growing plants in aeroponics growth system. Acta Horticulturae. 126
URL:https://www.ishs.org/ishs-article/126_49