Automated Hydroponic Pod

Submitted in partial fulfilment of the requirements for the subject of

Product Development and Management

by

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Under the guidance of

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DECLARATION

I hereby declare that the project entitled "Automated Hydroponic Pod" submitted by me, for the subject of *Product Development and Management* to VIT is a record of bonafide work carried out by me under the supervision of Prof Srinivasan Narayanan.

I further declare that the work reported in this project has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university.

Place : Vellore

Date :15-10-2020

Signature of the Candidate
Harsh Vardhan Singh (18BME0030)
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CERTIFICATE

This is to certify that the project entitled "Automated Hydroponic Pod" submitted by Harsh Vardhan Singh (18BME0030), Lakshya Mishra (18BME0096), Bade Soujanya (18BME2113) of **School of Mechanical Engineering**, VIT, for the subject of *Product Development and Management*, is a record of bonafide work carried out by him / her under my supervision during the period, 15. 07. 2020 to 15.10.2020, as per the VIT code of academic and research ethics.

The contents of this report have not been submitted and will not be submitted either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university. The project fulfills the requirements and regulations of the University and in my opinion meets the necessary standards for submission.

Place : Vellore

Date : 15.10.2020

Guide :Prof Srinivasan Narayanan

Acknowledgement

We would like to express the special thanks of gratitude to our Product Development and Management professor “Dr.Srinivasan Narayanan” for their able guidance and support in completing this project.

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Date : 15 – October- 2020

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Executive Summary

This project comprised of developing of an Hydroponic Pod which can be used for growing the vegetables and fruits. The idea behind its development was the considerable amount of reduction of landmass and increasing amount of population , which eventually requires more food production.

Our setup includes small pods which allow water circulation while holding the seeds of the plant in a basket and a tray which has holes to hold such baskets well, which are then stacked in the setup. The topmost tray has a direct connection to the water which is stored at the bottom with nutrients included. The solution after being poured onto the first tray flows on up to the last tray after which it drops down to the tank. The water reservoir (or tank) has a pump controlled by our microcontroller. The water contains necessary nutrients essential for the plant growth added to it prior to the starting of the system. And the microcontroller monitors the irrigation system.

This project develops a hydroponic pod which can be used in those areas which have a huge shortage of water and also at the homes and restaurants which can become self-sustainable by the use of these pods. The target customers are the people living in cities like Mumbai ,Kanpur, Chennai, Jaipur ,Jodhpur, Bangalore etc. which experience such difficulties during summer season .These pods are very user friendly and therefore can also be used by the people who are new in the field of gardening and want are in the process of learning as well as those who don’t have any prior knowledge at all.

It can be used as a training equipment to teach farmers who want to learn this new technology and want to scale it up. It provides the correct amount of nutrition and, because of the integrated greenhouse the plants can grow without any disturbances caused by the locusts ,insects and the other harmful creatures. The nutrients used in this process can be obtained from the natural resources thereby reducing the environmental impact caused by the harmful pesticides and insecticides , making the vegetables and fruits more nutritious and herbal.

Vegetables like lettuce, tomato, spinach as well as the fruits like strawberries and cherries can be grown using this pod.

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List of Abbreviations

Symbol	Abbreviation
D	Detectability
O	Occurrence
S	Severity
RPN	Risk Priority Number
Critic	Criticality

1. Abstract

Hydroponic farming is the need of the hour because of decreasing cultivation land area and increasing population. This type of farming should be highly promoted because of its sustainability and in pandemics like Covid-19, people can opt for this type of farming in their homes because it requires very small area to setup. With growing technology, automated hydroponic farming is quite practical. The main benefits of hydroponics include increased plant productivity, receiving a high yield per plant per square foot and having fresh produce. Today, there are many varieties of plants grown hydroponically serving many different market segments, including farm stands, grocery stores, restaurants, processing plants and institutions.

In this project, we proposed a method and design for automated hydroponic farming for domestic use. Various cabinets are maintained to harness full potential of this method. Cabinets are perfect for maintaining separate required conditions for such farming and are easily movable as well as convertible.

2. Introduction

Agriculture is the heart of India's economic activity and our experience during the last 60 years has demonstrated the strong relationship between agricultural growth and economic wealth. If India aims to be a powerful economically in the world, our agricultural productivity should be equal to that of other countries, which are currently rated as economic power of the world. Cultivation, adds up to an important aspect in GDP (Gross Domestic Produce) and has been affected tremendously over the past few decades due to the use of chemicals. Due to rapid urbanization and industrialization, arable land under cultivation is decreasing enormously. Organic farming, being the need of the hour, is opted as one of the widely chosen methodology to overcome the prevailing problem in cultivation. With an expanding population and changing dynamics in global food markets, it is important to find solutions for more resilient food production methods closer to urban environments.

Vertical farming systems have emerged as a potential solution for urban farming. However, although there is an increasing body of literature reviewing the potential of urban and vertical farming systems, only a limited number of studies have reviewed the sustainability of these systems. Advancements in agriculture have proven to serve the cultivators in a number of ways. To bring in another technological advancement by breaking all barriers, for organic farming is Hydroponics where consumption of space and water are very minimal.

Hydroponics is a method of growing plants purely using water and nutrients, without soil. The automated hydroponic farming is made to support non-professional farmers, city people who have limited knowledge in farming and people who are interested in doing vertical planting in very small areas in the city such as building tops, balconies of small rooms in high-rise buildings, and in small office spaces.

The significant decrease in agricultural land and the rapid development of hydroponic system technology such as Nutrient Film Technique (NFT), have brought huge challenge to farmers, as a hydroponic system requires special attention to several parameters such as the water temperature, water level, acidity (pH), and the concentration of the nutrient (EC/PPM).

The goal of this project is to design and construct a hydroponic system which is fully automatic that can be integrated into the home agricultural curriculum. Hydroponic cultivation offers many focal points when contrasted with regular cultivation. One of the principle points of interest is that products can be developed in spots with infertile or sullied arrive. Hydroponically developed plants are very impervious to water with a high salt substance. Another advantage incorporates not having any insects, creatures, and infections for example, growths effectively exhibit in the developing medium.

3. Research Problem

Through this project we aim to address the following problems –

- The growing food requirements of the country's growing population.
- The reduction in food production due to the shrinking of cultivable land.
- Food shortage of the urban areas.
- Food wastage due to the logistics of vegetables and fruits in the areas where there is no land for growing of food.
- Lack of cultivation in areas which experience water shortages and droughts during some seasons.(for e.g.: Chennai, Delhi, Mumbai and Bangalore)
- Market or External dependence of people during pandemic situations, ex. COVID-19 pandemic.

4. Aim and Objective

The aim is to create an hydroponic pod that can be fully automated for growing vegetables and fruits without the need of land and soil, it can be integrated with automation systems so as to reduce human interaction. It will serve as a source of food in homes and restaurants and can reduce the dependence of people for vegetables on farmers and markets and also increase the production of vegetables and fruits.

5. Literature Review

1. **<u>Complete reutilization of mixed mackerel and brown seaweed wastewater as a high-quality biofertilizer in open-flow lettuce hydroponics:</u>**

   Quality biofertilizer was produced from mixed wastewater of mackerel and Undaria.
   The biofertilizer enhances growth rate and antioxidant activity of lettuce.
   Antioxidants present in biofertilizer bio-accumulated in lettuce leaves.
   Pathogens did not permeate into the biofertilizer during open-flow hydroponics.
   Complete reutilization of mixed fishery wastewater occurred in lettuce hydroponics.

2. **<u>Nutrient Film Technique (NFT) Hydroponic Monitoring System Based on Wireless Sensor Network:</u>**

   This system is used to solve the problem in the real time monitoring lettuce cultivation using hydroponic NFT. The method in this system contains communication, planning, modelling, construction, and socialization.
   The result of experiment shows that pH sensor has an error level of difference is 0.4. There is an error of sensor Analog Electrical Conductivity Meter, that is 5.1 ms/cm. Monitoring System for Lettuce Cultivation Hydroponic Outdoor Type Nutrient Film Technique using Wireless Sensor Network is needed by the farmer to prevent crop failure and easier to monitor parameter hydroponic cultivation real time. So, the farmer doesn't need to go to greenhouse one by one in different area. It makes monitoring process get easier than before.
   The result of pH sensor and EC sensor are used to know accuracy of each sensor, is good or not to measurement. The next research for this system can be developed on the part of amount green house or nutrition tank more than two. So, the other plants in different greenhouse can communicate each other and know the condition itself.

3. **<u>Comparative life cycle assessment of aquaponics and hydroponics in the Midwestern United States:</u>**

   With high productivity and low land and water use, controlled-environment agriculture (CEA) like aquaponics and hydroponics has become a promising solution to feed the rapidly growing global population. This cradle-to-gate life cycle assessment (LCA), for the first time, compared the environmental performance, on an economic basis, of aquaponics and hydroponics with identical system design in Indiana, US.
   For a one-month cultivation period, tilapia and six vegetables produced in the aquaponic system had almost twice the total value of the vegetables from the hydroponic system. Aquaponics produced 45% lower endpoint environmental impact than hydroponics. Electricity use for greenhouse heating and lighting, and water pumping and heating contributed to the majority of the environmental impacts of both systems, which was followed by the production of fish feed and fertilizers. However,

changing the energy source from coal to wind power could make the hydroponic system more environment-friendly than the aquaponic system.

4. Hydroponic Smart Farming Using Cyber Physical Social System with Telegram Messenger:

In the Cyber Physical Social System (CPSS), collaborative work between hydroponic farmers is now possible. With this new concept, hydroponic smart farming system that can be monitored online via Telegram Messenger is developed.
The design that is created can monitor important parameters in the hydroponics system, such as light intensity, room temperature, humidity, pH, nutrient temperature, and Electrical Conductivity (EC).
With the monitoring system through this CPSS, it allows hydroponic farmers wherever and whenever to know the condition of plants in real-time. And data can be exchanged between the community so as to better improve the productivity.

5. Environmental Assessment of an Urban Vertical Hydroponic Farming System in Sweden:

The aim of this article is to understand the environmental impacts of vertical hydroponic farming in urban environments applied to a case study vertical hydroponic farm in Stockholm, Sweden.
This was carried out by evaluating environmental performance using a life cycle perspective to assess the environmental impacts and comparing to potential scenarios for improvement options. The results suggest that important aspects for the vertical hydroponic system include the growing medium, pots, electricity demand, the transportation of raw materials and product deliveries. Replacing conventional gardening soil as the growing medium with coir also leads to large environmental impact reductions.
However, in order to further reduce the impacts from the system, more resource-efficient steps will be needed to improve impacts from electricity demand, and there is potential to develop more symbiotic exchanges to employ urban wastes and by-products.

6. An AI Based System Design to Develop and Monitor a Hydroponic Farm (Hydroponic Farming for Smart City) :

In this paper, authors proposed to prepare an Artificial Intelligent system to do hydroponic farming in closed environment which will automatically deliver mix of water and nutrient solution along with light, directly to the roots of plants using sensors.
For experiment they have used Tomato F1 Hybrid seed. This system will help in calculating the average growth rate ratio for Tomato F1 Hybrid Suhyana seed that are grown hydroponically and would compare it with soil grown plants. This paper shows

how automatic hydroponic system can be implemented using Raspberry Pi 3 with Micro controller to control and monitor all the sensors connected to it.
This system is implemented in closed environment for automating crop plantation. It describes how the mix of water, Light and nutrient solution will be automatically delivered to the roots of tomato plants by maintaining the pH level of the nutrient solution and temperature.

7. Applied Internet of Thing for Smart Hydroponic Farming Ecosystem (HFE) :

This paper proposes a Hydroponic Farming Ecosystem (HFE) that uses IoT devices to monitor humidity, nutrient solution temperature, air temperature, PH and Electrical Conductivity (EC).
To make the system easy to control and easy to use, they have used an android application to control IoT devices in the HFE and alarm users when their farm is in an abnormal situation. This paper applies the Internet of Things for Smart Hydroponic Farming Ecosystem (HFE) and automates hydroponic farming.
After the experiments conducted they showed this system could work whether using it in automatic or manual mode. Further work is applying the system in a symmetrical plantation to check the accuracy of the HFE across multiple farms in the same area; and verify that controlling via mobile application works correctly.
In this report, source of light energy lags, they have not mentioned anything about light.

8. Hommons: Hydroponic Management and Monitoring System for an IOT Based NFT Farm Using Web Technology :

In this paper, a hydroponic monitoring and automation system is proposed that can be monitored using sensors connected to the Arduino Uno microcontroller, Wi-Fi module ESP8266 and Raspberry Pi 2 Model B microcomputers as the webserver with the concept of Internet of Things, in which each block hydroponic farming can communicate with the webserver.
Web is used as the interface of the system that allows user to monitor and control the NFT hydroponic farming. The NFT hydroponic web interface management systems uses a responsive web framework, such as Bootstrap for the front-end, JQuery and JavaScript libraries.
The result shows that this system helps farmers to increase the effectivity and efficiency on monitoring and controlling NFT Hydroponic Farm. The future work of this research is to collect environmental data, which is obtained from sensors and implanting an artificial intelligence that makes the Hydroponic Management and Monitoring System can run automatically.

9. Hydroponic Nutrient Control System based on Internet of Things and KNearest Neighbors :

In this research, authors propose a system that measures pH, TDS, and nutrient temperature values in the nutrient film technique (NFT) technique using a couple of sensors. They use lettuce as an object of experiment and apply the KNN (k-Nearest Neighbor) algorithm to predict the classification of nutrient conditions.
The result of prediction is used to provide a command to the microcontroller to turn on or off the nutrition controller actuators simultaneously at a time. The experiment result shows that the proposed KNN algorithm achieves 93.3% accuracy when k=5.
The evaluated system shows that KNN successful classifies the nutrient condition with several k values. The classification result output can be used in a realtime condition and used as a command to the actuator module. The actuator also can turn on or off the nutrition controller simultaneously at a time according to the label that is classified.

10. Integrating Scheduled Hydroponic System :

The proposed hydroponic system is built upon the concepts of embedded system. The system facilitates the growth of multiple crops under a single controller. Necessary supplements for the crops are provided based on the inputs obtained from the pH sensor and the water level sensor used.
The water and nutrient supply to the different varieties of crop is controlled and monitored at regular time intervals. An efficient algorithm has been proposed for controlling all the functionalities. Automation of the hydroponic system improves the efficiency and reduces manual work.
The proposed hydroponic system hence implements the integration of different varieties of crops. The short comings of the existing system like growth of a single type of crop in the entire system have been overcome. A methodological approach has been taken forth to regulate the working of the system.

11. Smart hydroponic farming with IoT-based climate and nutrient manipulation system :

In this study an automatic computer-controlled climate and nutrient manipulation system will be proposed. Manipulation will be based on monitoring carried out by a number of sensors that will be processed by computers in an IoT-based system.
Automation is done using NodeMCU as a controller and some sensors are used such as water flow, water level, pH meter, EC, humidity meter and lux meter sensor. The proposed architectural design will require a greenhouse where the environment inside the building will be manipulated.
Parameters that will be manipulated includes amount of sunlight needed, how often LED lights are used, humidity, and aeration. Based on this system design, it shown that it is possible to create fully automatic hydroponic agriculture by manipulating few parameters that need to be controlled.

12. Automatic Control and Management System for Tropical Hydroponic Cultivation :

This paper proposes automatic control and management system for tropical hydroponic cultivation. The system aims to reduce information exchange of multisensory data fusion within the wireless sensor network by grouping the sensors to decide the data fusion results.

It can control water level, humidity, and temperature as grower setting automatically. It also sends sensor data and status, collects pH and EC values of individual nutrient solution tank, and sends notification via Android mobile application. The data history is available on web application. This also helps to monitor, manage data, and setting online.

The system can control water level, humidity, and temperature as grower setting both automatically or manually.

6. Methodology

Step 1: Technical Specifications

Total height – 1524 mm (60 inches/1.524 m)
Total width – 812.8 mm (32 inches/0.8128 m)
Total length – 548.64 mm (21.6 inches/0.54864 m)
Tank total Volume – 680 L

Tank

Volume – 65 L
Number of Compartments – 2

Greenhouse

Volume – 350 L
Number of trays – 4

Basket

Diameter – 60 mm
Height – 80 mm

Step 2: FMEA Analysis

Possible Failure Modes

- Water Supply Doesn't Stop

Possible Consequences

- The vegetables gets excess nutrients and starts degrading(S=5)

Possible Root Causes

1. The microcontroller not working properly(0=4)
2. Nutrient sensor not working properly(0=5)
3. There is a short-circuit(0=8)

Controls/Indicators

1. The plant instead of growing becomes turning pale and start rottening.
2. Water amount reduces considerably

Detectability(D=7)

1. pH meter start showing neutral pH of the water(In actual the plants require slightly acidic environment of pH close to 6.5)

Possible Effect	Root Cause	S	O	D	RPN	Critic
1:Water Supply Doesn't Stop	Microcontroller not working completely	5	4	7	140	20
	Nutrient sensor not working properly	5	5	7	175	25
	There is a shortcircuit	7	8	7	392	56
Design Changes: Install a digital multi meter in the Pod can check the specified current in the circuit.						

Possible Failure Modes:

- Water Supply stops

Possible Consequences:

- The plants dies or the vegetables growth stops(S=8)

Possible Root Causes:

1. The wire breaks out.(0=8)

2. There is a leakage in pipes(O=7)
3. There is obstruction in pipes.(O=5)
4. Malfunctioning of pump.(O=6)

Controls/ Indicators

1. Vegetables dies
2. Plant growth stops

Detectability

1. Water becomes pale and start stinking(D=3)
2. pH meter starts showing the acidic pH below 6(D=5)

Possible Effects	Root Cause	S	0	D	RPN	Critic
Water Supply Stops	Wires breaks	8	8	5	320	64
	Leakage In pipes	8	7	5	280	56
	Obstruction In Pipes	8	5	3	120	40
	Malfunctioning of Pump	8	6	5	240	48
Design Changes: Install water flow sensors so that can measure the water pressure and flow across various sections.						

Step 3: Design Approach

The main motivation behind the product design was the combined horizontal and vertical hydroponic system (Figure 1.0), which had the plants placed in rows with the structure rising vertically to accommodate more plants and save space. Our design is shown in Figure 2.0

Figure 1.0 Vertical Hydroponic System

Since the main aim of the project is to make a hydroponic system available for domestic usage, the integration of a greenhouse with the hydroponic system was a must. Therefore, a closed rectangular structure was designed which would house the plant trays and would also act as a greenhouse. Each tray is fitted with a rubber gasket along its' outer perimeter, which separates each section, making it possible to maintain different environmental conditions in the different sections.

The different environments in different sections are maintained by a number of sensors and actuators (Humidity sensor, temperature sensor etc.) which are controlled by a micro-controller programmed to monitor and maintain the environments effectively. The air circulation is maintained by vents available in all the sections. The vents are connected to a heater which regulates the air temperature. The trays are also fitted with LED panels at their base, which act as a secondary light source when sunlight is not available. Their intensity and duration is controlled by the micro-controller which has pre-defined instructions, specific to the type of plant being grown. It should be noted that the product can be placed both indoors and outdoors.

Figure 2.0 - Our Design (The door is not shown for presentation purposes)

The trays (Figure 3.0 (a),(b)) in which the plants are placed are hollow rectangular structures, which are held in place using bolts. There are 8 slots in each tray. The basket containing the plant is placed in these slots. The distance between these slots was decided by taking the average of plant width that can be grown in this product. The nutrient solution flows in the hollow cavity of the tray. The trays are inclined at an angle of 2 degrees for easier water flow. A hole is present in each tray (opened and closed according to need), which is used to connect the tray to other trays or the tank via a pipe for solution transfer.

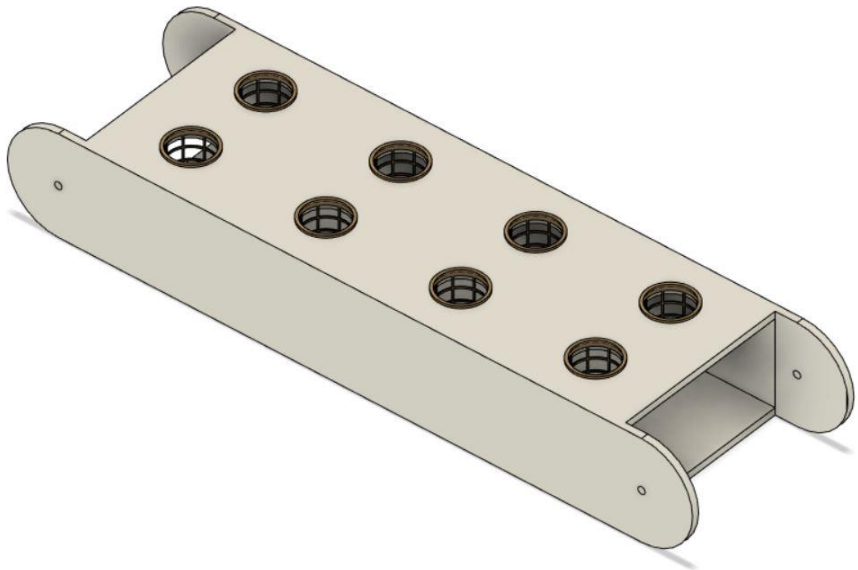

Figure 3.1 Tray

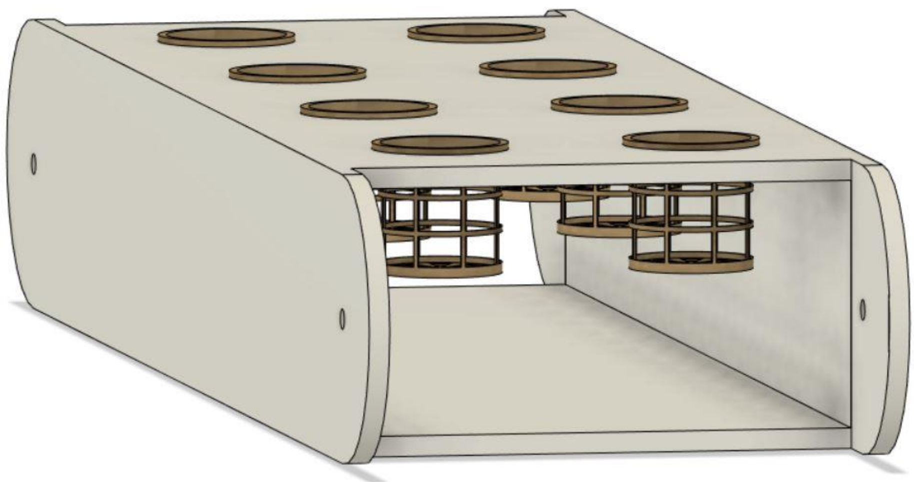

Figure 3.2 Tray with Basket

The tank is situated at the bottom of the design. It can be accessed separately from the greenhouse, via a track slider mechanism. It is divisible into 2 compartments so as to store the different nutrient solutions required when growing 2 different plants. Two sets of sensors are placed to measure water level, pH, nutrient concentration and temperature of the solution, which are operated according to need. Two sets of water pumps and air pumps are also placed (operated according to need). The tank can be connected to the main water supply so as to take in water when necessary. This function is regulated by a solenoid valve. The addition of nutrients is also controlled with the help of this valve.

Step 4: Working :

The plants are sown in coco-coir cubes where they germinate and are then placed in the holder. The environment of the greenhouse is set via manual input or using the predefined settings already present in the system.
The temperature controller controls the greenhouse temperature. It takes input from the temperature sensor and performs an action accordingly, by turning the heater on or off. The humidity is maintained via humidity controller. Air flow along with solution flow is also regulated.
The solution temperature is also maintained by the temperature controller.

[1] One Type of plant
Since only one type of plant is being grown the rubber gaskets are removed from the trays. This way only one unit (environmental control setup) is under use, hence reducing both, computational and power load on the system.
The solution is pumped from the tank to the topmost tray. It then flows along the tray and then drops down to the next tray. Since we are using gravity to circulate solution throughout the system we don't need to use extra pumps to keep the solution flowing. The inclination of the trays also facilitates the solution flow. After the solution reaches the bottommost tray, it falls back to tank via a pipe.

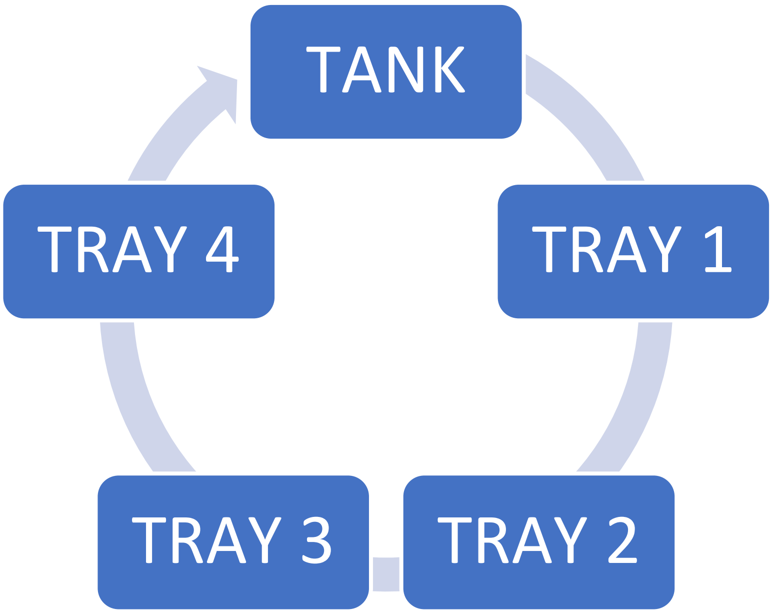

Figure 4.1 Water circulation in One-Type Plant case

[2] Two types of plants
The rubber gasket is attached to the tray which separates the plant 1 with the plant 2 region. This way different environments for the different plants can be created.
The tank is divided into two parts and both the pumps are put into use. The respective solution is pumped to the topmost tray of the respective plant section which then flows accordingly

and then flows back into their respective tanks via a pipe connected to the bottommost tray of the section.

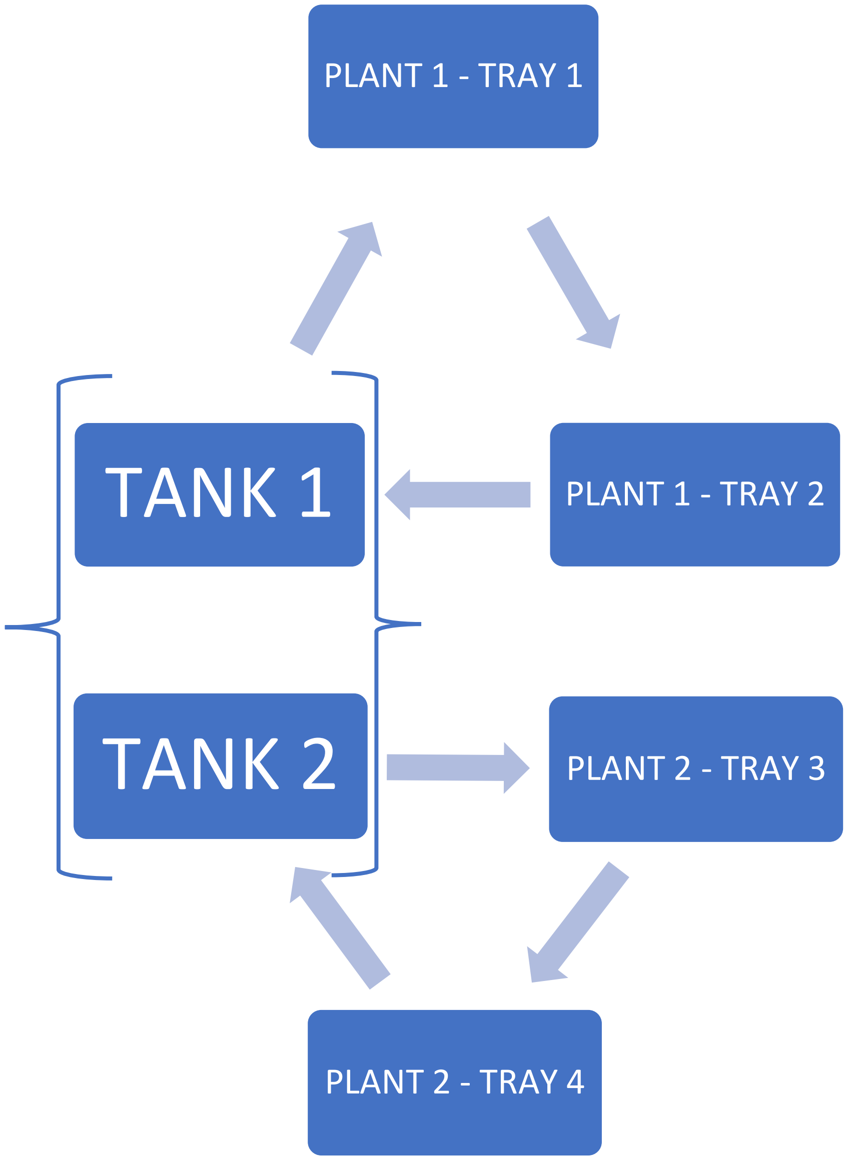

Figure 4.2 - Water circulation in Two-Type Plants case

Step 5: Automation:

A Raspberry Pi 3 with Micro controller is used to control and monitor all the sensors and actuators connected to it. Both the temperature and humidity controller are also monitored by this micro-controller. The micro-controller is connected to the Wi-Fi by using Wi-Fi module ESP8266.

The sensors used in the system are –

- pH sensor
- Temperature sensor
- Humidity sensor
- LDR sensor
- Water level sensor (Ultrasonic sensor)
- Concentration sensor

Other devices –

- Solenoid valve
- Ventilation fan
- Heater
- Battery

An android application is made which makes the system more easy to use and also makes it remotely operable. The application shows sensor status and sensor data and sends a notification in case of power outage or any malfunction. The user can connect the sensor with Wi-Fi and then add them directly to the mobile application.

The whole operation is divided into three processes –

- Sensors (Sensor Node) – To monitor the respective conditions.
- Comparison Condition (Sensor with Data Fusion) – Checks the reading from the combined nodes (sensors) and compares them to the optimum or pre-defined conditions.
- The Action (Data Fusion result) – The action taken to correct the result.

For example, to maintain the water level in the tank the following steps are taken –

1. Ultrasonic sensor (Water level sensor) checks the real time water level.
2. The status of the solenoid valve is checked i.e. on/off.
3. The combined condition is checked i.e. if the water level is correct and the solenoid valve is off then the condition is Green otherwise condition is Red.
4. If condition is Red, the valve is opened and the water flows till the water level comes back to normal.
5. It checks the status again and if the desired water level is attained and but the valve is on, the condition is Red and the value is turned off.

To check the power outage we use a wireless transmitter and wireless receiver. The wireless transmitter is connected to the main system and runs on battery while the wireless receiver runs on main power. If they connect to each other, the power status is green i.e. power available, whereas if they disconnect then the power status is red i.e. power unavailable. In this case a notification is sent to the user. The transmitter does not run continuously but sends a signal after regular intervals.

The data obtained by using of the mobile application is collected and stored in the database to analyse and improve hydroponic vegetable growing in different seasons more efficient.

Step 6 : Prototype Manufacturing:

Materials Used

Insulation – Fibre Glass
Greenhouse – Poly(methyl methacrylate) (PMMA)
Tank – PVC (Polyvinyl Chloride)
Trays – ABS (Acrylonitrile butadiene styrene)
Basket – ABS
Gasket – EPDM (ethylene propylene diene monomer) Rubber

We are using ABS for Trays and basket because of its' following properties –

- Chemical Resistance
- Structural Strength and Stiffness
- Great Electrical Insulation Properties
- Excellent High and Low Temperature Performance
- Can be used as a 3D printing material (ABS Filament)

Poly(methyl methacrylate) (PMMA) is a strong, tough and lightweight material which made it the best substitute for normal glass, in the construction of the greenhouse.

7. Project Demonstration

Figure 5.1 - The solution reservoir with pump

Figure 5.2 - Second level to support the plant basket and the place where the solution flows

Figure 5.3 - The Basket containing the plants grown using this method

The project is demonstrated in this fashion because of the non-availability of proper equipment and professional tools due to the pandemic situation.
The demonstration shows the feasibility of the idea and does not represent the whole design.
The following link contains the video of the final prototype demonstration –

https://youtu.be/xSElR4f1kok

Figure 5.4 Soujanya with the plant

8. Novelty and USP

- Setup is easy and highly affordable.
- Cabinets can be easily added or removed.
- Our setup is highly home oriented unlike shown in literature review which are farm or research oriented.
- Hydroponics offers the option to grow plants — vegetables such as tomatoes, herbs, hemp, and a variety of others — in a specialized environment without the use of soil in a controlled area.
- Different season plants can be grown in different cabinet.
- We use LED’s instead of bulbs as when you compare fluorescent and incandescent, LED delivers a much higher ability to produce visible light.
- It is fully automated and user friendly

9. Final CAD Assembly

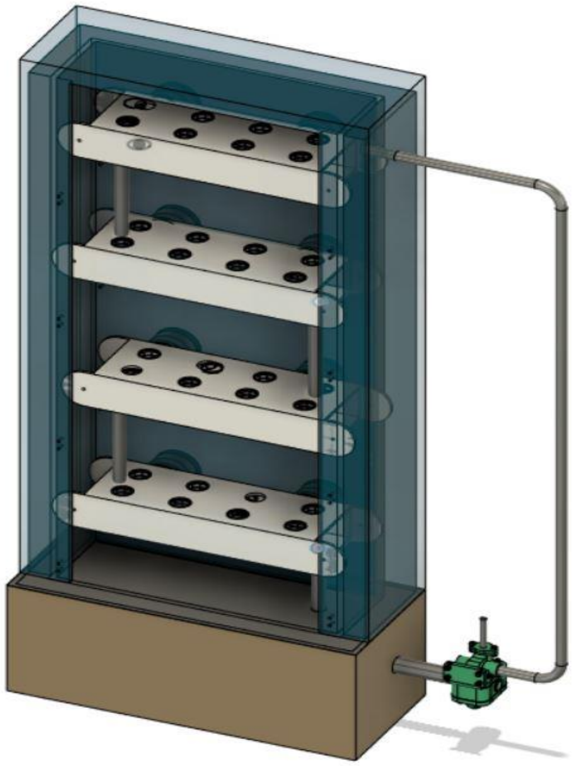

Figure 6.0 - CAD Model

10. COST ANALYSIS

Part	Cost
1: Pump	Rs 150
2: Greenhouse	RS 1000
3: Pipes	Rs 600
4: Exhaust fans	RS 4000
5: Microcontrollers	RS 500
6: Water trays	RS 4000
7: Plant Nets	Rs 300
8: Nutrient solution	Rs 200
9: multimeter	Rs 350

10:Light sensor	Rs 560
11: PH sensor	Rs 900
12:Relay:	Rs 200
13:Temperature and Humidity sensor:	Rs 1000
14:Solenoid valve:	Rs 1500
15:Water flow sensor	Rs 400
Total Cost	RS 15000

11. Results

Now, the main goals we achieve by this project are:

- Preventing soil usage for farming
- Increased yield in same space
- Better nutrition of plants
- No need of fertilizers
- Needs very less human effort

12. Conclusion

- The space occupied by this setup is much less than that occupied by a normal hydroponic setup.
- The plant growth is more closely monitored which results in better produce.
- The online format makes it more accessible and user friendly.
- The data collection improves the pod controls making it more and more efficient than any other hydroponic setup.

The points presented above easily show the great importance of this setup and it's wide application both in the field of domestic gardening and in farmer training.

13. References

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