Design and Implementation of Automated Greenhouse Management System

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Growing certain plants and vegetables in remote areas such as desserts and the polar region can be a challenge because of extreme weather. Very few species of the plants thrive in such situations and are often not used as a food source. In this study, we created a system that can grow common plants and vegetables and can operate without depending on the outside climate. The artificial greenhouse has a higher temperature in it than its surroundings. So, different plants can be grown in off seasons as well. Summer plants can be grown in winter. A climate control system automates the greenhouse to reach the desired temperature as required by your crops' growing process. The system monitors and handles humidity, shading, fogging, and much more. This is accomplished by the way of real time sensors, that communicate wirelessly in the greenhouse, via mesh wireless network. We achieved this by using a technique called Hydroponics. Hydroponics is a method of growing plants without using soil. The system was automated using microcontrollers and sensors to keep human intervention at a minimum. An Internet of Things (IoT) network was created to improve reliability and allow remote monitoring and control if needed. The user is only required to plant a seedling and set initial parameters. Once done, the system is able to maintain the parameters and promote healthy plant growth. The most obvious advantage of this control system is its widespread use throughout the world. According to operation, control system has a harmonized spectrum, which means that even though different countries may operate on different operation bands, users can transfer functionality between networks and keep the same number. The system can be monitored by automatically.

Keywords: Internet of Things (IoT), Google Cloud, Design Analysis, hydroponics; greenhouse; control system.

INTRODUCTION

A green house is where plants such as flowers and vegetables are grown. Greenhouses warm up during the day when sun-rays penetrate through it, which heats the plant, soil and structure. Green houses help to protect crops from many diseases, particularly those that are soil borne and splash onto plants in the rain. Green house temperature should not go below a certain degree, High humidity can result into crop transpiration, condensation of water vapor on various greenhouse surfaces, and water evaporation from the humid soil. To overcome such challenges, this greenhouse monitoring and control system is devised. Rather than using old method for farming we are using hydroponics method which can be defined as: Irrigation system by which the root crops are balanced nutrient solution dissolved in water with all the chemicals necessary for the growth of plants, which can be grown directly on the mineral solution, or in a substrate or medium inert. Hydroponics is increasing in popularity among commercial and hobby growers, and with good reason. With the right setup, hydroponic growing is a cost-effective method to grow high-quality produce with maximum yields. We have implemented an array of sensors inside the greenhouse viz. Light, Humidity, pH level along with air and water temperature sensors. Which will help us continuously monitor the Greenhouse's environmental factors and take actions to accomplish the necessary requirements. The output of the sensors will be fed to the microcontroller and will be processed and will be displayed on the LCD, so that monitoring the factors manually is possible. According to the sensor data, Microcontroller will process the data and accordingly will actuate the Fan, Sprinkler, Lamp and Pump.

Dennis McGuire, proposed Disclosed is a fully-automated greenhouse that utilizes hydroponic growing techniques in order to maximize the amount of crop production possible in a given footprint, and eliminates the need for soil, fossil fuels, pesticides and toxic chemicals. The greenhouse produces its own pure, clean water supply with proprietary, on-board atmospheric water generators incorporating water treatment technology, namely ozone, hydrodynamic cavitation, acoustical cavitation, and electrochemical oxidation to oxidize and destroy contaminants to maintain purity.

Mattew vail, Eric ellasted, proposed a model A high-density horticultural system having a lighting system is provided. The horticultural system comprises a lower shelving component that is attached to a first bracket within a vertical racking system. The horticultural system also comprises an upper shelving component. The upper shelving component is attached to a second bracket within the vertical racking system, wherein the second bracket is vertically displaced 11 inches from the first bracket. Additionally, the horticultural system comprises a lighting system that extends down from the upper shelving component. The lighting system component has a lighting fixture that extends from the top portion of the lighting system, a bottom cover that is at the bottom portion of the lighting portion, and a duct between the lighting fixture and the bottom cover.

Jan J Smits, Gerrit Oosterhuis, Antonius Paulus Aulbers., Greenhouse system may comprise an illumination, a sensor, and a controller. The illumination and controller are arranged to vary the intensity and the spectral distribution of the light emitted by the illumination. The emitted light may be pulsed light, the pulse characteristics being variable by the controller in dependency of the output of the sensor. The controller is arranged to interpret the relevant variables measured by the sensor and to assess the actual and/or expected growth of the relevant plants, and to control the intensity and/or the spectral distribution of the light emitted by the illumination. Some sensors may be provided for measuring the intensity and/or spectral distribution of the actual light in the greenhouse, other sensors for measuring plant dimensions of the relevant plants or plant groups. The illumination may comprise a heat collector which can be connected to heating or air conditioning inside or outside the greenhouse.

Deborah L. Walliser, developed a model This paper presents A greenhouse growing environment has a distributed control system for selecting, monitoring, and administering hydroponic nutrient solution mixtures that are tailored to crop varieties of the greenhouse. The crop varieties are preselected based on location characteristics of the greenhouse and analysis results of source water. The analysis results indicate a nutrient composition of the source water. A predefined nutrient formulation is then automatically combined with the source water by a nutrient dispensing subsystem, to achieve a desired nutrient solution mixture that is applied to a hydroponic bay. A computational system automatically monitors the state of a hydroponic environment and directs input modules as programmed, in order to increase plant growth, plant quality, and volume of plant yield.

Shree jhanavi build a theoretical proposal A greenhouse is an enclosed structure that provides micro-climate for the plant growth. This paper presents the design of a wireless sensor network that provides real-time monitoring of temperature, humidity and soil moisture of a greenhouse. An automated control system for managing these micro-climate parameters is developed to optimize the parameters and use of water. The sensor node developed handles the data from the sensors and triggers actuators based on the threshold algorithm programmed into the microcontroller. The gateway receives the sensor data and control information through Zigbee and transmits the data to the web application for remote monitoring. The monitor software provides network view with nodes and their information. Information management system is also designed to monitor the data at any required time.

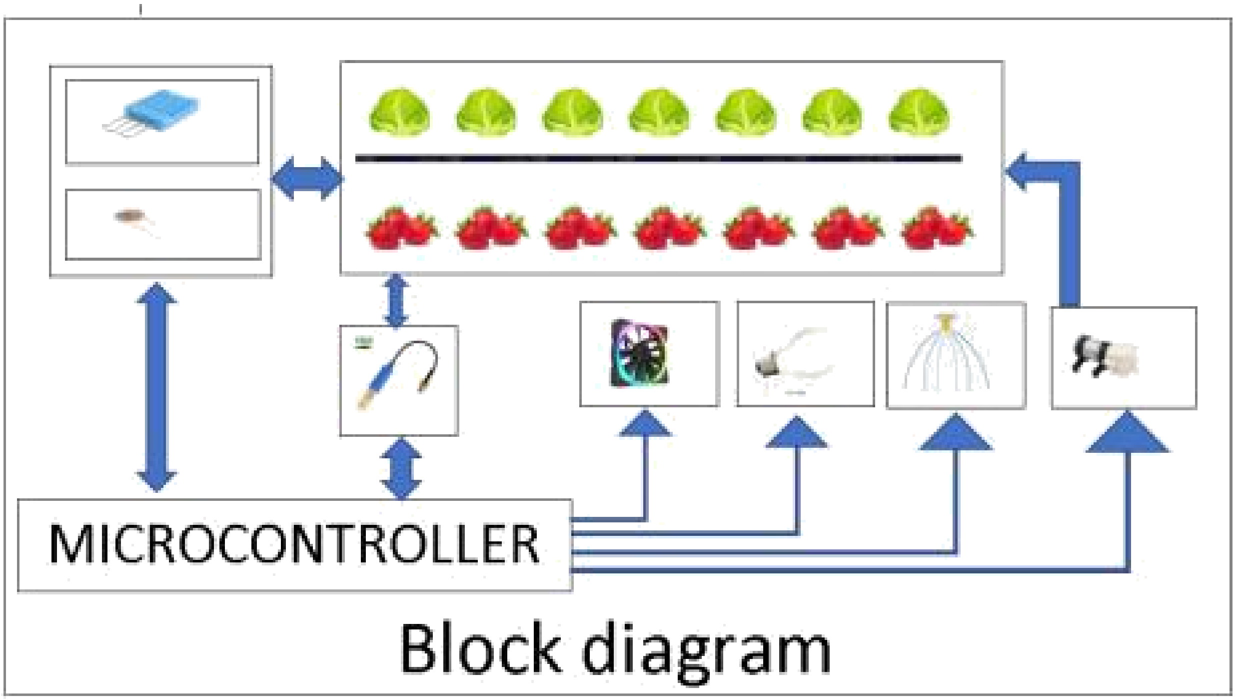
David, Anthony, Shaptai, proposed a model Interest is increasing in the development of methods to automatically and continuously detect crop stress, water use, growth and nutrition in greenhouse crops. Some of these techniques are now being tried in commercial greenhouses and hold the promise of improved climate management for better yield and quality, and reductions in environmental impact. However, integration of automated crop monitoring with computer environmental control systems is not yet commonplace, and will depend on the development of computer programs which incorporate the most appropriate real-time crop data into dynamic models.

Ziabul haque,Raju ahmed, give a theoretical propose In traditional farming, farmer has to visit the farming land regularly to measure the various environmental parameters such as temperature, humidity, light intensity and soil moisture to cultivate the right crops at right time in right soil. Even though this traditional farming system have been used for years, the system is hectic and fail to prove high productivity rate as farmer usually unable to measure all the parameter accurately [1]. In contrast, greenhouse farming is a system where farmer cultivate crops in ecosystem environments where all environmental parameters are adjusted based on crops types. Automation in greenhouse is a method where farmer is able to monitor and control the greenhouse environment automatically from anywhere in the world any time [3]. In this paper, authors proposed an automated greenhouse monitoring and controlling system that incorporate various sensors such as temperature sensor, humidity sensor, light sensor and soil moisture sensor to collect possible environmental parameters of greenhouse as well as integrate Arduino Uno R3 (to store and process data), GSM module (to send the measured value of the various parameters to the user cell phone via SMS to ensure efficient growth of plants), solar power system with rechargeable battery (to make sure continuous power supply to the greenhouse system). Moreover, Internet of Things (IoT) is used to store data to a database and process the collected data and finally send the information to the android apps which has been developed for monitoring and controlling of greenhouse by the user. Moreover, the authors compared the proposed greenhouse model with some recent works and found the proposed system cost effective, efficient and effective by analyzing major environmental parameters. Finally, authors analyze the cost associated with the deployment of proposed greenhouse model which depict quite affordable for farmers and worth deploying.

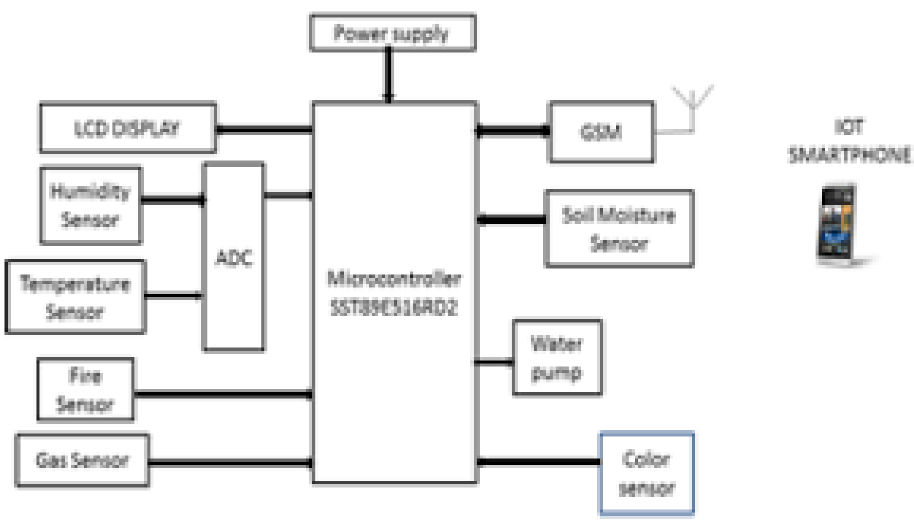
Cheng, yang, kuan weng, Huang, More and more crops are grown in greenhouses, and crop growth status monitoring is equally important as field-grown crops. An automation system based-on multi-spectral imaging and mobile environmental factor sensing has been developed and operated. To obtain necessary spectral image information of seeding growth status on greenhouse benches, a series of image processing procedures was developed. The study also explored the applications of the (RFID) system to construct a traceability system for seeding production in greenhouse. Days of seedlings growth can be calculated estimating the PLAI of the plant-oriented multi-spectral images with $R^2 = 0.989$. Appropriate irrigation level could be estimated using different indices with environmental factors. Greenhouse cultivation is a site-specific management illustrated by precision integration.

Based on this literature review, it can be concluded that management system of greenhouse has a great effectiveness for upcoming use. A comprehensive research has been performed to select different material, method and designing of different safety system that offer features such as productivity, Eco friendly, economical produced base in a large scale and benefit for users. Conceptual task has been performed on the provision of management system and theoretical expressions introduced, based on ideal assumptions. The proposed technique figured out new factors for design of an effective safety system. The Knowledge with respect to the factors governing for management system is beneficial for the society and accordingly, suitable modifications are introduced into the proposed model. Their effects on the using and efficiency are plotted for the proposed system.

DESCRIPTION OF WORKING PROCESS



Figure(1a): Block diagram of automated greenhouse effect



Figure(1b): Block diagram of automated greenhouse effect

Management system is connected to microcontroller via Module. Module is used to fetch data from the device, it is a communication bus which facilitate the communication between function and desired model functional operation.

Design Thinking is a methodology used by designers to solve complex problems, desirable solutions for users. Design Thinking draws upon logic, imagination, intuition, and In this work, systemic reasoning, to explore possibilities of what could be, and to create desired that benefit the end user. A design mind-set is not problem-focused, its solution focused, and action oriented. It involves both analysis and imagination The body formation of device related with metering operation incorporated with frame designing appropriation of components. The part which we elected for device, some of the parts we have purchased online and rest of them we bought from local shop. After collecting all of the parts, initially we structured and make an architectural design for settle down all the other parts orderly. Secondly, we have assembled them robustly with the glue for giving strength and clip in a manner that it cannot fall off. We have designed the device in a way that it can carry the whole part of structure etc. Once the assembly is done, now we dealt with most significant part of the project which is synchronizing all the part then that can give a moderate output of operation.

WORKING OPERATION OF AUTOMATED GREENHOUSE MANAGEMENT SYSTEM

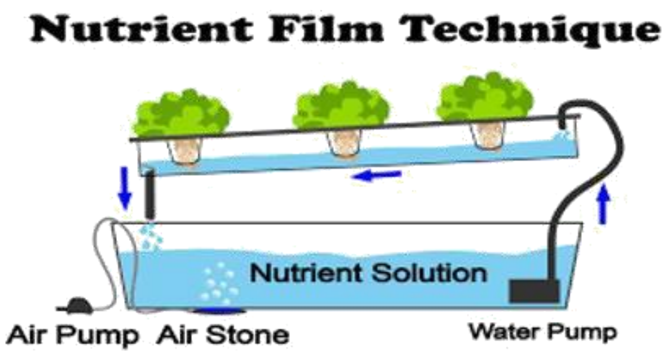


Fig 2: Hydroponic System.

Hydroponics: is a subset of hydroculture, which is a method of growing plants without soil by instead using mineral nutrient solution in a water solvent. Terrestrial plants may be grown with only their roots exposed to the nutritious liquid, or the roots may be physically supported by an inert medium such as perlite or gravel.

Sensors:

DHT11 Temperature and Humidity Sensor

LDR Light Sensor

pH Sensor

DHT11: The DHT11 is a basic, ultra-low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). Its fairly simple to use, but requires careful timing to grab data. The only real downside of this sensor is you can only get new data from it once every 2 seconds.

LDR Light Sensor: LDR is a component that has a (variable) resistance that changes with the light intensity that falls upon it. This allows them to be used in light sensing circuits.

pH Sensor: A pH meter is a scientific instrument that measures the hydrogen-ion activity in water-based solutions, indicating its acidity or alkalinity expressed as pH. The pH meter measures the difference in electrical potential between a pH electrode and a reference electrode, and so the pH meter is sometimes referred to as a "potentiometric pH meter". The difference in electrical potential relates to the acidity or pH of the solution. The pH meter is used in many applications ranging from laboratory experimentation to quality control.

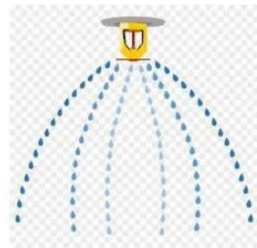
Microcontroller:

Arduino UNO: Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button.

Actuators:

Cooling Fan

LED Lamp

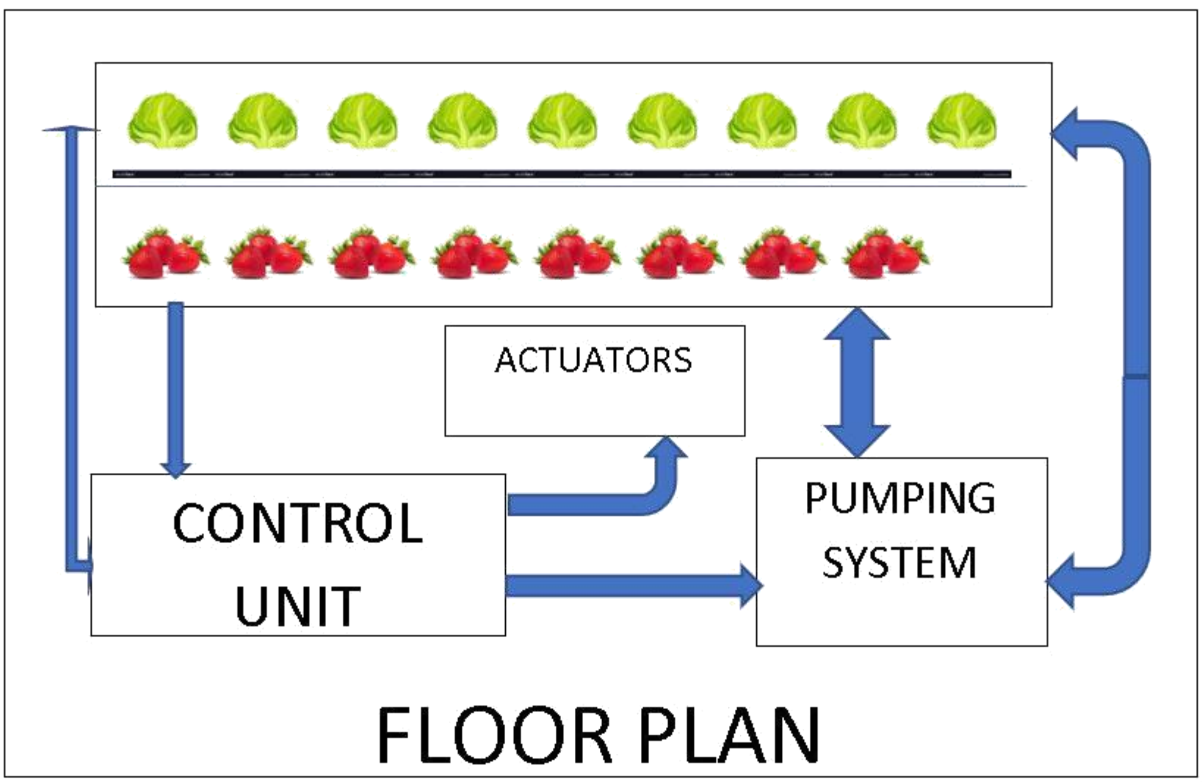


Sprinkler

Water Pump

Actuators: These fan, sprinkler, lamp and water pump are present to control the air temperature, Humidity, Lighting and Water temperature respectively.

Floor Plan:



Figure(3): Floor planning for Greenhouse.

WORKING OPERATION IN FLOW CHART OF AUTOMATED GREENHOUSE MANAGEMENT

III. SYSTEM FLOWCHART

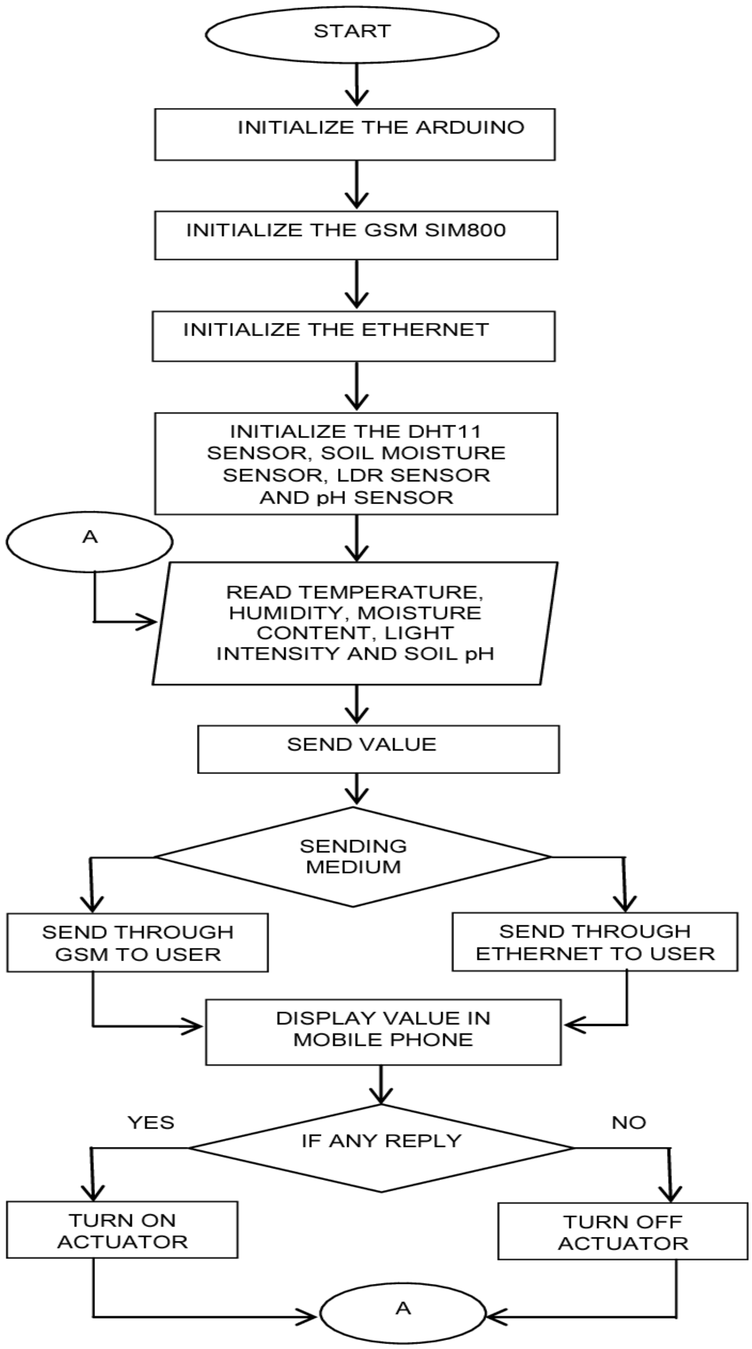


Fig. 10. Greenhouse System Flow Chart

Figure(6): Flowchart of working of management system

This flowchart shows that ho to operation will be done by the device by using, GSM module for sending notification to users as that taking effective action for chasing reading as well as better functional operation.

Figure (7): General working method of Greenhouse System.

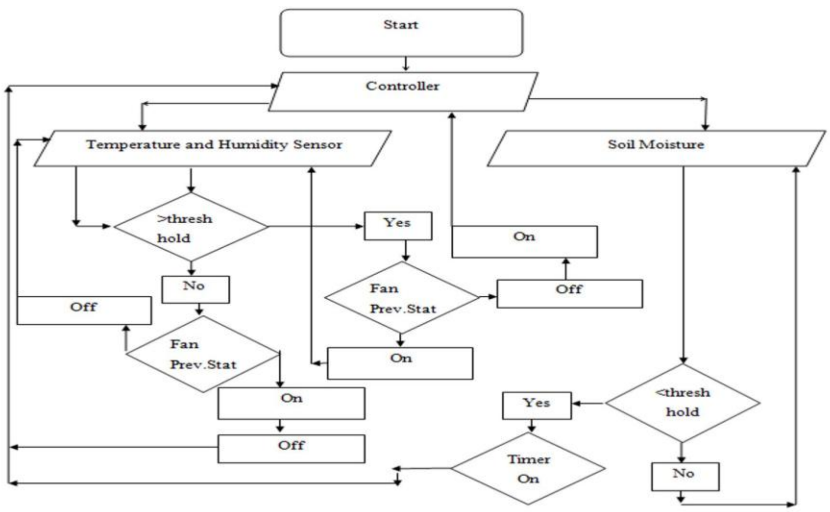


Figure (8): General flow operation of Greenhouse Management.

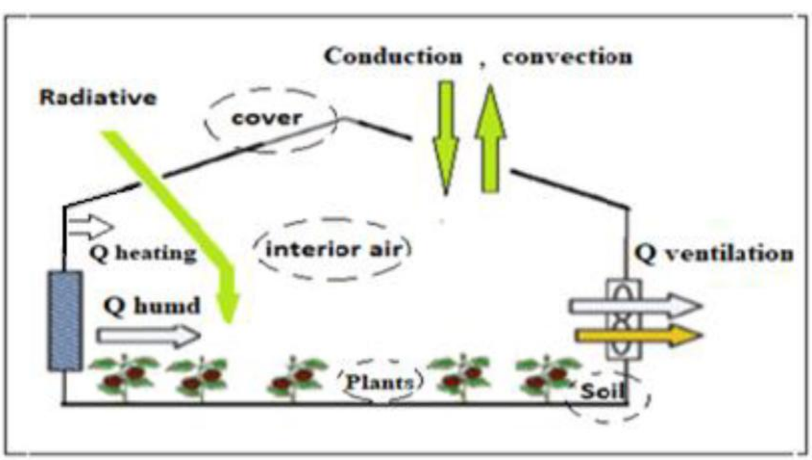


Figure (9): General working method of Greenhouse System.

FACTOR CONSIDERATION DURING THE DESIGN

Well Maintained Environment

At the time of designing and make structural function for getting benefited outcome, well maintained environment is needed for better output of result. The system should be well maintained with sufficient effort, and all functional parts should be well sound maintained. The outcome where work will be reflected should be fulfilled all that conditions.

Good Efficiency

All that efficiency will depend upon the proper connection as well as order nomination of all parts of device that can give a good result with ensure of betterment.

Eco-Friendly

The device working process is very much Eco friendly there is no collision in between components and the safe has been ensure for users.

RESULT AND DISCUSSION

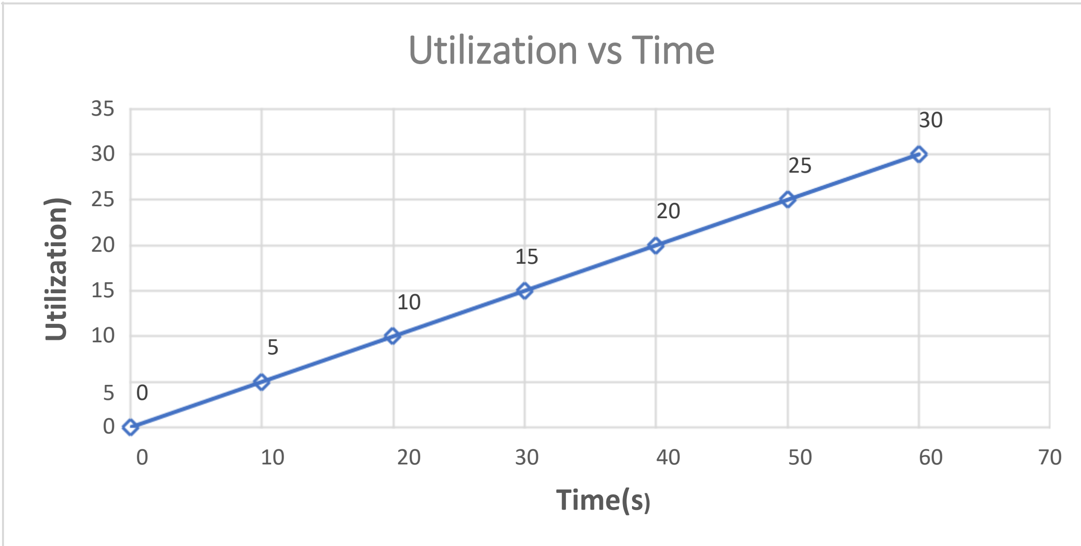
Problems Faced

There are just a few sensors and the area is too large (80-90sq meter). So sensor data is inconsistent at different locations. Sprinkler is on at regular pre-decided fixed interval of time. For condensation of the entire greenhouse, the fan is operated at fixed time intervals. For every reading to be taken, the in-charge operator has to enter into the greenhouse, raising the risk of contamination and infection. Light control was absent.

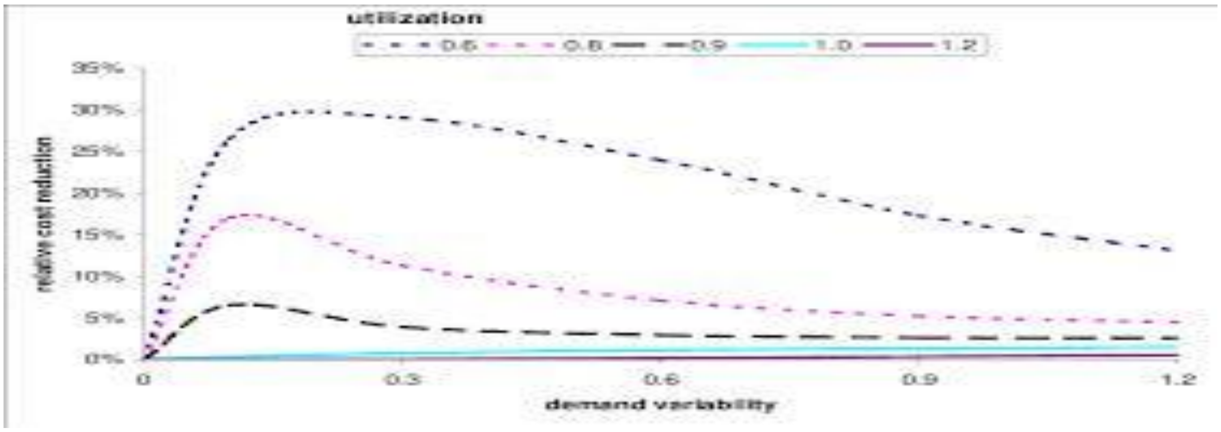
Future Scope

Though many have tried implementing a country wide Greenhouse management sysem, it is still an unreachable goal, many factors like cost, feasibility and mainly the need to replace the existing system have hindered its development. At least in near future, the cost involved in the building of this system could be minimized by using more efficient technology and commercializing it by production in a large scale thus reducing the production costs tremendously and hence making it more feasible to be implemented worldwide. This project will prove its utility efficiently once its implemented, it will help farmer to control and manage the greenhouse to improve the productivity of plants. Farmer can remotely control whole irrigation and other factors by connecting the system to the internet. We can even implement technologies like energy harvesting to power our circuit and sensors.

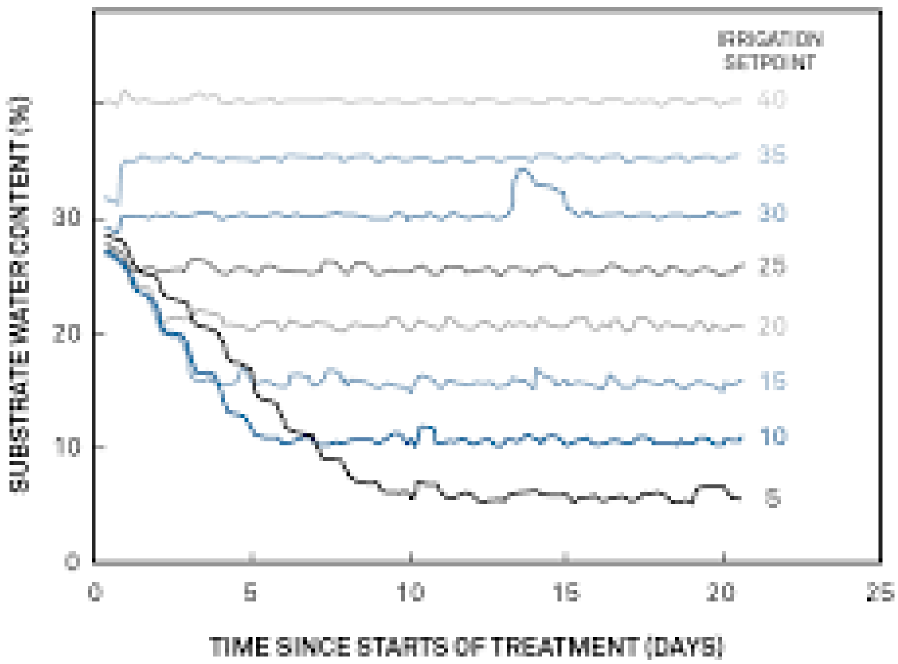
The system of digital management system device considers the time and utilization cover by device in a decent large city. Various factors are considered when it sated in different location of different place.

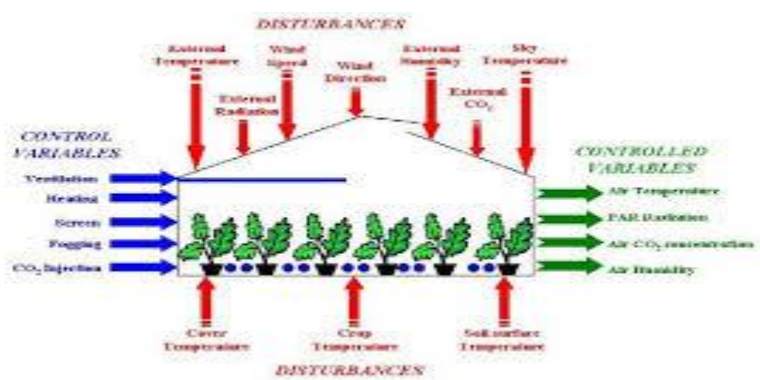


Figure(10): Utilization vary with time (Basis of Response)



Figure(11): Utilization vary with flow time (Response)





Figure(12):Utilization vary with flow time (Response)

The graph fairly demonstrates that when the time is increasing the utilization covered by the device is also increased.

Several problems and factors related to design, selection of equipment and their application were confronted during the process of implementation of the device. In this section, the accomplishment of the proposed or introduced problem should be entertained by users as per requirement.

CONCLUSION

Based on this study of greenhouse management automation system, the following limitations can be drawn:

Based on the performance criteria considered, several systems where compared and now we come to a conclusion that Greenhouses help to protect crops from many diseases, particularly those that are soil borne and splash onto plants in the rain, to overcome that we used Hydroponics.

Green house temperature should not go below a certain degree, High humidity can result into crop transpiration, condensation of water vapor on various greenhouse surfaces, and water evaporation from the humid soil. To overcome such challenges, We used Microcontroller paired with sensors and actuators to control above mentioned factors. Hence our project Automated Greenhouse Management is devised.

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