Smart Vertical Farming Using Hydroponics

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Abstract: *Smart farming makes a tremendous contribution for food sustainability for 21st century. Our project vertical farming is the practice of producing food in vertically stacked layers, vertically inclined surfaces and/or integrated in other structures using Controlled environment agricultural technology, where all environmental factors are controlled. These facilities utilize artificial control of light, environmental control like humidity, temperature, gases, fertigation. Controlled-environment agriculture (CEA) is a technology-based approach toward food production. The aim of CEA is to provide protection and maintain optimal growing conditions throughout the development of the crop. Production takes place within an enclosed growing structure where the growth conditions are maintained. The crops are grown based on hydroponics method of soilless farming*

Keywords: *Controlled environment agricultural technology, Hydroponics, Smart farming, Vertical farming,*

I. Introduction

Smart farming is the logical advancement of precision farming. The focus of precision farming was mainly on technological invention to allow for site-specific farming [1]. Moreover, smart farm is about empowering today's farmers with the decision tools and automation measurement technologies that seamlessly integrate products, knowledge and services for better productivity, quality and profit. Technological advances in these areas gather increasing momentum and this means that maintaining an overview of latest developments becomes more and more of a challenge [2].

The most important things of smart farming are environmental measurements and water management. The reason is that the environmental and water management affects plant growth directly. Vertical farming is considered as a modern tool for feeding large world population by year of 2050. Vertical farming according discounts the value of natural landscape in exchange for the idea of "skyscraper as spaceship. Plant life is mass-produced within hermetically sealed, artificial environments that have little to do with the outside world sense. They could be built anywhere regardless of the context. Hydroponics is a subset of hydro culture, the method of growing plants without soil, using mineral nutrient solutions in a water solvent. Therefore a combination of smart vertical farming and hydroponics would help to double the advantages of each separate system.

In this paper we propose a smart vertical farm module in which plants will be grown in vertical pipe stacks using hydroponics technology. The temperature, humidity [7] inside the module is continuously monitored using sensors and feed into microcontroller. The liquid level [5] inside the pipes is monitored using magnetic float switches and controlled using solenoid valves. The temperature inside the system is controlled with a specific range using a fan and bulb arrangement using a PLC. On top surface two holes were drilled to place an exhaust fan and a bulb respectively. The water supply to the system is from a central water tank , alkaline and acidic solutions are kept in two separate tanks on either side of the main tank and flow is controlled using solenoid valves. LED strips of blue and red light were pasted on side walls of the frame to produce a pink light which is absorbed by the plant during photosynthesis.
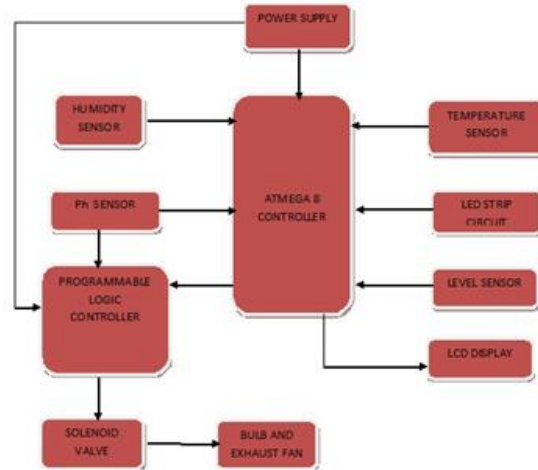
Figure 1.1 Block Diagram

II. Methodology

In our project we implemented a smart vertical farm module in which various sensors and controllers were used to sense and control the major factors that affect the crop yield. We have implemented a vertical farm module based on hydroponics technology that is soilless farming method [4].

Figure 2.1 Farming module

An aluminum frame of dimension 20*15*30 cm was constructed which is covered by glass on front and back surface. Inside this frame three layers of PVC pipes were stacked horizontally to form vertical layers. Holes of fixed diameter were drilled at equidistant points on each pipe row where the plants are to be placed. The pipes were connected using solenoid valves to regulate the water flow between the pipes. On top of the frame a central water tank was placed and a hole was made at its bottom to allow flow from tank to the below PCV pipe layer. Two separate tanks of smaller capacity compared to the main tank were placed on either side of the main tank that stores alkaline and acidic solutions.LED strips of blue and red light were pasted on side walls of the frame to produce a pink light which is absorbed by the plant during photosynthesis. On top surface two holes were drilled to place an exhaust fan and a bulb respectively.

III. Implementation

The central controller is the Delta DVP-SS2 digital PLC and the secondary controller is AT mega 8 microcontroller. Inside the frame a temperature sensor LM35 is placed which continuously monitors the temperature inside the case. When the temperature inside the case goes beyond 40 degree Celsius the exhaust fan is automatically turned on to cool the system and similarly when the temperature becomes less than 26 degree Celsius the bulb gets on to heat up the system.

The Ph sensor is dipped inside the main tank and it monitors the ph level whenever it deviates from the required level PLC through a relay circuit opens or closes the respective solenoid valve of the acidic or alkaline tank. A humidity sensor [7] is also placed inside the frame that monitors the humidity and display it on the LCD screen placed on the front glass panel.

The supply of 230 volt ac is given to an SMPS and the 24 volt out from the SMPS is given to the PLC and relay circuit directly. This 24 volt is also given to a bridge and regulator circuit where it is regulated to 5 volt and is given to the microcontroller circuit.

Level inside the vertical pipe stacks is monitored and controlled using a magnetic type float level sensor [5] . The sensor consist of a rod, float with magnetic ring on top and its output is connected to the solenoid valves. Supply is provided from SMPS(24V) Initially when the liquid level is below the preferred level the sensor output will be high , that means the valve will be open and water will flow from the above pipe or the central tank. When the water reaches the preferred level, the valve will be closed and the flow is stopped.
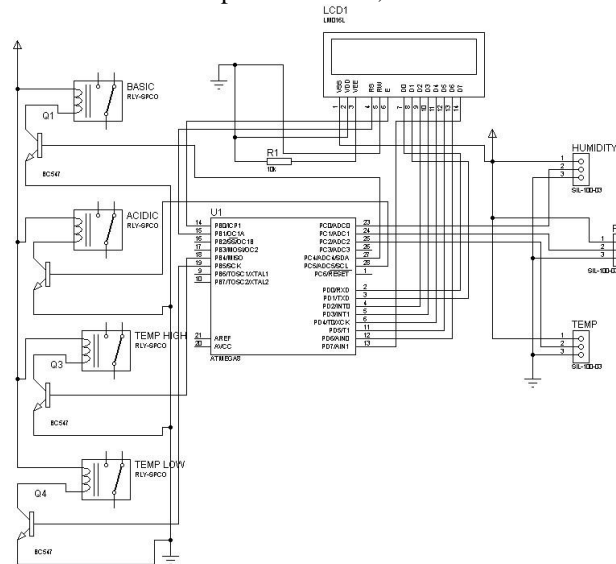

Figure 3.1 Circuit simulation using Proteus

IV. Result

In this project we implemented a smart vertical farm module in which plants are grown in a controlled atmosphere that suits its growth. We have developed the module based on hydroponics technology. All the parameters like temperature, humidity, ph and liquid level were sensed and controlled automatically.

V. Conclusion

As technology enables new farming opportunities in indoor, warehouse-based settings, food production can be retooled to accommodate high-density urban living and maintain food security despite a future of increasing climate instabilities and vulnerabilities. The visionaries behind this new farming technique are working toward a networked agricultural system that looks to the open-source software movement for inspiration. Also with a large scale use of these vertical farming modules in unused factories and buildings a 20 cent land can be converted into a one acre farming space.

In future by in cooperating image processing and mobile applications we can control this module remotely by the using mobile application software.

Acknowledgements

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