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Design and Development of Solar Powered Smart Hydroponic Greenhouse.

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ABSTRACT:
The key objective of this paper is to present low-cost solar-powered Smart Hydroponic Greenhouse. Hydroponics is a new agricultural production system in which the production takes place in a soilless medium using water. The hydroponic system requires controlled environment for the proper growth of plants, less chance of diseases and faster growth. It includes Automated Monitoring and controlling environmental parameters like temperature, humidity, PH, conductivity etc. The parameters are acquired by the respective sensors. If the values exceed or decrease their corresponding set points, the system starts the controlling action and tries to achieve its nominal value. The second part of the proposed design is the power supply. A proposed hydroponic greenhouse used Smart solar power unit which functions as primary power supply and will shift to conventional electrical energy if there is no adequate energy to run the automation for hydroponics system. So to provide primary supply as a solar power we have to monitor the solar panel as well battery voltage, According to the demand, it will switch over to the main supply (conventional grid). And using this technique we can grow plants like tomatoes, cucumber, peppers etc. without any harmful pesticides and fertilizers.
KEYWORDS - Hydroponics Greenhouse; Nutrient Film Technique(NFT); PLC; Solar panel; Soil-Less Cultivation; Nutrient Solution; pH; EC; wireless communication.

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I INTRODUCTION

Hydroponics is a method of growing plants using mineral Nutrients solutions in Water without soil. Hydroponics technique is the best way to grow vegetables, fruits, plants without soil. Hydroponics can be grown outdoors, indoors even in small space. Hydroponic allow for the crop to grow in the area where Growing traditionally has been a problem and the place where the soil is poor in terms of fertility and where water is minimum, where farmland is too expensive. In Hydroponics techniques plants are placed in growing medium and nutrients are delivered directly to roots. Plant May grow with their roots in nutrient solution only or in an inert medium. The hydroponic technique is better, faster way to grow plant than the growing plants in soil. Hydroponic provides better, the more nutritional result with the efficient use of water and fertilizer. Hydroponics allow farmers to grow more food in less space as compared to traditional Soil gardening. Vegetables, plants, and flower can be grown on the roof of houses. Fruits grow in a shorter period of Time as compared with soil system. There are six main types of hydroponic systems.

1. Wick Systems
2. Deep Water Culture (DWC)
3. Nutrient Film Technique (NFT).
4. Ebb and Flow (Flood and Drain)
5. Aeroponics
6. Drip Systems

The Nutrient Film Technique (NFT) is a popular commercial hydroponic system.[5]
This Research is based on providing automation to such an agriculture thing which has the tremendous future scope and very useful to the farmer, so that they get more production and quality in the product (Crops) with very less effort, in very less space and at very low cost.

II NFT SYSTEM

The NFT system (Nutrient Film Technique) is quite popular with home hydroponic growers as well. Mainly because of it is fairly simple to design. However, NFT systems are best suited for, and most commonly used for growing smaller quick

growing plants like different types of lettuce. Along with growing lettuce, some commercial growers also grow different types of herbs and baby greens using NFT systems. While there is a lot of different ways design the system. They all have the same characteristic of a very shallow nutrient solution cascading down through the tubing. Where the bare roots of the plants come in contact with the water and can absorb the nutrients from it as shown in Fig 1. The major downside to an N.F.T. system is that the plants are very sensitive to interruptions in the flow of water from power outages (or whatever reason). The plants will begin to wilt very quickly any time the water stops flowing through the system. [6]

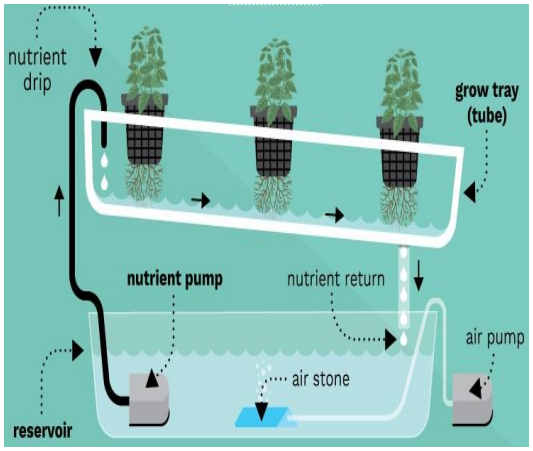

Fig-1

III WORKING OF SYSTEM

Smart Hydroponic greenhouse divided into two parts:

1. Hydroponic Greenhouse System
2. Solar Power Unit

1) Hydroponic Greenhouse System:

In Automated Hydroponic system plants are placed in a growing medium and nutrients are delivered directly to the roots. PLC (FX5U) is the main part of the automated hydroponic system [1]. The programmable logic controller is used for Monitoring and controlling the parameters like Temperature, Humidity, Conductivity, pH etc.

To increase the temperature of the system heater has been fitted into the system while reducing the temperature cooling fan has been provided. Same is the case for humidity to increase it humidifier is mounted in the system and to reduce it exhaust fan has been mounted into the system.

We have to also maintain pH and conductivity into the nutrients tank for that pH up, pH down solution, nutrients solution has been provided with automatically dosing action into nutrient tank so proper pH and conductivity will be maintained. If these values exceed or decrease their corresponding set points, the systems start the controlling action and try to achieve its nominal value.

We have used HMI (GS Series) in our system for visualization and controlling purpose. HMI configures data like Set points, Mode selection, Light on-off timing cycle etc., and for monitoring it shows historical trends and real-time data of process parameters [3]. The home screen of the software used for the HMI designing is shown in Fig-8.

2) Solar Power Unit:

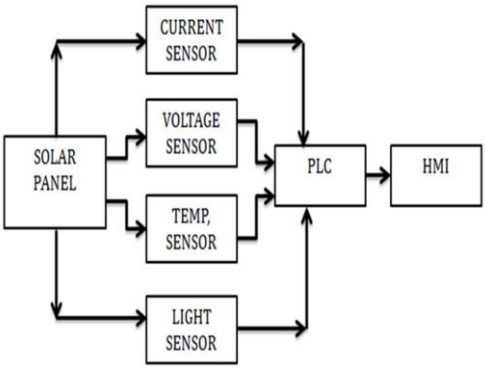

Fig-2

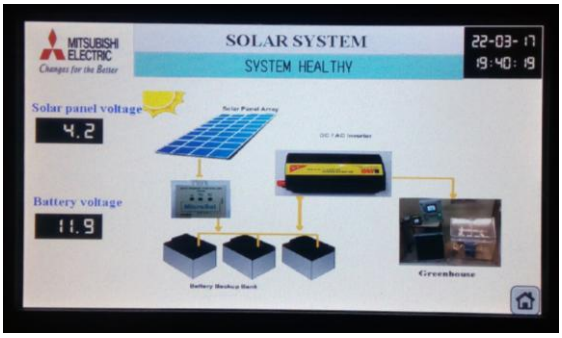

Fig-3

As shown in Fig 2 Solar Power Unit consists of the solar charge controller, battery, and inverter the solar energy derived from the sun is converted into electricity with the help of a solar panel. In our system, we have used 50 WATT solar panel which produces 12 VDC output. A solar charge controller is a small box consisting of solid state circuitry that is placed between the solar panel and a battery. Its function is to regulate the amount of charge coming from the panel that flows into the deep cycle battery banking in order to avoid the battery being overcharged. Our system which operates on 230 VAC, for that we have used an inverter which converts DC to AC voltage.

In Fig 3 Result of the solar power unit is shown. It shows the indication of Battery voltage which is used for the storing of the voltage generated by the solar panel so that inverter can convert that DC voltage of battery into the AC form. Also, it provides the indication of the solar panel voltage.

IV PROGRAMMING FLOW

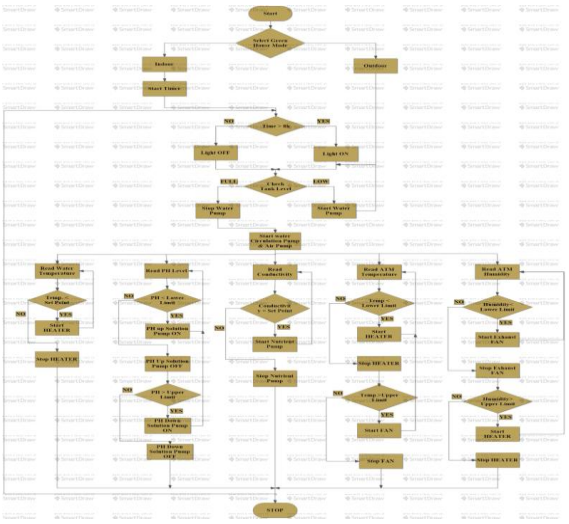

Fig-4

As shown in the programming flowchart (Fig-4) there are two modes in a greenhouse system

1) Indoor mode
2) Outdoor mode

When we select indoor mode timer will be set for 8-hour on-off cycle. It will check tank level according to that water pump will be operated. When we select outdoor mode then directly it will check tank level.

When water circulation and air pump will be started at that time all the process parameters data like temperature, humidity, conductivity, pH will be read by the respective sensor and automatically try to achieve its nominal value as per the plant's requirement.

V HARDWARE

The block diagram shown below in Fig-5 is a basic layout of the hardware design that will be used for the Automated Hydroponics System. The Power supply will give power to PLC. The PLC will receive data from the hydroponic system via many sensors located throughout the system. Using this data, the PLC will control the pH Level of the nutrient water in the system by adding stabilizers if it exceeds the acidic limit and also adding more nutrients whenever needed. This will require a small pump for the stabilizer additions and then the second type of dispenser for adding the nutrients. Also, it has the ability to drain and refill the hydroponic system's water if needed for various reasons which will require a water pump and a valve that can be opened to drain the water out of the reservoir. Another, the Temperature and humidity sensor will sense the system's temperature and humidity and give it to PLC. Accordingly, it will operate the humidifier, heater, and fan. It will maintain the system's Atmosphere Temperature, Conductivity, pH, and Humidity.

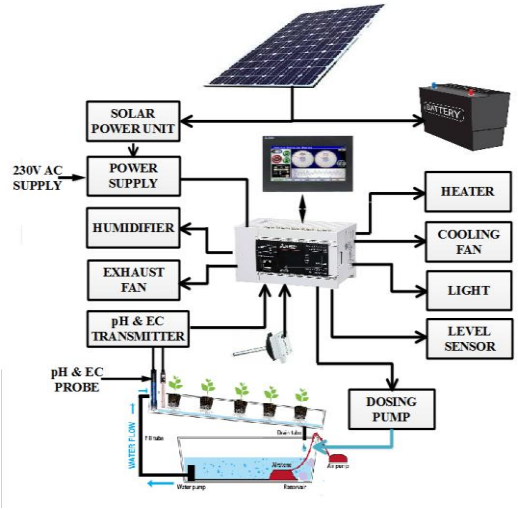

Fig-5

In Fig-6 Panel wiring of the system is shown. The panel contains various hardware which works together and based on the logic provides controlling to the system so that whole automation system working smoothly.

Fig-6

VI SOFTWARE USED

For PLC programming GX Works 3 [2] and for HMI Designing GT Designer 3 [4] used in the given system.

In the Fig-7 home screen of GX Works 3 is shown. It is a PLC programming software which provides the facility to generate a logic based on that parameter of the system like Temperature, PH, and Humidity etc. are maintained at the appropriate range.

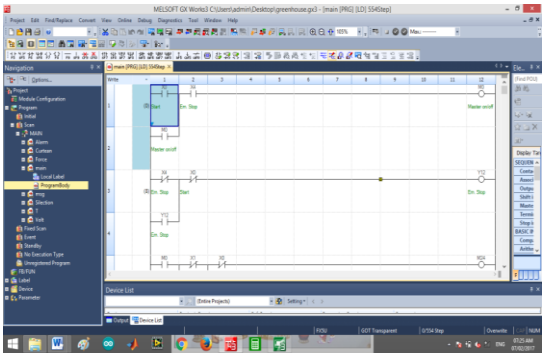

Fig-7

In the Fig-8 home screen of GT Designer, 3 is shown. It is an HMI Designing software. In this system, we are providing real-time monitoring as well as historical trends of the parameters which we want to maintain under specific range. Also, we are providing manual control of each part shown in hardware model in Fig 5.

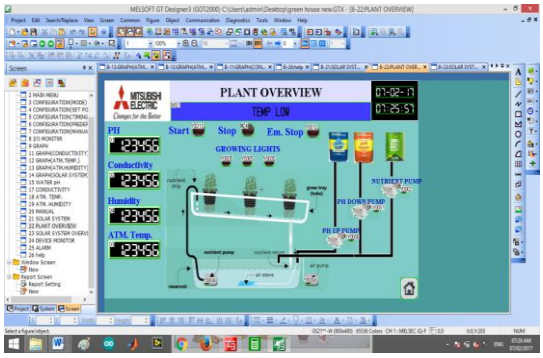

Fig-8

VII MODEL BENEFITS

- We can grow crop anywhere, it grows 50% faster than the conventional method.
- It requires much less water compared to the conventional growing method.
- There are no worries about changing the atmosphere, we can take off-season crop.
- No harmful fertilizers or pesticides are used to the quality of the crops is maintained.

VIII FUTURE SCOPE

- In future, we can also make this system IOT based solar powered smart industrial greenhouse system. In which we need server and IOT module. Real-time data will be sent to the server and through the server, it will be distributed to authorized persons for monitoring purpose.
- Further, we can use the solar tracking by which we can maximum utilize the solar power and for cutting, packaging and distributing the crops we can use robotics technology.

II. FIGURES

Fig-1 NFT System.
Fig-2 Solar power unit block diagram.
Fig-3 Result of the solar power unit.
Fig-4 Programming flowchart.
Fig-5 Hardware block diagram
Fig-6 Panel wiring of the Automation system.
Fig-7 PLC Programming software (GX Works 3)
Fig-8 HMI Designing software (GT Designer 3)

IX CONCLUSION

Finally, we can conclude that by using maximum energy resources like solar panel and water we can grow hydroponics plants like tomatoes, peppers, cucumber, etc., by controlling the process parameters using control panel. Which leads to creating more energy efficient and eco-friendly system. It will be beneficial to the society to create better and greener tomorrow.

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