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Survey on Smart Hydroponics (Sensing,Monitoring and Controll) Prototype based on Arduino and IoT

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Abstract: Scarcity of natural resources and insufficient agricultural food production due to increase in population is a major problem in today's world.To overcome this problem, hydroponic system is used which is a type of indoor agriculture style that is independent of weather, and it also avoids the cost of plowing and labor works. The Hydroponic farming is the method of growing plants without making use of sunlight & soil. In this method, the plants are grown with their roots exposed to the mixture of minerals with water instead of underground soil with the help of NFT(Nutrient film technique) and DFT(Deep flow technique) . Many studies has been conducted in developing the food production techniques using hydroponics.
An IOT technology is used in hydroponics system to preserve natural resources and increase food production by monitoring and controlling the micro-climate and environmental factors . Therefore we will be conducting a comparitive study on hydroponic plants first by controlling the parameters and then without controlling the parameters to represent the difference in productivity of crops in each case. By doing research on multiple papers related to hydroponics and different techniques used to controll and monitor various factors, we are able to understand and analyse the techniques which has been used in different research papers.
By using the number of sensors we were able to monitor the data which is processed by computers in an IoT system. Hence the real time status of the plant growth is monitored by the authorised person and the micro climate and environmental factors are controlled automatically.
Keywords: Hydroponics, IoT, Sensors, Smart Agriculture, Arduino mega

I. INTRODUCTION

Hydroponic culture as a flexible modern technology is a sustainable and environmental food production method for reducing the use of agricultural chemicals (fertilizers and pesticides) while maximizing the water, soil and power use efficiencies reported that nutrient film technique (NFT) where the plants are grown in plastic tubes, PVC pipes, plastic channel (gullies) which nutrient solution is continuously circulated while the plants are floating in pool, in deep flow technique (DFT) which the plants innet pots, holes are perforated in a foam board which rest on the surface of the water. Both systems are the most popular systems of hydroponics on the commercial scale for producing leafy vegetables and herbs. Hydroponic lettuce is commercially produced using NFT or DFT.
Sensors such as DHT 11 and DHT 22 will be used for measuring air temperature and relative humidity. LDR module for estimating light intensity, MQ2 Gas Sensor Module for measuring methane content in the atmosphere and pH kit sensors for measuring pH of solution respectively. IoT allows for machine to machine interaction and controlling the hydroponic system autonomously .

II. LITERATURE SURVEY

Mohammad Rizalul Fikri [1], A variety of vegetables, such as tomatoes, lettuce, cucumber, and chilli, have been successfully grown using hydroponic systems. To further improve crop quality and yield, a smart hydroponic monitoring and controlling system has been developed.
This system combines a wireless sensor network with both an Android and web application to more accurately monitor and control key environmental factors such as oxygen content, temperature, pH, and electrical conductivity. The study aims to manipulate these parameters, as research has demonstrated their significant impact on plant growth. Proper management of the nutritional solution's parameters is critical to achieving optimal gains.
The study's findings reveal that 84% of farmers surveyed strongly agree that this system simplifies the monitoring and control of hydroponic plants.

Varsha Chhabria [2], Additional IoT applications include the monitoring and management of feed and agricultural production utilising cutting-edge sensor systems. Such systems will guarantee the safety of items made from plants meant for consumption by both humans and animals . In environment with omnipresent computing, unique considerations are needed to interpret massive volumes of data coming from and moving through such a scattered and diverse environment. To implement this, Machine learning and data mining techniques are used, which allows the users to extract knowledge and make wiser decisions . These data streams are used to forecast the future. Once a pattern is recognized, metrics embedded into the data will alert for immediate actions and better decisions. Large-scale development and results from numerous nations across the world have demonstrated the practicality and distinct advantages of this technology. In locations where gardening is not feasible, soilless culture and vertical hydroponics can be used. Thus, it is not just a wise strategy, but also one that has greatly benefited humanity.

Mohit D. Dongargaonka [3], The conventional hydroponic method reuses water in a single tank, resulting in water conservation of up to 60% compared to traditional farming. Water-soluble nutrients are utilized, generating a Nutrient film, a widely-known hydroponic technique. Nevertheless, the hydroponic system has drawbacks such as the inability to store or retrieve real-time settings. To nourish hydroponic plants, fertiliser microprocessors are utilized. The system recirculates water from a fixed tank, which reduces water usage by up to 60%. There is minimal weeding in hydroponic plants, resulting in higher-quality yield and market value compared to soil-grown plants. The plants in hydroponic systems grow taller than in traditional soil farming, reaching an optimal height in a noticeable time frame

Rowena Maria S. Fruto[4], The focus of this study is on a Smart Vertical Farm that employs a hydroponic system for growing plants in vertical pipes. The use of sensors allows for the monitoring of temperature and humidity levels, with data transmitted to a microcontroller for processing. Additionally, magnetic float switches are employed to measure the amount of liquid in the pipes, and solenoid valves regulate the liquid flow. This technology offers an alternative to traditional soil-based farming, especially in areas with limited space or unsuitable environments. The hydroponic system uses mineral water and does not have any adverse effects on plant growth. The study found that automatic control results in superior crop quality compared to manual control, with gains ranging from 20% to 60% for all evaluated parameters.

Rangga Perwiratam[5], The primary purpose of a smart hydroponic system is to automatically monitor and manage the nutrient levels in hydroponic plants. When a hydroponic plant's ppm is less than 1000, the levels of the peristaltic pump operation will be added until the value is attained. Plant nutrients are dissolved in water using a pump mixer. The dissolution can be aided by the nutrients' ability to dissolve in water. In smart hydroponics, the wireless transmission of the sensor's observations of physical changes in the environment through the MCU node allows the real-time presentation of the sensor data in both web and Android applications utilizing Firebase as a database. The outcomes of installing this system are quite pleasing due to its excellent computing capabilities and dependable sensor accuracy. In order to do the manipulation as quickly as possible, parameters are precisely calculated in a short amount of time, ensuring that the plant receives the finest care possible from this technology. It implies that plants will flourish and yield higher returns.

Dr.D.Saraswathi [6], The first purpose of this project is to automate the monitoring of the greenhouse environment. The preceding is automation of electrical conductivity and PH level maintenance. In order to make monitoring and maintenance easier, IOT is utilised to send the extracted data to the internet (mass storage) and mobile apps. The early results of the irrigation control method's tests indicate that it is a good replacement for the current methods for controlling irrigation and fertiliser supplies. Tuning the irrigation system is done using a feed-forward loop. Since feedback is solely used for fine-tuning the parameters of the model, instability issues brought on by feedback loop delays are avoided. In comparison to robust control design, the proposed technique practically needs no effort to apply to a specific problem, which is solved in a very simple manner. The user-friendliness and openness of control techniques is another important benefit. The cause of an unexpected big error is predicted , drain or a sudden change in the model's parameters might be traced by hydro-mechanical gear or plant physiology problems, depending on the fault identification process used.

Smita Pawar, Shreya Tembe, Sahar Khan [7], Soil can be replaced with materials like rock wool, coco-peat, or pebbles in hydroponic systems, but this makes plants more sensitive to nutritional solutions. The pH of a solution, water, or soil indicates its acidity or basicity on a scale from 0 to 14, with lower values being more acidic and higher values being more basic. Nutrients are taken up by plants from recirculating hydroponic systems, which can cause pH levels to deviate and require correction to maintain an ideal range of 5.5 to 6. pH probes have an analog output impedance of 1013 Ω and require signal conditioning with pH modules, which can be expensive. This paper focuses on designing a low-cost pH module that can be connected to boards like Arduino, Node MCU, and Raspberry Pi for use in automated hydroponic systems. The pH probe is a crucial component that senses pH data and transmits it to a development board to maintain the proper pH levels for plant growth. Regular calibration of the pH probe was a challenge during development, but an algorithm can be created to self-calibrate the pH module based on the probe's readings. To keep the system economical, a less expensive pH probe was used, although more precise probes are available.

Sahar Khan, Sheetal Yadav [8] Some mediums like sand, gravel, rock wool, and coco peat are utilised in place of the soil often used in farming. The project's major objective was to create a vertical hydroponic farming system that Indian farmers could afford. By developing a proprietary pH module that was less expensive than pH modules available on the market, this objective was achieved. At first, it was believed that using an Arduino 2560 would make the system too large and call for extra parts. As a consequence, the issue was resolved and the system was made smaller by switching it with a Node MCU ESP8266 module. The main objective was to design a driver circuit capable of driving two submersible pumps and two 2A LED strips. IC for a conventional L293D motor driver

Supachai Puengsungwan [9] To maximize the use of solar panels in a hydroponic system, an IoT-based transpiration leaf sensor is a vital component. Unlike external factor-based sensors, such as temperature, humidity, or light intensity, transpiration leaf sensors detect and monitor internal changes in lettuce plants in real-time. For an 800 square meter hydroponic farm, 30 sets of solar panels with batteries (300 watts and 100 A-Hr each set) are required to sustainably power the system, which accounts for 25% of the hydroponic system's cost. However, by utilizing the suggested IoT-based method, only 10 sets of solar panels with batteries are needed in the same location, as the system can identify the appropriate duty cycle in real-time. The IoT-based leaf sensor is constructed using the transpiration principle, allowing for real-time connectivity between plants and growers. It also includes a WiFi-based controller to manage the smart pump for optimal control. Experimental findings demonstrate that using the suggested leaf sensor-based control significantly reduces hydroponic lettuce farming's power consumption by 67%. This indicates that the installation cost of the system would be just 33% of the standard solar panel design without the leaf sensor approach.

Otrinanda Gandhi, Casi Setianingsih [10] In this study, a microcontroller based on the Internet of Things was utilized to regulate water flow and ensure even distribution. The results demonstrated that the system can enhance plant growth by promoting greater uniformity in plant length and leaf breadth across growing tubes. The analysis of the valve control system and IoT-based water distribution monitoring suggest that the system can replace the traditional manual method of valve movement with an accuracy tolerance of 7.09%. Through effective control, the system can achieve and maintain the desired range of water flow distribution. The Antares User Interface was used to display the sensor's data readings, facilitating easy monitoring of water flow. Compared to manual growth without the system, the use of this technology can help to promote more uniform plant growth in all areas of the pipe.

III. CONCLUSION

The sophisticated hydroponic system with monitoring, sensing capabilities and controling various microclimate and environmental agricultural parameters is being used .The sensor's ability to detect the environmental parameters and control them which will help farmers present the necessary information to precise agricultural management practises to increase agriculture production and sustainability. Farmers now have the ability to respond to threats from climate change, global pandemics, and demands for food production using IOT. With the lack of natural resources, all agricultural practices especially in developed nations are becoming more necessary. This project uses technology in agriculture which preserves natural resources, labor costs, and time , while increasing sustainability and production by it's friendliness, ease to use, flexibility and efficiency factors.

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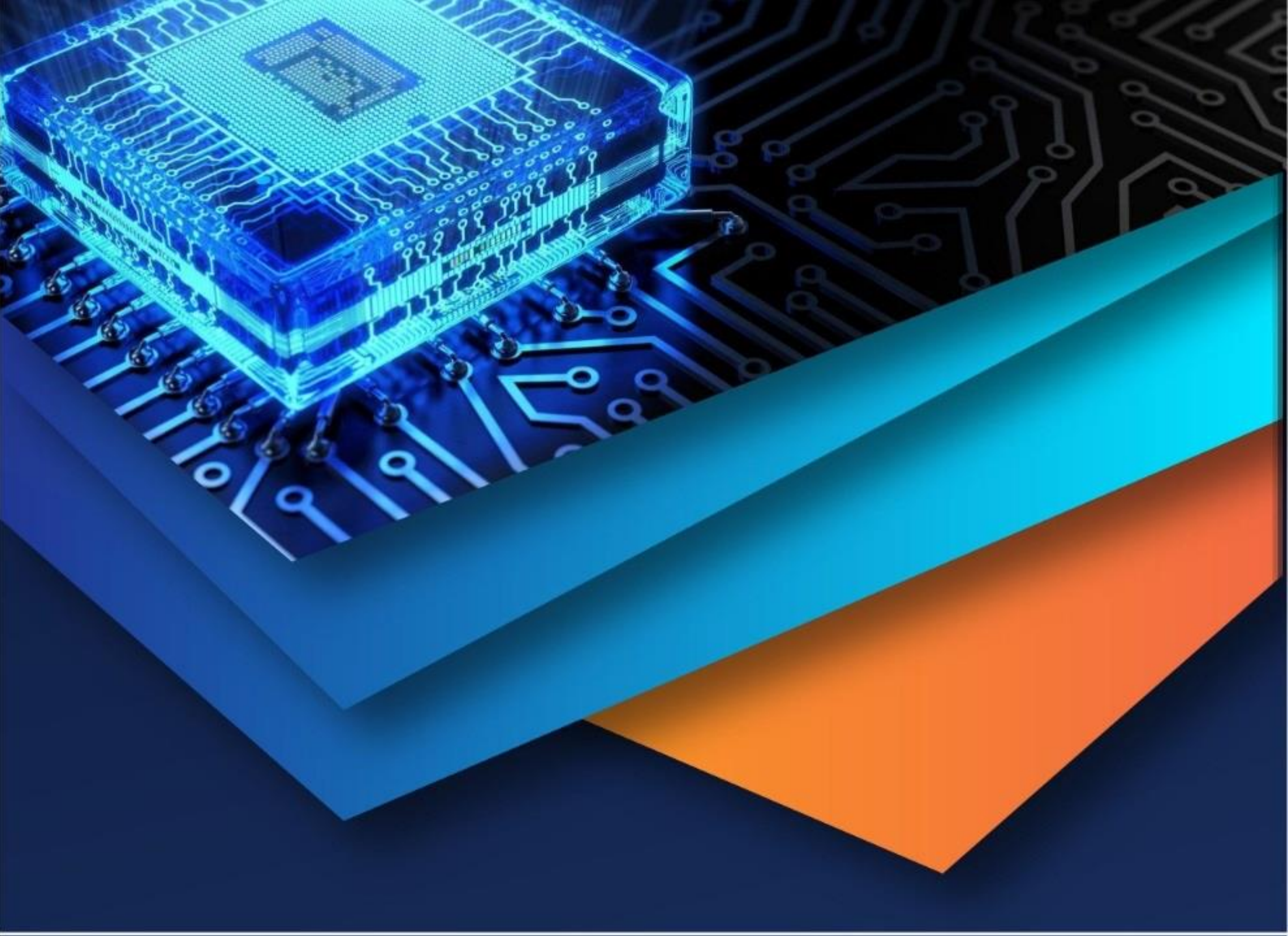

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