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Decision Support System for Greenhouse with Hydroponics Farming

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ABSTRACT*:* Cultivation, adding up to an important aspect in GDP (Gross Domestic Product), 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. Advancements in agriculture have proven to serve the cultivators in a number of ways. Cultivation of crops is being done at home, which consumes limited amount of space and cost. To bring in another technological advancement by breaking all barriers, for organic farming is the Hydroponics where consumption of space and water are way too minimal. Hydroponics is a method of growing plants purely using water and nutrients, without soil. 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.

KEYWORDS: Nutrient Control System, Hydroponics, Solution Grading.

I. INTRODUCTION

Rapid industrialization of the global economy and alarmingly increasing population compels countries like India to upgrade their agricultural techniques to meet the needs of the people. Soilless agricultural techniques like hydroponic have gained a lot of importance over the years , one of the most popular soilless agricultural technique in which the crops are grown in nutrient solutions is now gradually being employed for commercial agriculture. India, in spite of being an agro based country, has found it very challenging to implement hydroponics on a commercial scale. Sensitivity of hydroponics to technical faults is a major limiting factor when it comes to their large scale implementation. In addition to this, agriculture in India is predominantly being practiced by unskilled labour which makes imparting knowledge on hydroponics even more challenging. Considering the wide range of advantages which hydroponics offer and increasing need to meet the food requirements of the growing population with the limited agricultural land available, practicing hydroponic procedures has become the need of the hour. Automation of Hydroponics is a viable concept which can solve the challenges faced in its implementation.

Among all the procedures involved in hydroponic process, preparation of nutrient solution is the most sensitive one hydroponic cultivation shows very little error tolerance nutrient quality. Studies have shown that the nature of nutrient solution varies randomly throughout the growth cycle of crops and it is very important to maintain its quality at optimum level to ensure high yield. Several optimization procedures have been proposed to optimize the process of nutrient solution control. In this paper, we propose a novel technique to implement nutrient solution control using genetic algorithm based on mamdani fuzzy inference system (FIS) that grades the nutrient solution control. A novel FIS grading system has been developed for this purpose based on expert guidance from agricultural scientists of Murugappa Chettiar Research Centre (MCRC), Chennai, India. The designed FIS is used as fitness function to execute genetic algorithm which optimizes the control system parameters of nutrient preparing unit periodically and thus maintaining the quality of solution.

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The proposed technique has been implemented using Matlab and the results of algorithm are validated by simulating a virtual nutrient control unit using Lab view. The performance of the system is compared with classical nutrient control unit designed using genetic algorithm using absolute error as fitness function. Food being the primary requirement worldwide for leading an energized and healthy life must be abundantly produced and made available. This production is carried over by the technique called cultivation. Agriculture facilitates in providing the most essential commodity required for a living which is food. A number of vegetables, fruits, nuts and spices are all constantly being cultivated by various techniques. Each crop is grown in a different environment requiring a wide range of essentials, depending upon the crop's genetic organization.

II.LITERATURE SURVEY

Hydroponics is a technique to grow the plant without using the soil. This technique ensures the plant gets all nutrients needed from the water solution. There are many types of hydroponics technique. The Deep Water Culture (DWC) is one of the hydroponics technique types. DWC is a technique that grows the plant by supplying the nutrient direct to the root of the plant until the plant can be harvested. By using this technique, the plant root will be always submerged into the water that contains nutrient and oxygen. However, this technique manually controlled the pH water, which can give bad effect to growing of plant. In this research, the pH level in water solution will be automatically maintained by microcontroller and measured by sensor [1].

Next, the period of pH level started to change and the effects of pH adjuster solution to the water solution are determined. Lastly, this research also focuses on the ability of the system can adjust the pH value in water solution for DWC. The water solution from the DWC container is transferred to the main tank to measure the pH level by sensor and make adjustment if needed and then transfer back to the deep water culture container to continue growing the plant [2].

There are six stages in methodology for this project, which are details of study, hardware identification, software identification, hardware and software interfacing, analysis and troubleshooting, data and result collection. The result from the experiment test showed that the system able to decrease the pH level by 0.58 pH and increase the pH level by 1.15 pH. Hydroponics is a technique to cultivate the plant without using soil as a growth medium. This paper presents an efficient hydroponic nutrient solution control system whose system parameters are optimized using genetic algorithm [3].

A novel mamdani fuzzy inference system (FIS) that grades the quality of solution for a given set of control parameters has been used as its fitness function. The FIS evaluation function has been designed using expert opinion from researchers at Murugappa Chettiar Research Centre, India. To evaluate the performance of the proposed algorithm, a virtual hydroponic nutrient control system with a solution monitoring unit was designed using Lab view. The designed algorithm demonstrated better convergence efficiency and resource utilization compared to conventional error function based nutrient solution control systems [4].

This technique supplies the nutrient needed by plant through the water solution. There are many types of hydroponics technique such as deep water culture, aeroponic system, drip system, EBB and flow (food and drink) system, N.F.T (nutrient film technique) and wick system. Deep water culture (DWC) is one of the hydroponic system techniques that prepare the nutrient in water solution into the plant. This technique will ensure the root of plant will absorb the nutrient in water solution to grow wisely [5].

By using this technique, there are several environmental factors that should be considered such as oxygenation, salinity, pH and conductivity of nutrient solution, light intensity temperature, photoperiod and air humidity. There are two variables must be considered when growing the plant in nutrient solution, which is electrical conductivity (EC), potential of hydrogen ion (pH) [6].

III.PROPOSED SYSTEM

The growth environment differs for each and every crop based on the morphological and genetic structure. The proposed work deals with integrating the growing environment for individual crops on to a single system. This system is designed and built upon for growing three different types of crops which can be further extended to many a number of crops. A well-organized setup is built for the smooth functioning of the system. Appropriate nutrient solution is supplied to the crops, mixing them with the required quantity of water. Various sensors are used for monitoring the pH level of the nutrient solution and the water level. The input obtained from these sensors will enable the controller to regulate the water and nutrient flow in correct proportion. The controller is programmed with an efficient algorithm which will systematically regulate the flow. The system once built is tested upon for meeting an individual crop's requirement and then all of which are integrated. This integrated system will improvise the growth of crops rapidly. The soul of this system is the controller which enables the entire functioning.

ARM processor performs all the control actions necessary for the system. pH meter and water level sensors are used for calibrating the appropriate measurements needed for the plant growth. All the water and nutrient solution are placed in a reservoir from which they are sent to the crops. The proposed hydroponic system module is described in Fig 1. The system comprises of L293d motor driver which acts as a valve for controlling the nutrient and water supply. In addition, it has a mixing tank to dilute the nutrient solution with water and this solution is fed to the crops. There are sensors being placed in the mixing tank to constantly monitor the values, and feed the results to the controller. The controller operates the motors based on the pH values of the nutrient solution and the level of the mixture. This helps in the proper functioning of the system. In this system also water tank is placed for giving water supply to plant also for adding nutrient. It has a mixing tank to dilute the nutrient solution with water and this solution is fed to the crops. There are sensors being placed in the mixing tank to constantly monitor the values, and feed the results to the controller. The controller operates the motors based on the pH values of the nutrient solution and the level of the mixture. This helps in the proper functioning of the system.

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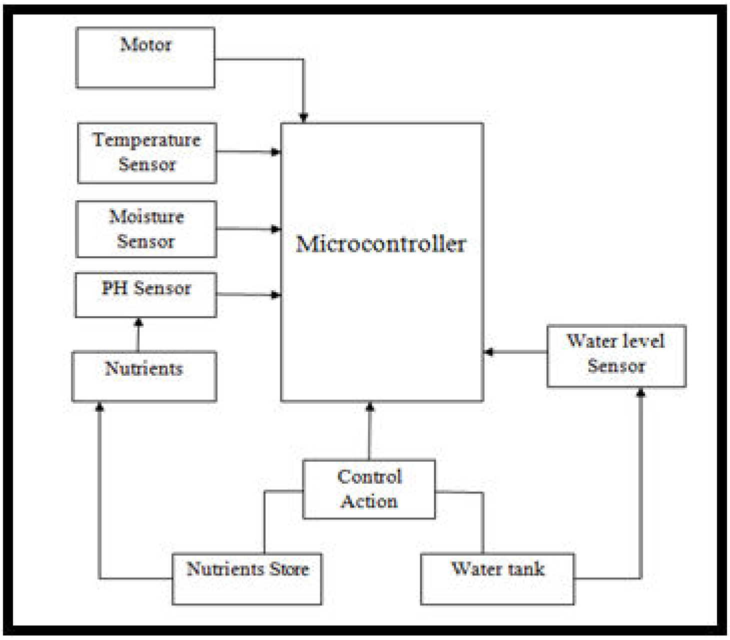

Fig 1: Block diagram of system

A. Elements of block diagram are as follows:

a) LPC 2148:

The LPC2141/42/44/46/48 microcontrollers are based on a 16-bit/32-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combine the microcontroller with embedded high-speed flash memory ranging from 32 kB to 512 kB. A 128-bit wide memory interface and a unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode reduces code by more than 30 % with minimal performance penalty.

b) Power supply:

Once you have calculated the total current (I) choose one that fits the requirement. For example a 1Amp one for the 600mA power supplies. Now the rms secondary voltage (primary is whatever is consistent with your area) for our power transformer T must be our desired output Vo PLUS the voltage drops across diodes (two diodes). Vo1 must be enough to feed the minimum operational input requirements for the LM7805 at all moments (min 7.3v to max 25v). Inverter:

c) *Humidity sensor:*

A humidity sensor (or hygrometer) senses, measures and reports both moisture and air temperature. The ratio of moisture in the air to the highest amount of moisture at a particular air temperature is called relative humidity. Relative humidity becomes an important factor, when looking for comfort.

d) LM135

The LM135 series are precision, easily-calibrated, integrated circuit temperature sensors. Operating as a 2-terminal Zener, the LM135 has a breakdown voltage directly proportional to absolute temperature at 10 mV/°K. With

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less than 1-Ω dynamic impedance, the device operates over a current range of 400 µA to 5 mA with virtually no change in performance. When calibrated at 25°C, the LM135 has typically less than 1°C error over a 100°C temperature range.

e) 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 difference in electrical potential relates to the acidity or pH of the solution. The pH of a solution is a measure of the molar concentration of hydrogen ions in the solution and as such is a measure of the acidity or basicity of the solution.

f) Dc motor

A DC motor in simple words is a device that converts direct current (electrical energy) into mechanical energy. It's of vital importance for the industry today, and is equally important for engineers to look into the working principle of DC motor in details that has been discussed in this article.

V. FLOWCHART

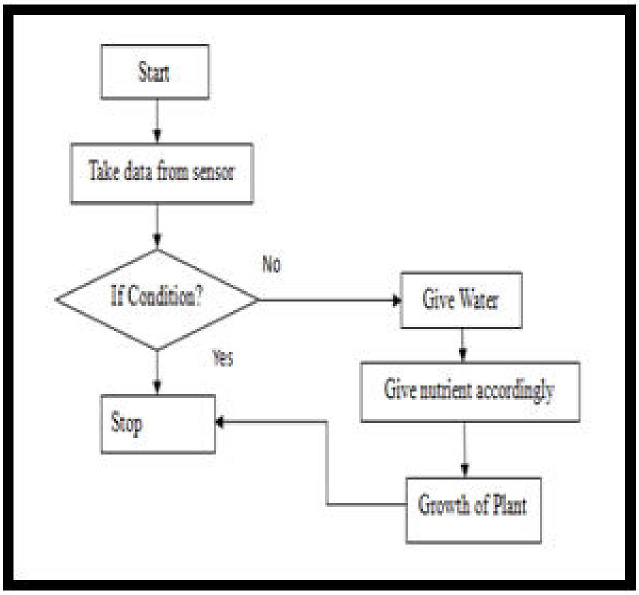

Fig .2: Flowchart of System

VIII. APPLICATIONS

- More precise application of pesticides, herbicides, and fertilizers, and better control of the dispersion of those chemicals are possible through precision agriculture, thus reducing expenses, producing a higher yield, and creating a more environmentally friendly farm.
- Crop can be grown where no suitable soil exists or where the soil is contaminated with disease abor for tilling, cultivating, fumigating, watering, and other traditional practices is largely eliminated.
- Conservation of water and nutrients is a feature of all system.
- This can lead to a reduction in pollution of land and streams because valuable chemicals need not be lost.
- Maximum yields are possible, making the system economical feasible in high density and expensive land areas.

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IX. CONCLUSION

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. The plants grown under this system is analyzed with traditionally grown ones and has been found that these plants grow a lot quicker with minimum requirement of nutrients. They are much cleaner with minimum chemical constituents using up only required water, preventing loss of water. Also the cost for cropping is nominal on consideration of its advantages. Hence this model encourages practicing of an alternate approach towards farming that is eco-friendlier and efficient on comparison with upcoming techniques.

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