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Automation in Monitoring of Hydroponics for Tomato

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Abstract: ***Nowadays, as the population is increasing widely, it becomes necessary for the cultivation of plants without the utilization of many land resources. There are different types of soil present on earth and different crops need different types of soils. Due to scarcity of water, it becomes difficult for the farmers to cultivate crops on land which requires a lot of water. With a hydroponic system in which the farmer has more control over plant growth, can get very high yields. In conventional methods, farmers need to monitor as well as manually control the parameters required for the efficient growth of the plants frequently. We have a sensing unit that senses various parameters like pH, Total Dissolved Salts (TDS), temperature, and humidity. The gathered information regarding these parameters is fed to the Arduino and monitored continuously. The Arduino is programmed such that whenever there is a change in these parameters from the optimum value, an alert message is sent to an android application installed in the smartphone.***
Keywords: Hydroponics, Automation, Monitoring, pH, TDS

I. INTRODUCTION

Hydroponics is the method of growing plants in the nutrient solution. Plants grown hydroponically have better growth and yield. But requires constant monitoring and maintenance. Due to advancements in technology such as sensors, machines, and Information Technology, hydroponics works better than before. We aim to make a system that is cost effective and requires less human intervention after placing the germinated plant into the system. This enables the collection of sensor data related to air temperature, humidity, pH and Total Dissolved Salts [TDS].

II. HYDROPONICS

Hydroponics is a method of growing plants without soil. Usually, plants are grown in media such as sand, gravel, etc. In many cases, even these media are not used. Simply the nutrient solution (organic nutrient dissolved in water in the required ratio) is used to grow the plants. Not using the soil makes it possible to grow any kind of plant, anywhere in the world regardless of the climate and soil type.
Nutrient Film Technique (NFT) is a type of hydroponics. It mainly consists of two components. A grow tray in which the plants are grown with its roots hanging down, through which the nutrient solution flows; and a reservoir containing the nutrient solution. The solution is circulated between these two with the help of a motor. The grow bed of NFT is kept inclined at an angle so that the nutrient solution after flowing through the roots, drains back to the reservoir. Hence the nutrient solution is cyclically circulated within the hydroponic system.

III. ADVANTAGES OF HYDROPONICS

A. No land resource required.
B. Needs less water resources.
C. Not much affected by climate.
D. No use of harmful pesticides or fertilizers.

IV. DISADVANTAGES OF HYDROPONICS

A. Demand more time.
B. Need special care.
C. Demand skilled labour
D. Need to ensure a controlled environment.
E. Need a systematic approach.

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V. AUTOMATION IN HYDROPONICS

Hydroponic plants need to be grown in a controlled environment with optimum parameter requirements. These plants need special care and hence require skilled labour. It is difficult for a human to always check on the parameters required for the effective growth of a particular plant. Because any variation in these parameters leads to an uncontrolled environment that affects the normal growth of the plant. Therefore it is necessary to bring automation in monitoring the hydroponic system.

Automation can be established using a set of sensors and a microcontroller. IoT offers the benefits of accessing monitored information to human hands through smartphones. We monitor a certain set of parameters that are essential for the plant growth with the appropriate sensors. In our project, we monitored the pH, TDS of the nutrient solution, temperature, and humidity of the environment.

VI. TOMATO

If we need to take care of a particular plant, it is necessary to ensure the physical parameters required by that plant. Each plant has its own nutrient requirements. In this paper, we set up an automated hydroponic system for tomato. The scientific name is *Solanum Iycopersicum.* It is one of the fast-growing plants with high commercial value and market demand. The optimum range of parameters required by tomato is shown in Table I.

Table I: The optimum range of parameters for tomato

PARAMETER	RANGE
TDS	1400 to 3500 ppm
Temperature	18 to 28 ^{o}C
Humidity	35 to 65 %
pH	5.5 to 6

IV. SYSTEM MODELLING

Firstly, hydroponic setup is made with a grow tray, and a reservoir. The nutrient solution is circulated in a cyclic manner through separate pipe connections which are made for this purpose.

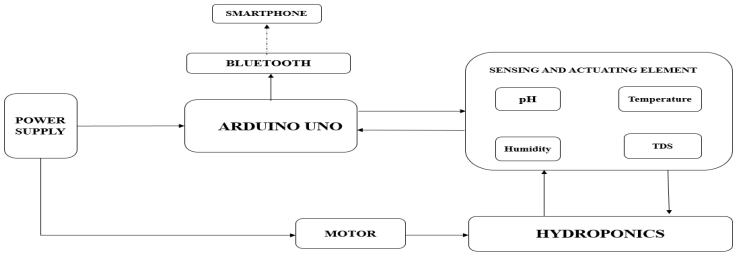


Fig. 1. Block diagram of the proposed system

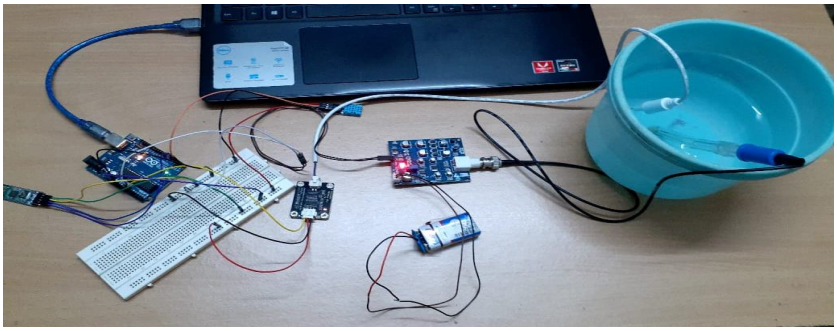


Fig. 2. Hardware setup of monitoring part

The sensor probes are dipped in the reservoir and the sensor boards are connected to Arduino. The Arduino has to be programmed to monitor the parameters and send the values to a smartphone via Bluetooth. A motor is used to pump the nutrient solution from the reservoir to the grow bed. The motor as well as the Arduino is needed to be powered by an external power supply.

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VIII. COMPONENTS

A. Arduino Uno

Arduino Uno is an open-source microcontroller board based on ATmega328P. It has analog input and digital input-output pins that can be interfaced with various other electronic components or circulates like sensors. The operating voltage of Arduino Uno is 5 V. It can be connected to a laptop via USB cable to run a particular program or feed a successfully run program to its memory. Arduino Uno is programmed using Arduino IDE software.

B. pH Sensor

PH sensor is a sensor device that indicates the pH of a solution. It can detect pH levels between 0 and 14. The probe detects the hydrogen ion concentration in the solution and the output is converted to a voltage by the sensor board circuit in the range of 0 to 5V.

The probe detects the hydrogen ion concentration by finding the potential difference between the solutions inside the glass rod probe and the solution to be measured of Ph

C. TDS Sensor

TDS stands for Total Dissolved Salts and as the name suggests, it indicates the amount of dissolved organic or inorganic salt in a particular solution.

The probe consists of an electrode to measure the electrical conductivity of the solution. The more dissolved salt, the more will be its conductivity. The value of TDS is expressed in ppm (parts per million).

D. Temperature and Humidity Sensor

DHT11 is a commonly used digital temperature and humidity sensor. This sensor uses a thermistor to measure the temperature and a capacitive humidity sensor to measure the humidity.

The capacitive humidity sensor is a capacitor whose change in capacitance value corresponds to the change in humidity level of the surroundings. For measuring temperature, an NTC (Negative Temperature Coefficient) transistor is used whose resistance value decreases which increases in temperature.

E. Bluetooth Module

Bluetooth module HC 05 is designed for wireless communication. It is IEEE 802.15.1 standardized protocol to build a wireless PAN and use FHSS radio technology to send data over air. To access data to a smartphone, an android application, “Bluetooth Terminal HC05” has to be installed from the play store.

IX. ALGORITHM

The Arduino is programmed using Embedded C language. The algorithm of the program for monitoring parameters of hydroponics is simple. The algorithm also establishes Bluetooth communication to transfer the data about the monitored parameters to smartphones. The sensor output values are fed as program input values.

The optimum values are present as the reference values while coding. The program always checks for the sensor output values. If any of the sensor values go below or beyond their corresponding optimum values an alert notification is sent to the android application installed on smartphones by Bluetooth transmission. It is also programmed to display the real-time values of each parameter on the app screen.

X. HARDWARE ASSEMBLY

A. pH sensor and TDS sensor are connected to A0 and A1 respectively (pin number 23 and 24)
B. The humidity and temperature sensor is connected to digital pin 2 (pin number 4) ·
C. The Bluetooth module is connected to digital pins 3 and 4 (pin number 5 and pin number 6)
D. The VCC and ground of Arduino is taken to connect the VCC and ground of the sensor

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XI. RESULT

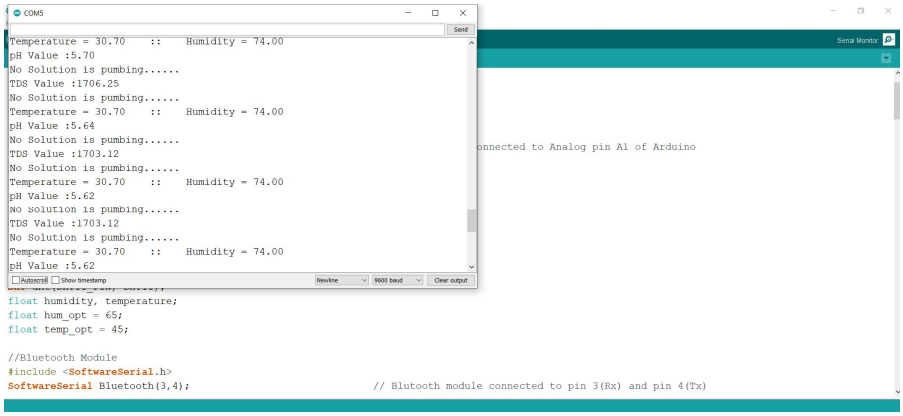


Fig. 3. Output in the serial monitor of Arduino IDE

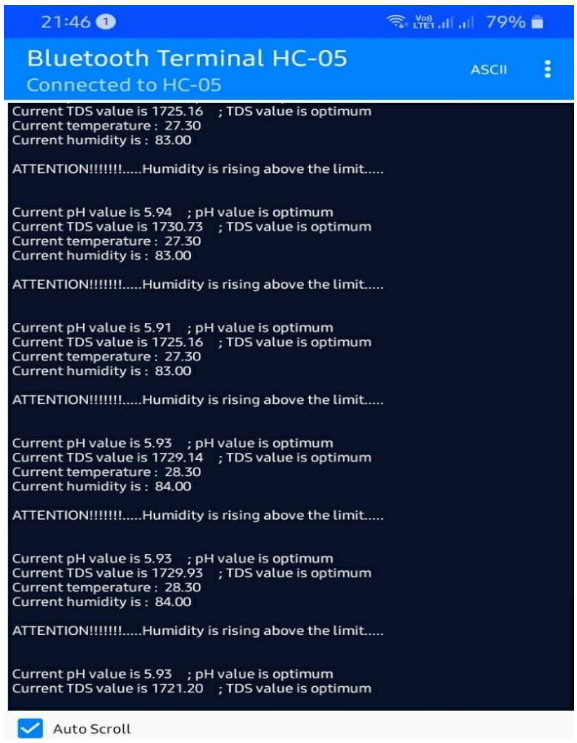


Fig. 4. Output in the smartphone

XII. CONCLUSIONS

We could develop a remote hydroponic monitoring system which helps in time management using various sensors and Bluetooth connection. We are expecting that this proposed system could be integrated with actuating elements in order to control pH, TDS, temperature, and humidity effectively. Once done, the system could improve the efficiency of hydroponics farming for better yield and growth.

XIII. FUTURE SCOPE

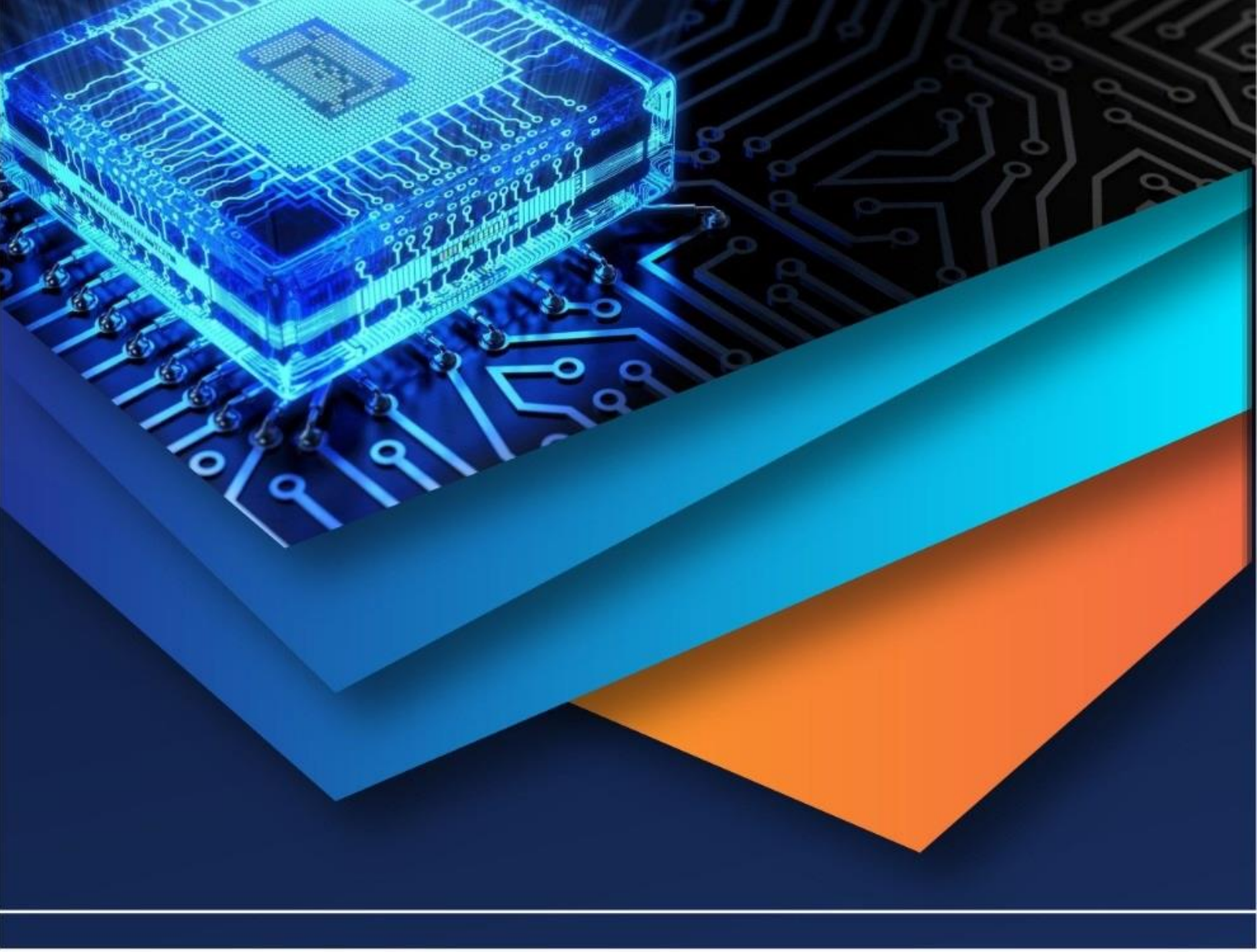
Hydroponics can be set up at every house in a locality and a larger web of IoT can be established to access the information about each house to an organization/ institution to ensure efficient growth of the plants. This ensures chemical-free, fresh vegetables and fruits to every household. Wastewater from households can be treated to be used in hydroponics to ensure optimum use of water. Researches are going on to establish hydroponics in space vehicles to develop food for Astronauts. The water supply to such type of hydroponics can be through the wastewater treatment within the space vehicle.

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