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Automated Iot-Based Monitoring Hydroponic System

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Abstract—*The nation's economy is significantly impacted by agriculture. IoT-Based Automated Hydroponic System is a con- temporary farming technique which improves method for growing plants in nutrient solution without the need of soil. In this paper IoT-Based Automated Hydroponic System is implemented using sensors, actuators and connectivity, the proposed system enables precise monitoring and control of environmental parameters such as temperature, humidity, pH level, nutrient concentration, and light intensity. Real-time data collection facilitates proactive decision-making, allowing farmers to optimize plant growth conditions while conserving resources. The pH sensor implemented on the physical layout design of the hydroponic system indicates the right pH value and water level necessary to provide proper nutrition to plants. Continuous real time monitoring of the temperature and humidity enables us to track the health of plants and enhance high yield. Internet of Things is included in this system, enabling intelligent and autonomous operation of the hydroponic system.*
Index Terms—*IoT, intelligent farming, sensor networks, rasp- berry pi, nutrient solution*

INTRODUCTION

Numerous challenges faced by traditional farmers restrict their productivity and ability to remain sustainable. Initially, one of the biggest obstacles to the development or advance- ment of agricultural methods can be the lack of access to basic resources like land and water. The fact that traditional farming methods mostly rely on favorable weather makes farmers vulnerable to changes in the climate, which could havean instant impact on crop growth and output. under addition to making matters worse, pests, diseases, and crop failure put livelihoods and food security under jeopardy. Because tradi- tional agricultural methods require a lot of human effort and reduce operational efficiency, they place a significant burden on farmers.An automated hydroponic system can be created to overcome these conditions. By doing this, it is ensured that there is reduced water waste, moisture, temperature, pH, and automatic steps to minimize any negative effects are achieved. An exhaust fan assists in the frequent monitoring of the temperature. Photosynthesis is ensured by a continuous
light cycle lasting three to four hours. Each of these factors makes sure that every resource required for a plant's growth is duplicated. Ensuring that the system appears as simple as feasible while developing the necessary yield in a methodical manner with the fewest number of compartments is a difficult issue. Thus, there are several advantages when comparinghydroponic gardening to traditional farming methods. Among its many benefits is its outstanding water efficiency. Compared to conventional farming techniques, hydroponic systems use a lot less water since they provide plants with exact nutritional solutions and circulate water. This allays concerns regarding water scarcity while also cutting waste. Another advantage of hydroponics is that it makes the most of the available spaceby allowing for vertical farming and compact layouts, which are ideal for urban areas with limited space. Furthermore, hy- droponic plants have direct access to nutrients, they frequentlydevelop at faster rates, which results in shorter harvest cycles and higher yields overall.

LITERATURE REVIEW

In this section, the previous studies related to this research is presented.
Uroromu Ighrakpata et al. research describes moisture sen- sor to detect water content in the soil . Moisture sensor was being interfaced with Arduino Mega. We also monitor temperature, moisture

content, and pH in addition to this project. This lessens water waste and facilitates the growth of aquatic crops in constrained spaces. It is possible to grow aquatic plants using this type of irrigation. The soil is the mostimportant component of conventional agriculture because it contains water, retains the majority of nutrients, and stores them for the crops. It gives the plant stability and strength. Sponge can be used in place of soil to support the roots. Wateris absorbed by sponges and held till the plant absorbs it. Asa result, less water is wasted. H.F.Lakma Upendri et al. research describes a system which is organized based on organic agricultural concept and this system employ liquid organic fertilizers that are made from industrial waste. However, the nutrient solution in this organicsystem isn't always suitable for the growth of the plants. The nutritional solution utilized in the project will adhere to the specified NPK ratio. With the addition of a pump, the system isstabilized by pumping enough solution in response to a relay, which controls whether the suction motor is turned on or off. In order to prevent the solution from wasting, the relay activates the suction pipe. Because the suction pump doesn't turn on and saves energy while the pH level is maintained, thistechnology allows for the use of power. The suction pump is turned on and off using a conventional relay.

Deise Sliva Castro Poltronieri et al. According to research, the study's goal was to assess the various N:K ratios in fruitingnutrient solutions for hydroponically grown vegetables. The findings showed that the highest K concentration in the nutri- ent solution increased the diameter of the yield rather than its length. The N:K ratio in the project is fixed for every yield grown in the hydroponic system. The system is made up of effective chemicals in nutrient solution, and relay functions as the primary functional component of the yield-cultivation system.

Libia I. Trejo-Tellez et al. explains the idea of pH and showshow the availability of nutrients and their solutions' electrical conductivity affect each other. Additionally, the significance of temperature and oxygenation was noted, although the physical arrangement lacks appropriate functionality. Three containers are used in the project, and each container has three distinct NPK solutions positioned across it. As a pump, the suction motor works. The nutritional solution is pumped via the suction pipe when the pH value varies, and the pH value is then checked once more. Nutrients are provided until the pH is at its ideal level.

METHODOLOGY

A. Hardware Design

The hydroponic system's physical layout is depicted in Fig.

1. The water flow via the pipes is gravity-supported. Since the design has greater space than an open agricultural area, the number of compartments can be increased. Due to plant compartments that allow for more than twice the amount of cultivation in a single compartment, vertical farming will save a lot of space. The water canal and pipelines are set up so that every compartment satisfies the need for waste supply with theleast amount of garbage.

The circuit implementation is shown in Figs. 2 and 3, wheresensors are interfaced with the Raspberry Pi to operate motors and measure the pH of nutritional solutions.

B. System Workflow

This Fig. 3, shows the block diagram of the hydroponicsystem implemented such as

- Sensors: The hydroponic system uses these devices togather data. Sensors that measure temperature, humidity,

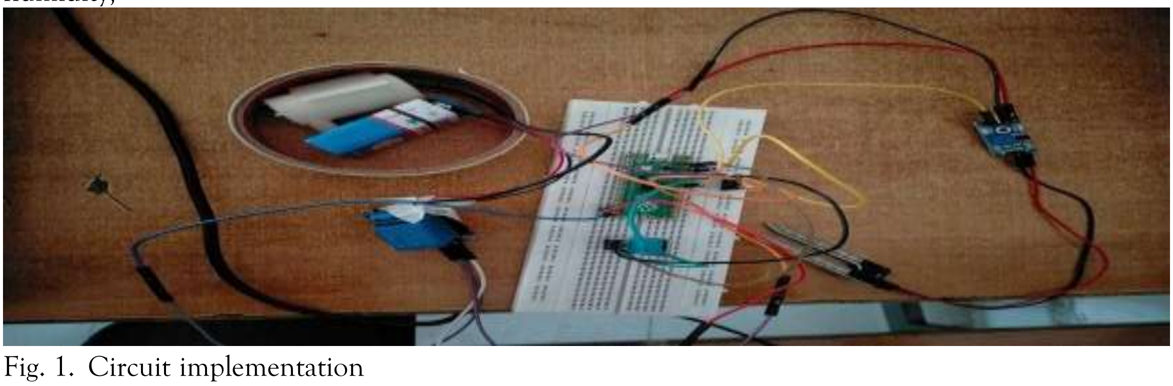

Fig. 1. Circuit implementation

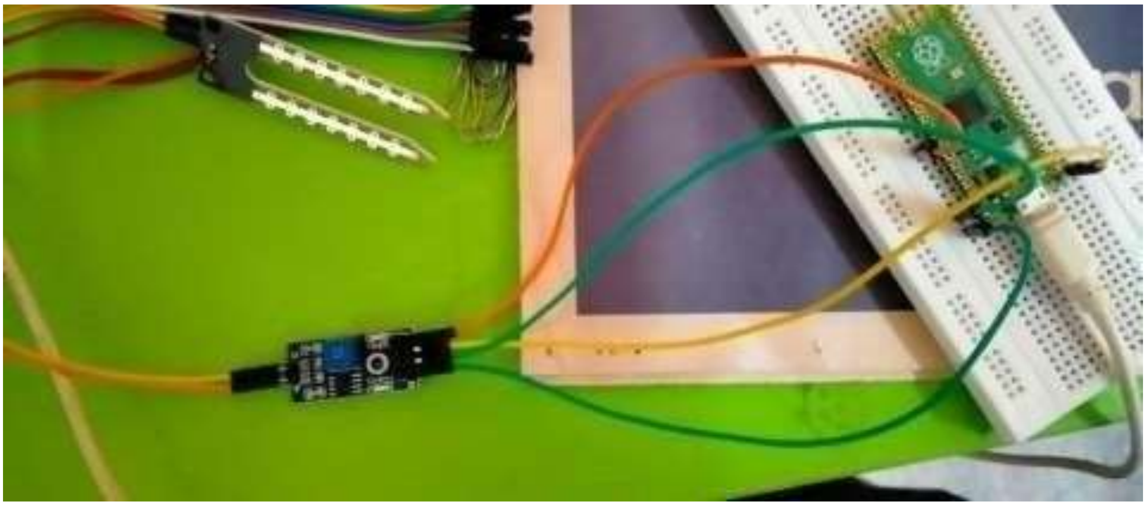

Fig. 2. Circuit implementation

pH level, light intensity, and nutrients could be included in them.

- Microcontroller/Raspberry Pi: This component controls the actuators in the system and interprets the information that the sensors have collected. It can be a microcon- troller similar to Arduino or a Raspberry Pi single-board computer.
- IoT Gateway: The microcontroller or single-board com- puter connects to the IoT gateway in order to relay sensor data to the cloud. The gateway can use Wi-Fi, Ethernet, or other communication protocols to connect to the internet.
- MQTT Broker: MQTT is a lightweight communications protocol that is widely used in Internet of Things appli- cations. The MQTT broker serves as a central messaging hub, distributing data to the appropriate subscribers after receiving it from the IoT gateway.
- Cloud Server: This is where the MQTT broker is often found. Data is sent by the MQTT broker to the cloud server, which can then process, store, and analyze it more.
- Interface User: Users can interact with the system viaa mobile application or web-based interface. The user interface, which can also be used to remotely adjust settings and send out alerts and warnings, may display real-time sensor data.

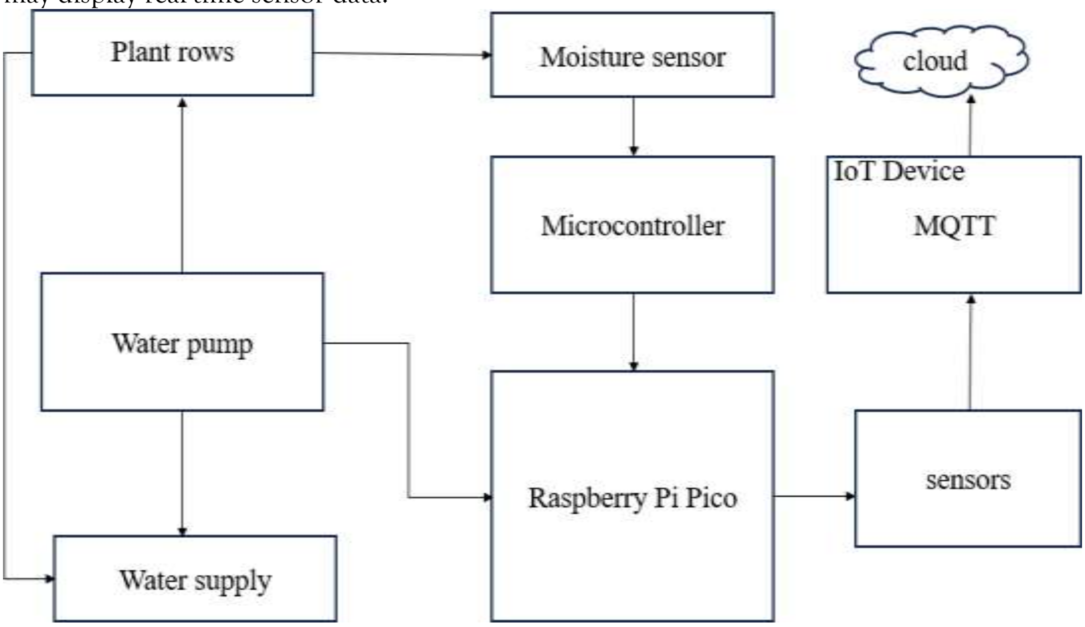

Fig. 3. Block diagram

C. Design Implementation

The Raspberry Pi Pico board receives digital data from the microcontroller after it has converted the analog input from the sensor. Since the Raspberry Pi Pico cannot deliver enough power for heavy loads, the water pump is connected to an external power source. Just enough power is available to turn on the sensors and deliver analog signals.

- The moisture sensor functions as an open circuit sinceit is an electric conductivity sensor. It creates a closed circuit and communicates with the micro controller when submerged in water.
- The moisture sensor functions as an open circuit sinceit is an electric conductivity sensor. It creates a closed circuit and communicates with the micro controller when submerged in water.
- When the plants are not moist, the water pump turns on via a relay switch that is managed by the Raspberry Pi Pico Board.
- The water pump either shuts off or keeps up a steady flow to save energy when the water's moisture content is just right for plant growth.V

Fig. 5. Implementation of real time Hydroponic system

Fig. 4. Physical Structure

RESULTS

This specific design system illustrates the newest IoT technology that monitors and regulates hydroponic plants growth automatically. Fig 1 and 2 presents the hardware circuit design which consists of sensors, actuators, and motor. Fig. 4 and 5, shows the real time automated hydroponic system and the physical structure with the continue supply of nutrients water to plants. This system is used to determine whether a supply of nutritional solution is needed. If so, the motor is turned on right away to pump the solution, and it is turned off as soon as the solution level is reached.

Fig. 6,7 and 8 display the temperature and humidity data that has been recorded on 5thJan,14th Feb and 5th March. The monitoring of temperature and humidity is tabulated in Table1,2 and 3. The relevant data is retrieved and sent to the client devices such as smartphones or computers indicating the growth in plant, disease alert and fertilizer to be used.

Fig 9 shows that output obtained using Arduino IDE software. These real time results enables us to track the condition of the hydroponic system, analyze the deviation from optimal range and take active measures immediately.

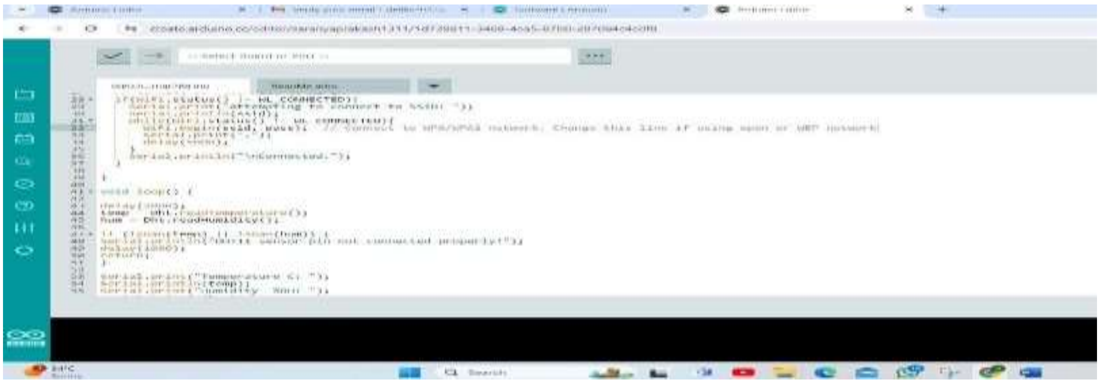

Fig. Implementation of Arduino IDE

Fig. 6. Temperature and Humidity observed on 5th Jan 2024

Table 1:Monitoring of temperature and humidity on 5th Jan 2024

Fig. 7. Temperature and Humidity observed on 14th Feb202

Table 2:Monitoring of temperature and humidity on 14th Feb2024

Timestamp	Temperature (°C)
2024-01-05 17:14:30	30.80
2024-01-05 17:15:00	30.89
2024-01-05 17:15:45	31.23
2024-01-05 17:16:00	31.23

Timestamp	Temperature (°C)
2024-02-14 15:17:15	45.55
2024-02-14 15:17:30	35.23
2024-02-14 15:17:45	35.34
2024-02-14 15:18:00	7.88

Table 3:Monitoring of temperature and humidity of 6march2024

V.

CONCLUSION

In this paper the IOT based smart hydroponic system demonstrate a modern technology which effectively regulates the monitoring conditions of the plants growth. Our methodology presents, the integration of IoT into agriculture which enables precise control of environment in parameters such as temperature, humidity, pH level, nutrients concentration and light intensity with real time monitor and control capability. The level of control not onlyoptimizes growth and productivity of the plant but also conserves resources by minimizing in water and nutrient waste. The remote access provided by the internet of things allows the growers to monitor and control the hydroponic setup from anywhere. In addition, the ability to receive real time alerts and insights into crop health and system performance enable timely action, reducing the risk of crop loss and maximizing the productivity.

In conclusion our work is cost effective and results in an

Fig. 8. Temperature and Humidity observed on 6th March 2024 Table 3: Monitoring of temperature and humidity on 6th March2024

innovative design product.

Timestamp	Temperature (°C)	Humidity (%)
2024-03-06 14:14:30	28.66	43.59
2024-03-06 14:14:40	29.5	43.25
2024-03-06 14:14:50	28.89	42.56

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