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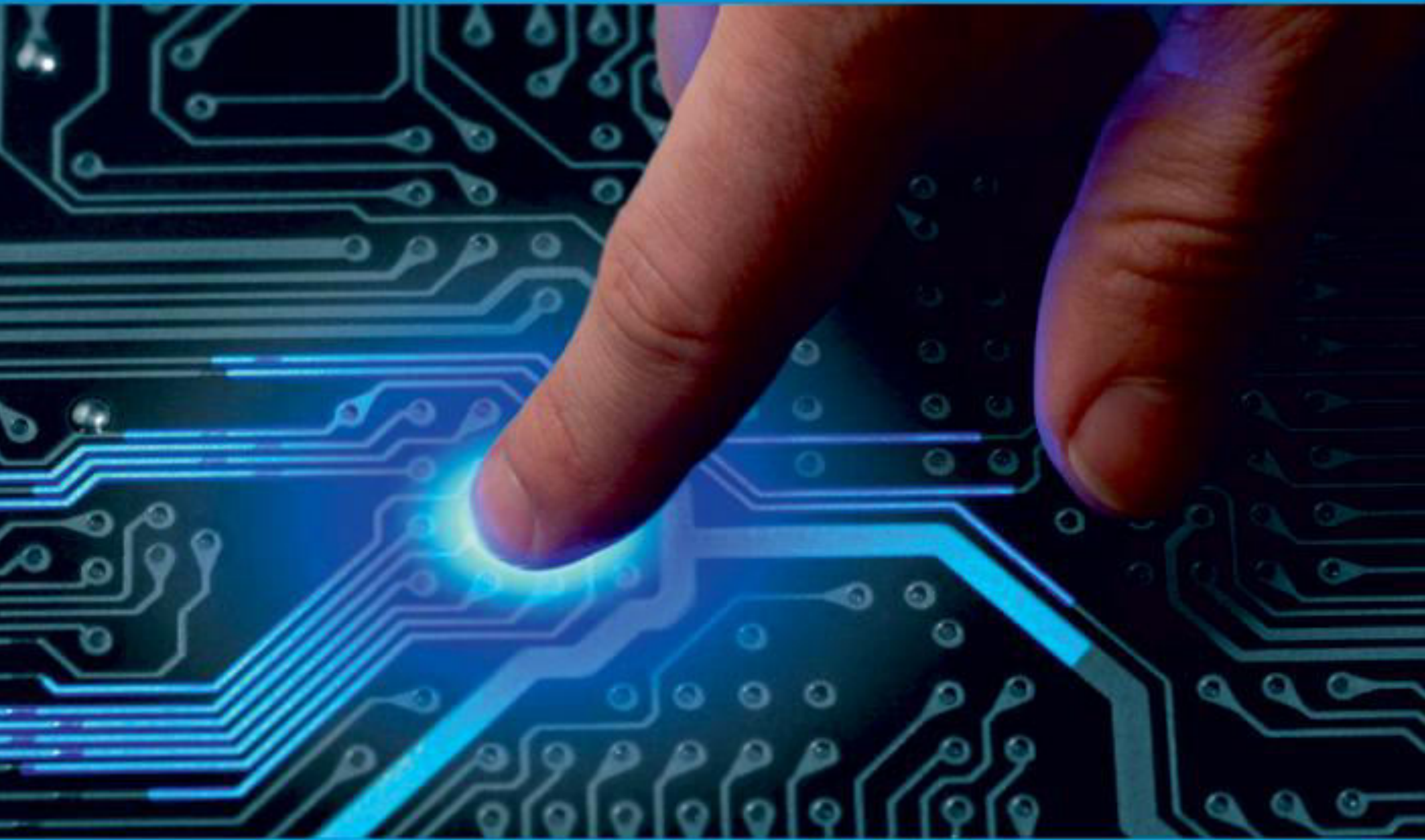

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IOT-ENABLED AEROPONIC SYSTEM MONITORING WITH RASBERRY PI PICO MICROCONDROLLER

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ABSTRACT: The aim is to develop an IoT-enabled aeroponics system using a Raspberry Pi Pico, allowing remote monitoring and control of environmental conditions, nutrient levels, and plant health for optimized growth and resource usage. The goal is to use a Raspberry Pi Pico microcontroller to enable IoT capabilities in an aeroponics system, allowing remote monitoring and control to optimize plant growth by tracking environmental conditions, nutrient levels, and plant health in real-time. The background involves leveraging Raspberry Pi Pico microcontrollers and IoT technology to enhance aeroponic systems and greenhouse management.The technology stack project includes Raspberry Pi Pico microcontroller, sensors for environmental data, , communication modules (Wi-Fi or Bluetooth), an IoT platform for data management, programming in Embedded C and data visualization tools like Telegram.The Blynk app is often utilized in sensor technology to interact with and manage various types of sensors.It is real-time data tracking, automated alerts, cloud integration, low-power operation, scalability, customization with various peripherals. In conclusion, utilizing the Raspberry Pi Pico microcontroller for IoT-enabled aeroponics system monitoring offers the opportunity to optimize plant growth through remote tracking of environmental conditions and nutrient levels. This setup enhances efficiency and empowers users to make informed decisions for healthier and more productive crops.

KEYWORDS-- Iot,Rasberry pi pico condroller, DHT11 sensor,PH leval sensor,liquid level sensor,blynk app,telegram.

I. INTRODUCTION

Urban farming has been increasingly popular recently as society has become more conscious of the quality of the food it consumes. One urban farming method that uses air as a growing medium is called aeroponics. Compared to hydroponic or conventional farming, aeroponics enables a significant reduction in water usage with enhanced yield. This work presents a design and implementation of an Aeroponics system that employs the Internet of Things (IoT) for online and automated monitoring capability. The pH level of the solution in the tank is maintained using a pH sensor. The DHT11 sensor is used to meticulously track the temperature and humidity in this chamber. With the use of a peristaltic pump, the liquid level sensor is employed to liquidate the tank level. All of these operations are precisely timed and published to the and telegram App for user engagement using the raspberry pi pico Microcontroller and ESP 32 Wi-Fi module. In response to the growing demand for sustainable and high-quality food production, urban farming methods have witnessed a significant surge in popularity. Among these

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methods, aeroponics stands out for its efficient use of resources and ability to produce robust yields in limited spaces. By harnessing air as the primary growing medium, aeroponics offers a promising solution to urban agriculture challenges, such as water scarcity and land constraints. This work introduces an innovative aeroponics system that leverages the power of the Internet of Things (IoT) to revolutionize urban farming practices. By integrating IoT technology, this system enables real-time monitoring and automated management of key environmental factors critical for plant growth. Through precise control and optimization of parameters such as pH levels, temperature, humidity, and nutrient solution volume, the system aims to create an ideal growing environment for crops

II. MODERN AEROPONIC GROWING SYSTEM

. At the heart of the aeroponics system lies a sophisticated array of sensors and actuators, meticulously designed to maintain optimal growing conditions. For instance, a pH sensor continuously monitors and adjusts the acidity level of the nutrient solution, ensuring that plants receive the essential nutrients they need for healthy development. Additionally, a DHT11 sensor provides accurate readings of temperature and humidity, allowing growers to fine-tune environmental settings to maximize crop productivity. Moreover, the aeroponics system incorporates advanced automation features, facilitated by the Raspberry Pi Pico microcontroller and ESP32 Wi-Fi module. These components enable precise timing and control of irrigation cycles, nutrient replenishment, and ventilation, thereby minimizing manual intervention and streamlining farming operations. Furthermore, to enhance user accessibility and engagement, the system integrates with online platforms such as a web interface and the Blynk App, enabling growers to monitor and manage their crops remotely from anywhere. this work presents a comprehensive and technologically advanced approach to urban farming through IoT-enabled aeroponics. By harnessing the power of data-driven monitoring and automation, this system offers a sustainable and efficient solution for cultivating nutritious and high-yielding crops in urban environments. Through continuous innovation and integration of emerging technologies, urban agriculture can pave the way towards a more resilient and food-secure future.

III. AEROPONIC SYSTEM

Aeroponics is a method of growing plants without soil, where the plant roots are suspended in air and regularly misted with a nutrient-rich water solution. This allows for efficient nutrient uptake and oxygenation, leading to faster growth rates and higher yields compared to traditional soil-based methods. Aeroponic systems often use a closed-loop setup to conserve water and nutrients, making them a sustainable and resource-efficient way to cultivate crops.

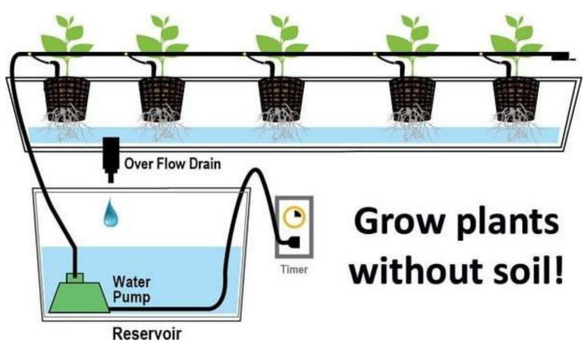

Figure: a)Aeroponic plant system

IV. SMART AEROPONIC SOLUTION

Smart Aeroponics Solution" refers to an aeroponics system that incorporates advanced technology and automation to optimize the growing environment for plants. This could include features such as sensors to monitor nutrient levels, pH, temperature, and humidity, as well as smart control systems that adjust these parameters automatically to ensure

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optimal growth conditions. Additionally, it might include remote monitoring and control capabilities, allowing growers to manage their aeroponic system from anywhere using a smartphone or computer. Overall, a "Smart Aeroponics Solution" aims to maximize efficiency, yield, and convenience in aeroponic farming.

V.CULTIVATION OF PLANTS USING AEROPONIC TECHNIQUES

The greenhouse based modern agriculture industries are the recent requirement in every part of agriculture in India. In this technology, the humidity and temperature of plants are precisely controlled. Due to the variable atmospheric circumstances these conditions sometimes may vary from place to place in large farmhouse, which makes very difficult to maintain the uniformity at all the places in the farmhouse manually. It is observed that for the first time an android phone-control the Irrigation system, which could give the facilities of maintaining uniform environmental conditions are proposed. The Android Software Development Kit provides the tools and Application Programmable Interface necessary to begin developing applications on the Android platform using the Java programming language. Mobile phones have almost become an integral part of human life serving multiple needs of humans. This application makes use of the GPRS [General Packet Radio Service] feature of mobile phone as a solution for irrigation control system. GSM (Global System for Mobile Communication) is used to inform the user about the exact field condition. The information is passed onto the user request in the form of SMS.

The aeroponics setup described integrates IoT technology to enhance efficiency, precision, and convenience in cultivating plants without soil. Its components include a pH sensor, DHT11 sensor, liquid level sensor, peristaltic pump, Raspberry Pi Pico Microcontroller, and ESP32 Wi-Fi Module. The pH sensor monitors nutrient solution pH crucial for plant health, while the DHT11 sensor tracks temperature and humidity for optimal growth conditions. The liquid level sensor ensures consistent solution levels, activating the submersible pump when necessary. The pH is low in the plant water; the submersible pump is on the nutrient solution. Conversely, if the pH level is high in the plant water, the submersible pump switches to the pH low solution. The Raspberry Pi Pico coordinates sensor data collection, pump control, and communication with external platforms. Through the ESP32 Wi-Fi Module, the system transmits data to the Blynk App for remote monitoring. Users receive real-time updates and notifications if parameters deviate, enabling prompt action to maintain optimal growth conditions. This integrated system offers precise environmental control, nutrient delivery, and remote monitoring, promoting efficient and sustainable urban farming practices..

VI. HARDWARE DESRIPTION

POWER SUPPLY

Power supply is a reference to a source of electrical power. A device or system that supplies electrical or other types of energy to an output load or group of loads is called a power supply unit or PSU. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others.

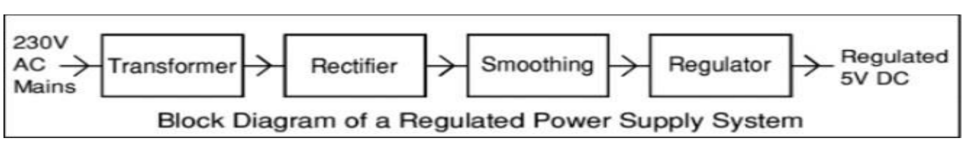

Figure: b) Block Diagram Of Regulated Powern Supply System

Transformer:

Transformers convert AC electricity from one voltage to another with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is AC.Step-up transformers increase voltage, step-down transformers reduce voltage. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage (230V in UK) to a safer low voltage.

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.The input coil is called the primary and the output coil is called the secondary. There is no electrical connection between the two coils; instead they are linked by an alternating magnetic field created in the soft-iron core of the transformer. The two lines in the middle of the circuit symbol represent the core.

Turns ratio=Vp/Vs=Nn/Ns and Power out=Power in

Vs*Is=Vp * Ip

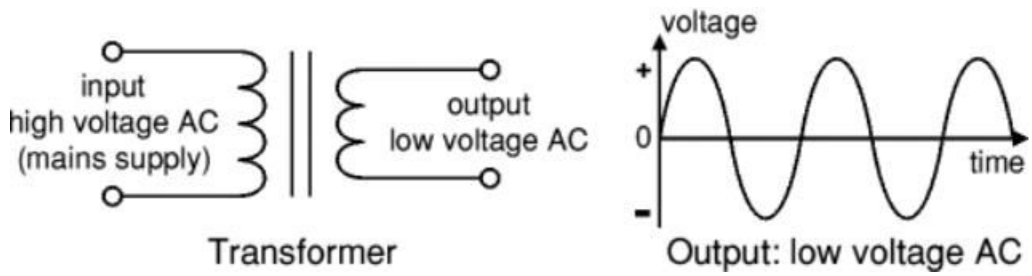

Figure:c) Transformer And Output

PH SENSOR

Use the pH Sensor just as you would a traditional pH meter with the additional advantages of automated data collection, graphing, and data analysis. Typical activities using our pH sensor include; Acid-base titrations, Studies of household acids and bases, Monitoring pH change during chemical reactions or in an aquarium as a result of photosynthesis, Investigations of acid rain and buffering, Analysis of water quality in streams and lakes. A **pH meter** is a scientific instrument that measures the hydrogen-ion activity in water-based solutions, indicating its acidity or alkalinityexpressed as pH. The pH meter measures the difference in electrical potential between a pH electrode and a reference electrode, and so the pH meter is sometimes referred to as a "potentiometric pH meter". The difference in electrical potential relates to the acidity or pH of the solution. The pH meter is used in many applications ranging from laboratory experimentation to quality control.

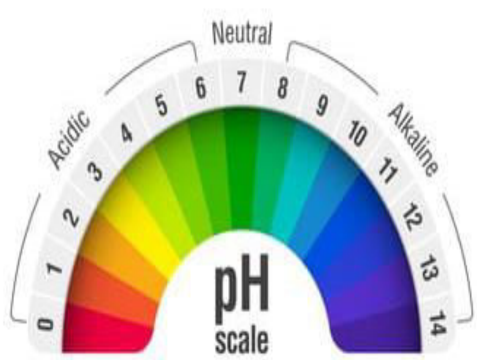

Figure:d) Ph Leval Detector

Figure:e) Plant Growth In Nutrient Content

ESP32-CAM MODULE

ESP32-CAM is a low-cost ESP32-based development board with onboard camera, small insize. It is an ideal solution for IoT application, prototypes constructions and DIY projects.

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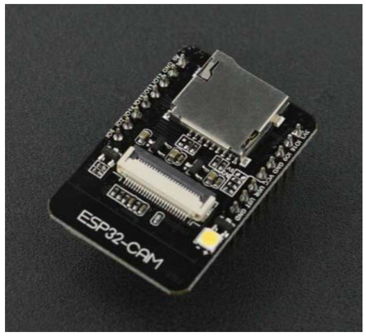

Figure: f) Esp32 Cam Module

VII. EMPOWERING AEROPHONICS WITH IOT

The difference between "men power" and automated aerophonics technology lies in the method of operation. "Men power" typically refers to human labor or manual effort, while automated aerophonics technology involves the use of machinery and automation to perform tasks related to aerophonics (the science of sound). So, one relies on human effort, while the other relies on technology for operation.

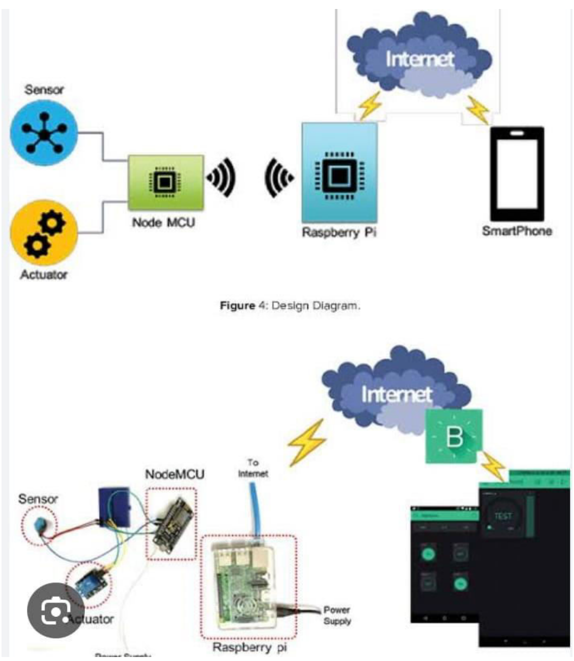

Figure: g) Iot Performance

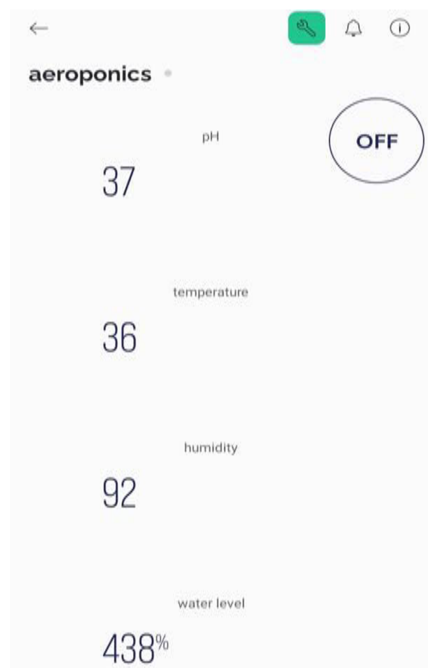

Figure: g) Blynk App Sensor Measurement

RASPBERRY PIPICO

Used for overall system control, data processing, and IoT connectivity.: Interface between the Raspberry Pi and the aeroponic system's hardware components.Aeroponic System Components, This includes a reservoir for nutrient solution, a pump for nutrient delivery, misting nozzles, growing chambers, sensors (such as pH, EC, temperature, humidity, etc.), and actuators (for controlling pumps, fans, etc.).Connect sensors to the Pico microcontroller to measure environmental parameters like temperature, humidity, pH, and EC (electrical

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conductivity).Connect actuators such as pumps, fans, and misters to the Pico microcontroller to control nutrient delivery, airflow, and misting cycles.

VIII. METHODOLOGY

Write code for the Raspberry Pi to communicate with the Pico microcontroller and receive sensor data.Implement control algorithms to regulate environmental parameters based on sensor readings. For example, adjusting nutrient delivery based on pH and EC levels, controlling misting cycles based on humidity, etc.Integrate IoT functionality to enable remote monitoring and control of the aeroponic system over the internet.Implement data logging on the Raspberry Pi to record sensor readings over time.Analyze the collected data to gain insights into the performance of the aeroponic system and make adjustments as needed for optimal plant growth.

User interface Develop a user interface (web-based or mobile app) to visualize real-time sensor data, control system parameters remotely, and receive alerts or notifications for any issues detected by the system.Conduct thorough testing of the entire system to ensure proper functionality and performance.Calibrate sensors and fine-tune control algorithms as necessary for accurate and reliable operation.Deployment and Maintenance:Deploy the aeroponic system in the desired location (indoor or outdoor) and perform regular maintenance to keep the system running smoothly.Monitor system performance over time and make adjustments as needed to optimize plant growth and productivity.

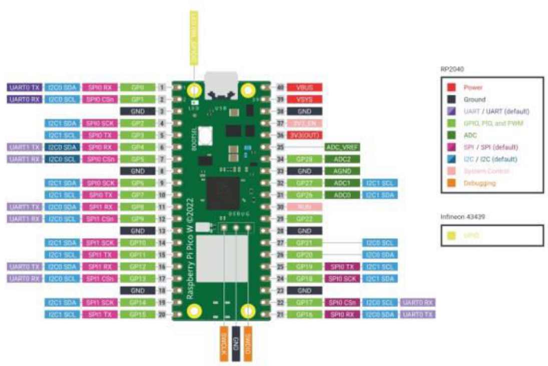

Figure:i)Raspberry Pi Pico Microcondroller

IX. CONCLUSION

The aeroponics system is a highly efficient, precise, and convenient method for cultivating plants without soil. By integrating IoT technology, the system achieves several key outcomes. Firstly, it maintains optimal growth conditions by continuously monitoring and adjusting environmental parameters such as pH, temperature, humidity, and nutrient levels. Secondly, through the Blynk App, users can remotely monitor the system in real-time, receive notifications, and take prompt action if any parameters deviate from the desired range. This allows for proactive management and minimizes the risk of plant stress or damage. Thirdly, the system promotes resource efficiency by precisely controlling nutrient delivery and water levels, minimizing waste and maximizing resource utilization, thus promoting sustainability by reducing water and nutrient consumption. Fourthly, the ability to maintain optimal growth conditions throughout the cultivation process leads to improved crop yield and quality. Plants grown in this system are healthier, more resilient, and may have higher nutritional value. Lastly, the automated nature of the system, combined with remote monitoring capabilities, makes it easy to manage and maintain, even for inexperienced users, thereby promoting wider adoption of aeroponics for urban farming and indoor gardening applications.The integration of iot technology into aeroponics cultivation represents a significant advancement in modern agriculture. By leveraging sensors, microcontrollers, and wireless communication, this system enables precise monitoring and control of key environmental parameters essential for plant growth. The real-time data

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transmission to the Blynk App allows users to remotely monitor the system, receive timely notifications, and take immediate action to maintain optimal conditions. With its ability to regulate ph levels, nutrient delivery, and liquid levels, this integrated system offers a sustainable and efficient solution for urban farming practices. Overall, the aeroponics setup exemplifies how technological innovation can revolutionize agriculture, promoting greater productivity, resource efficiency, and environmental sustainability.

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