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Design and Development of Automatic Aeroponic Irrigation System Using IoT

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ABSTRACT: Monitoring and control. The system integrates environmental sensors, a microcontroller-based control unit, and a cloud monitoring platform to optimize water and nutrient delivery. Parameters such as temperature, humidity, and nutrient flow are continuously monitored. Automated misting control improves irrigation efficiency, reduces water consumption, and enhances plant growth.Experimental results demonstrate improved resource utilization and system reliability compared to conventional irrigation methods

KEYWORDS: Aeroponic system, Arduino, Sensors, Plant irrigation.

I. INTRODUCTION

The foundation of organic farming is the soil. However, soil degradation and nutrient contamination are some of the unfavorable effect of soil-based agriculture on the ecosystem. This encouraged scientists to create urban agricultural techniques. Aeroponics, which substitutes the air for soil as a growing medium, is one of the most promising techniques. Without using soil or a bulk media, aeroponics is the practice of growing plants in an atmosphere of air or mist. The Greek words for "air" and "labour," ponos, are where the word "aeroponics" comes from. Contrary to traditional hydroponics, aquaponics, and plant tissue culture growing, aeroponics culture is unique. Aeroponics doesn't use a growing medium like hydroponics or aquaponics, which use water and fish waste to support plant development and a liquid nutrient solution as the growing medium. Given that nutrients are transferred through water in aeroponics, it is occasionally regarded as a form of hydroponics. The changes in the food industries have been driven by a significant rise in global health consciousness over the past two decades. The general public is now more conscious of food quality issues including nutrition and safety.

II. LITERATURE REVIEW

1. TITLE :MICROCONTROLLER-BASED AEROPONICS FARMING SYSTEM:
Microcontroller-Based Aeroponics Farming Management System (Aguas et al., 2019) This study presents a microcontroller-based aeroponic farming system designed to monitor and control essential plant growth parameters such as temperature, humidity, lighting, and irrigation.

2. TITLE : AUTOMATED AEROPONIC FARMING: Automated Aeroponic Farming (Singh et al., 2023 – IRJET):
This paper proposes an IoT-based automated aeroponic farming system using NodeMCU (ESP8266) for real-time monitoring and control. Temperature and light intensity data are collected using sensors and transmitted to the ThingSpeak cloud platform.

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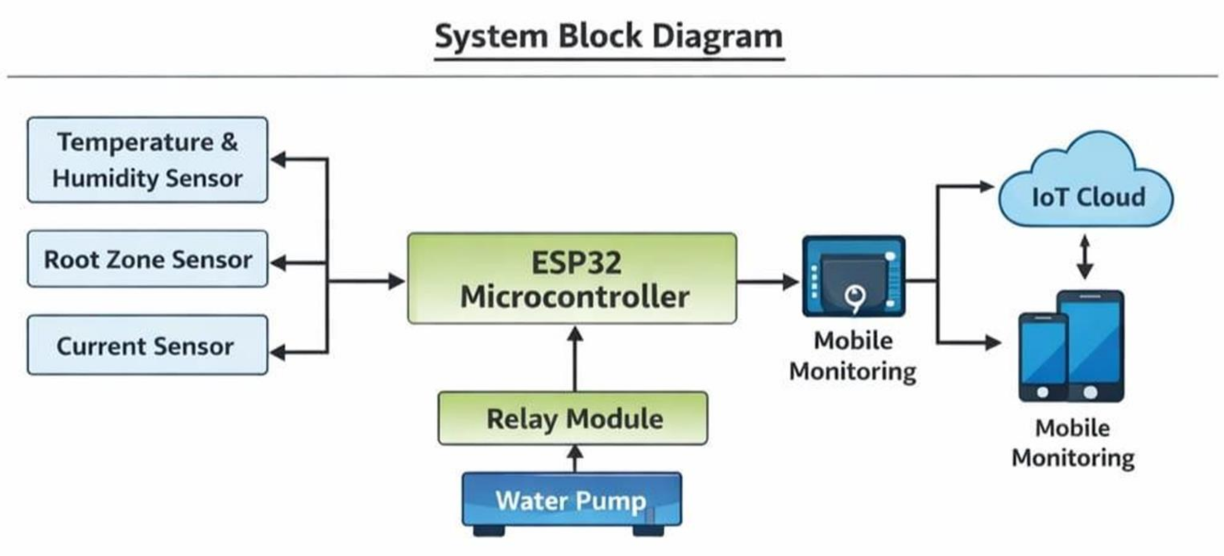
3.TITLE : SMART FARMING ON IOT-BASED AEROPONIC SYSTEM: Smart Farming on IoT-Based Aeroponic Systems (Simanungkalit et al., 2023).
This study develops a smart aeroponic farming system using IoT technology integrated with Arduino Mega and an Android mobile application. Sensors such as DHT11, pH, TDS, ultrasonic, and water level sensors were used to monitor plant conditions and automate nutrient mixing.

4. TITLE : PARAMETER CONTROL SYSTEM OF AEROPONIC BASED ON IOT: Parameter control system of Aeroponic based on IOT (Dzaki Zahran et al.,2025)
The Internet of Things (IoT)-based Aeroponic System is an innovation in the cultivation of crops, especially potatoes, on limited land. The system uses the ESP32 as the main data processor, with a DHT11 sensor for temperature and humidity measurements, as well as a pH sensor for nutrient regulation.

III. ALGORITHAM

Read sensor data
↓
Check root zone condition
↓
If moisture low → start pump
↓
Monitor pump current
↓
Send data to IoT cloud
↓
Send alert if abnormal

IV. BLOCK DIAGRAM



V. WORKING

⇨ Sensors continuously collect data :
• Temperature
• Humidity
• Water level
• pH

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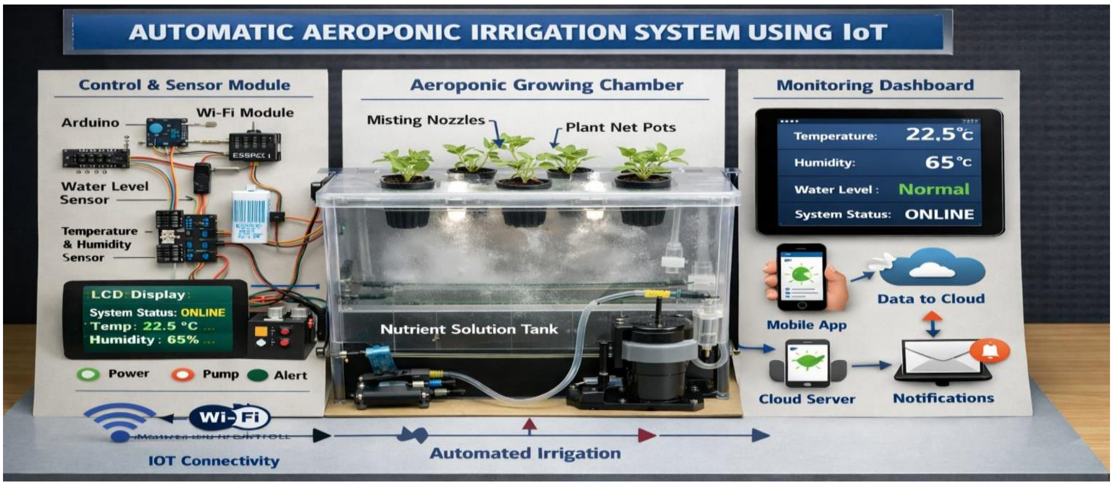
⇨ Data is sent to the microcontroller:
⇨ Based on predefined conditions :
pump turns ON & sprays nutrient mist
pump turns OFF & after set interval
data upload to IOT cloud
user moniter via mobile app /dashboard.

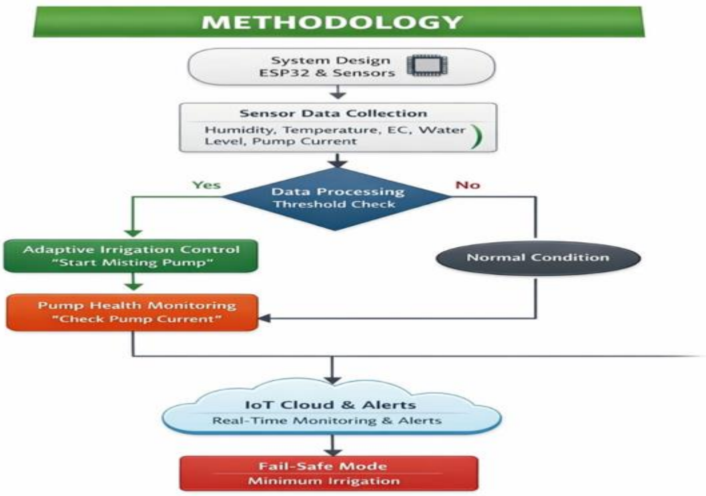
VI. APPLICATION:

➢ smart agriculture
➢ vertical farming
➢ green house
➢ urban indoor farming
➢ research labs

VII. PROPOSED WORK:



VIII. METHODOLOGY



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IX. COST ESTIMATION:

Core Electronics Components:
ESP32 WiFi Bluetooth Board → ~₹600–₹700
Temperature & Humidity Sensor
DHT11 Sensor Module → ~₹50
Water Level Sensor (XKC-Y25) → ~₹500–₹600
LCD Display
16x2 LCD Display → ~₹150–₹200

Irrigation System Components:

Water Pump (for misting / nutrient flow)
12V Submersible Water Pump → ~₹400–₹500
Mist Nozzles (aeroponic spraying) → ₹200–₹500
Pipes / Tubing → ₹150–₹300
Nutrient Tank (plastic container) → ₹300–₹700

Power & Control:

Relay Module → ₹100–₹200
Power Supply (12V adapter) → ₹200–₹400
Jumper Wires + Breadboard → ₹150–₹300

IoT & Software:

WiFi (ESP32 built-in) → ₹0
Cloud platform (ThingSpeak / Blynk) → Free / ₹200 (optional premium.
Optional Advanced Sensors (Recommended):
pH Sensor
pH Sensor Module → ~₹600–₹700
Water Flow Sensor → ₹250–₹300

Total Cost Summary:

Electronics - ₹1,300 – ₹2,000
Irrigation Setup - ₹800 – ₹2,000
Power & Misc - ₹400 – ₹900
Optional Sensors - ₹600 – ₹1,000

Total Project Cost:

Basic Prototype: ₹2,500 – ₹4,000
Advanced IoT System: ₹4,000 – ₹6,000

X. COMPONENTS & MATERIALS:

Hardware components:
1. ESP32 Microcontroller
2. Temperature & Humidity sensor
3. EC sensor
4. Water level sensor
5. Current sensor
6. Water pump / mist pump
7. Relay module
8. Power supply
9. Aeroponic chamber / pipes / Nozzles

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Software & IOT Platform:
1. Arduino IDE
2. IOT cloud platform
3. Mobile / web dashboard
4. Real - time Alert system
5. Fail safe operation program

XI. RESULT & DISCUSSION:

The developed IoT-based automated aeroponic irrigation system successfully monitored and controlled the nutrient misting process in real time. Sensors were used to measure humidity, temperature, water level, and nutrient flow conditions. Based on sensor readings, the microcontroller automatically activated the pump and spray nozzles. The IoT module enabled remote monitoring through a mobile app or web dashboard. The system reduced water usage compared to traditional irrigation methods. Plant roots received a uniform nutrient mist, which improved growth efficiency. Automatic control minimized manual intervention and reduced human error. The system also provided alerts during low water levels or pump failure. Experimental results showed improved plant health and faster growth rates. Overall, the developed system proved to be efficient, reliable, and suitable for smart agriculture applications.

XII. CONCLUSION

➤ IoT-based aeroponic irrigation improves water efficiency, root safety, and system reliability using sensors and automated monitoring.

➤ This system is a AI based irrigation control using in Large scale farming system.

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