“Smart Hydroponics System”

by

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Contents

Problem Statement

Problem Statement :

Hydroponics is soil-less agriculture farming, which consumes less water and other resources as compared to traditional soil-based agriculture systems. However, monitoring hydroponics farming is a challenging task due to the simultaneous supervising of numerous parameters, nutrition Monitoring, and Controlling.

Introduction

- Hydroponics, a revolutionary approach to farming, uses materials other than soil to support plant roots, allowing crops to grow directly in nutrient-rich water.
- This Smart Hydroponic System will have sensors, internet communication, and computer technology. To solve the current deficiency, this system is designed for monitoring and controlling system.
- This Smart Hydroponic System will automate crop monitoring during the growth process using the network of sensors and actuators.
- This system assists in monitoring and commanding numerous real issues in fields such as water PH level, water temperature, and relative humidity.

Literature Survey

Website / Paper / Article /APP	Reviews / Findings
Automatic monitoring system for hydroponic farming: iot-based design and development (AESS) 2022	This paper presents how the hydroponic will be monitor by user in real time by using various sensors nodes.
Design and Implementation of Smart Hydroponics Farming Using IoT-Based AI Controller with Mobile Application System (Hindawi) 2022	The application is mainly focus on prediction, monitoring and controlling.
Automated Hydroponics with Remote Monitoring and Control Using IoT (International Journal of Engineering Research & Technology) 2020	This review paper basically present Remote monitoring and controlling are as of the main objectives.

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Revolutionizing Holy-Basil Cultivation With AI-Enabled Hydroponics System (IEEE - 9 August 2023)	This research study focuses on the design and implementation of an IoT-based hydroponic system specifically optimized for the growing of exotic and medicinal plants.
Modular IoT-based Automated Hydroponic System (ICMEAE) ©2021 IEEE	This work proposes the development of an automatic modular and vertical hydroponic system capable to regulate the water flow, the artificial lights, and the pH of the water.
Fuzzy-Based Smart Farming and Consumed Energy Comparison Using the Internet of Things(IEEE - 12 July 2023)	This research investigated hydroponics and electrical energy consumption concerns for prototype design, and analysis with a fuzzy logic framework and the Internet of Things (IoT).

Literature Survey

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3D Printable Hydroponics: A Digital Fabrication Pipeline for Soilless Plant Cultivation(IEEE - April 2, 2019)	The paper conclude with a discussion on how the pipeline may be further extended to realize fabrication of more complex ecological systems.
IoT based Indoor Hydroponics System(©2021 IEEE)	In this paper, considering the yield and the growth of plants, an efficient approach is provided for the accurate growth of plants with less water usage and minimum need for nutrients using IOT-based techniques.
Intelligent Management of Hydroponic Systems Based on IoT for Agrifood Processes(Hindawi Journal of Sensors Volume 2022)	For improvements, we are adding more sensors to have better precision or maintenance of the system like flood sensor, with the objective of making this project a solution for wide variety of situations with different needs.

Aim & Objectives

Aim:

A smart hydroponic system with IoT aims to revolutionize hydroponic-based agriculture by integrating sensors and connectivity. It enables remote monitoring and control, resource efficiency, data-driven decision-making, automation, and environment sustainability.

Objectives:

- To be able to provide a better temperature for plants to grow in hydroponic farming.
- To Control nutrient parameters in water.
- To Design such an application that gives the user all information regarding temperature, nutrient composition, and recent crop conditions.

Proposed Work

Components To Be Used :

- Microcontroller (ESP32)
- Air temperature and humidity sensor (DHT 11): Used to monitor temperature and humidity of a given area.
- Water quality sensor (TDS Sensor): To detect the composition of chemicals and Indicate the quality of water.
- Water temperature sensor (DS18B20): Used to detect water temperature.
- Float Switch Sensor: Detecting the amount of liquid in a tank
- Water PH Sensor: To measure the pH of water
- Fan
- Solenoid valve
- Submersible Pump

Methodology

- Set up the microcontroller and connect sensors (DHT11, Float Sensor, water temperature sensor, TDS sensor, pH sensor) and actuators (solenoid valve, fan).
- Connect the microcontroller to the internet for IoT capabilities.
- Establish communication with Firebase for data storage and retrieval.
- Continuously read sensor data (temperature, humidity, water level, water temperature, TDS, pH) at regular intervals.
- If TDS value exceeds the defined range (600 ppm to 1773 ppm), trigger the solenoid valve to drain the tank and refill it from the main water source.
- If the temperature surpasses the predefined maximum range (18oC to 23oC), activate the fan to regulate the environment.

Methodology

- Develop a mobile application for users to monitor system readings and manage settings manually or automatically.
- Implement manual and automatic controls in the mobile app for controlling the setup.
- Set up notifications and alerts to notify users about critical parameter deviations or system malfunctions.
- Store sensor readings and system statuses in Firebase for historical analysis

System Architecture

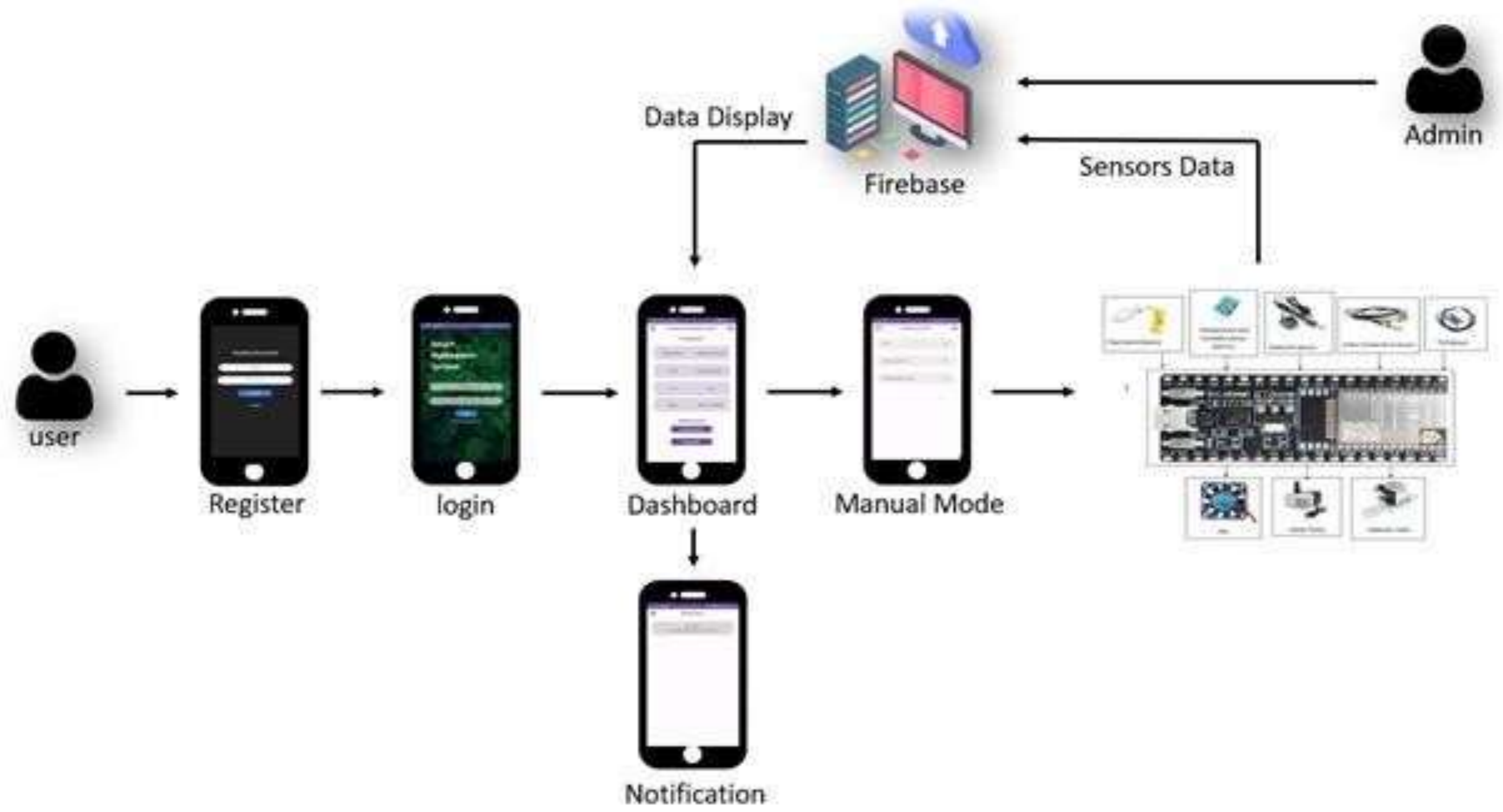

Fig 1: System Architecture of Smart Hydroponic System Using IoT

System Architecture

- The above-described architecture depicts the Smart Hydroponic System's system architecture.
- The sensors collect data on the environmental conditions in the hydroponic system and send it to the ESP32. The ESP32 then analyses the data and sends commands to the actuators to adjust the conditions as needed.
- The ESP32 can also be configured to send notifications to the user's mobile app if any of the sensors detect a problem.
- The Firebase is a cloud-based database that stores the sensor data from the ESP32. The Firebase Notifications service allows the ESP32 to send push notifications to the user's mobile app.
- This allows the user to monitor the status of the hydroponic system and receive alerts if any problems arise.

Circuit Diagram

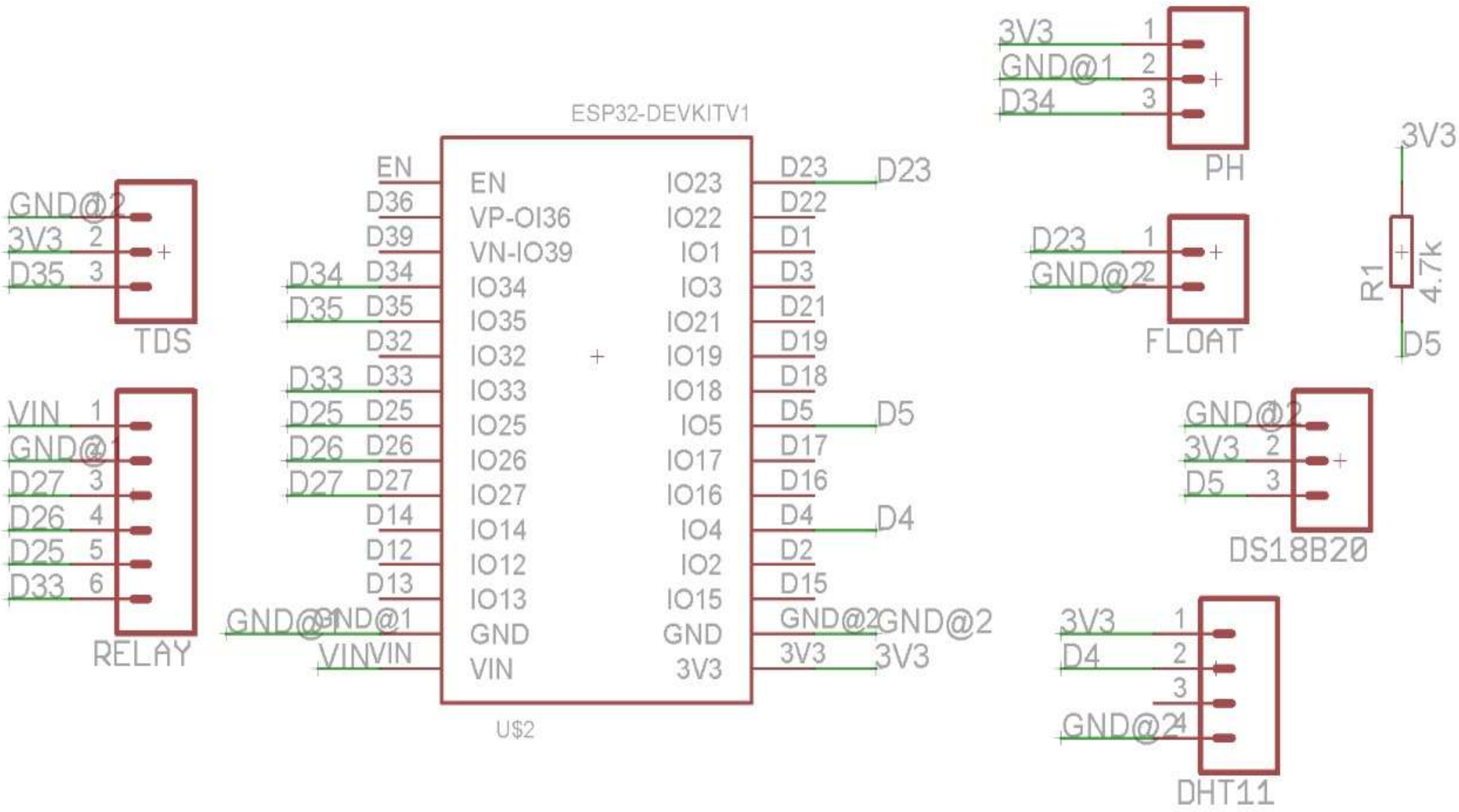

Fig 2: Circuit Diagram of Smart Hydroponic System Using IoT

Circuit Diagram

- This above image explains how pins on the ESP32 module is connected to the pins on the sensors and components.
- The component we have used are TDS, Relay Module, Ph sensor, Float Meter, Humidity and temperature Sensor DHT 11, Water Temperature sensor DS18B20 and ESP32 microcontroller.
- The purpose of these connections is to allow the ESP32 module to communicate with the sensors and components, read their data, and control their actions.

System Design: Flowchart

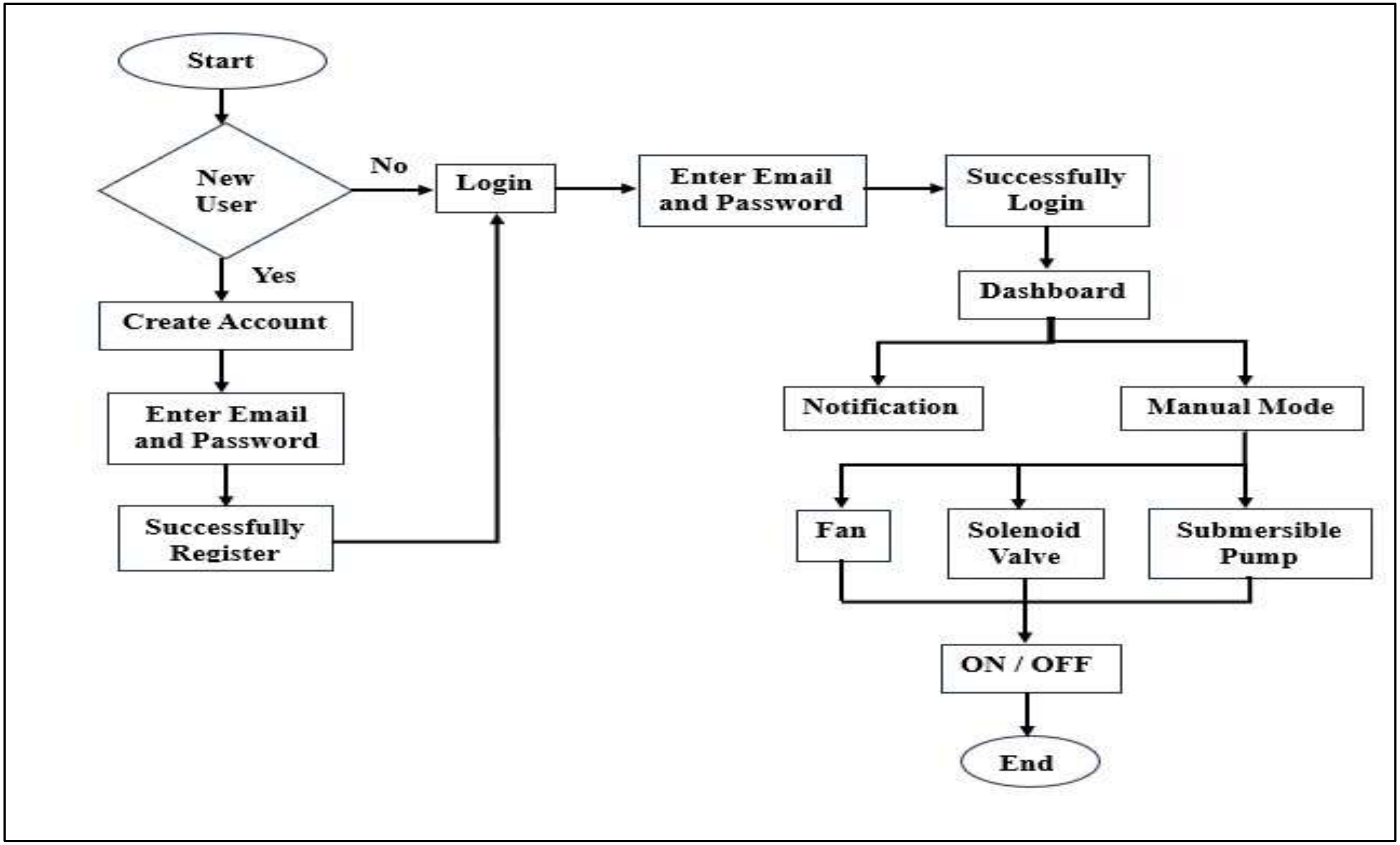

Fig 3: Real Time Data Monitoring Application

System Design: Flowchart

- In the project's workflow, the customer assumes the primary role as the main user of the application.
- Their purpose revolves around monitoring sensor readings and managing different parameters manually according to specific requirements.
- Additionally, the system is designed to notify the user promptly whenever updates or modifications are made.
- This feature ensures that the customer remains informed about any changes within the system, allowing for seamless engagement and informed decision-making.

Module Description

- Registration Page
- Login Page
- Dashboard (Display Sensors Data)
- Manual Control (Actuator Control Unit)
- Notifications /Alerts

Technology

- **Front End:** XML
- **Back End:** Java
- **Library/API/Framework:** Android Studio, Arduino IDE – Code Design
- **Database** – Firebase

Implementation

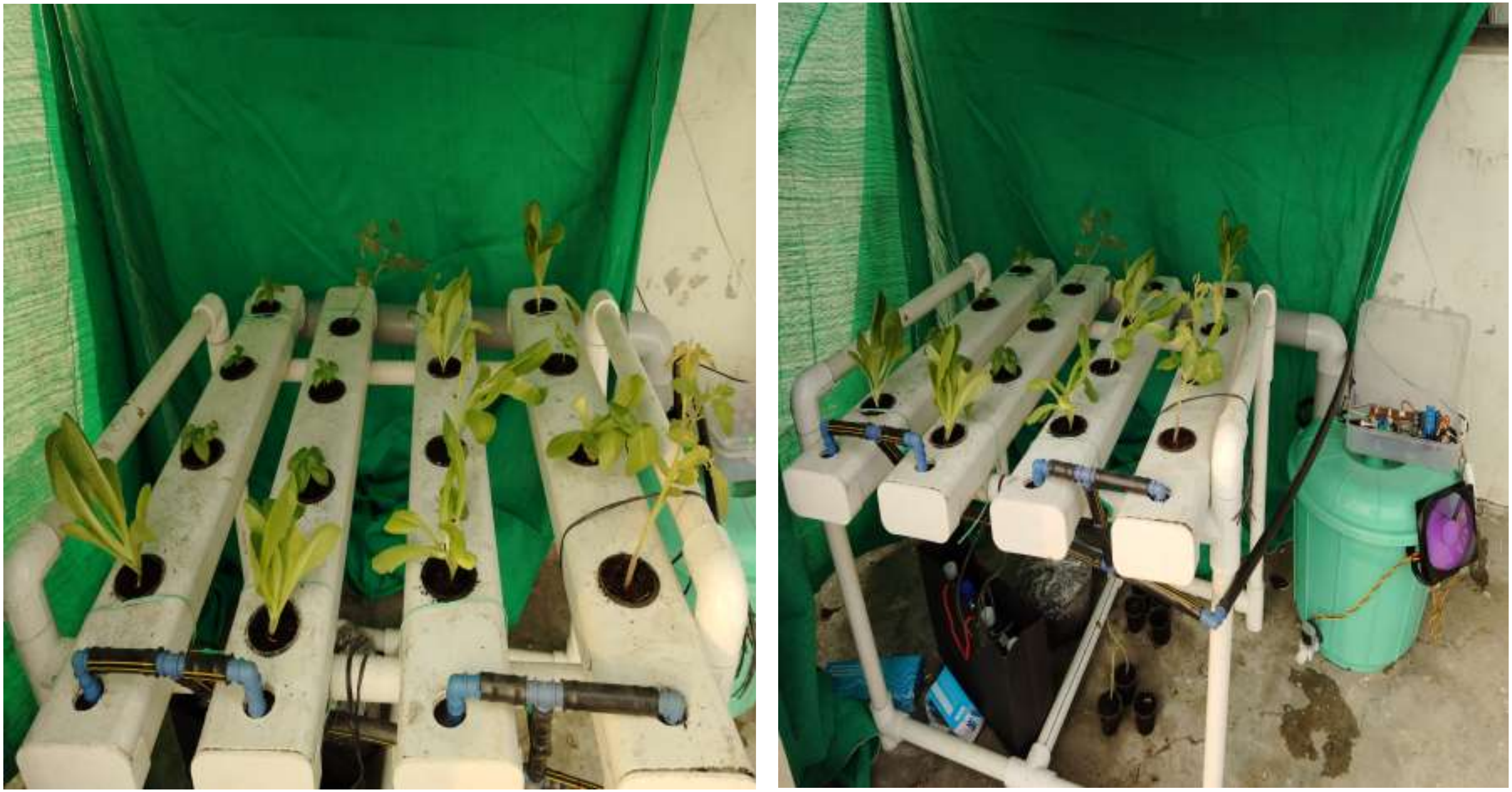

Fig 4.1: Project Setup

Implementation

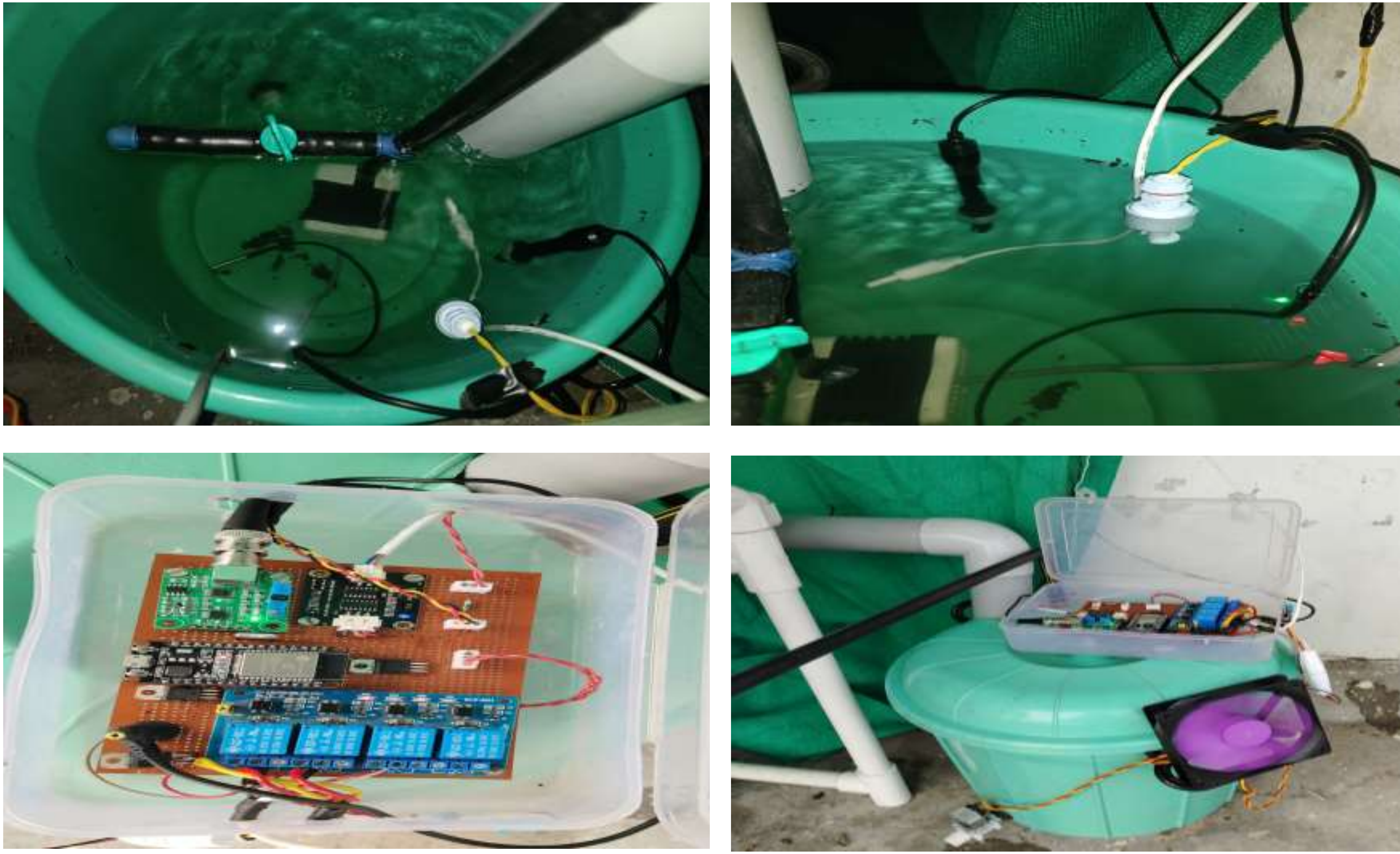

Fig 4.2: Project Setup

Implementation

- We have used a Nutrient film technique (NFT) Setup. In NFT plants are grown in shallow channels or gutters with their roots in a thin film of nutrient-rich water. The water is recirculated continuously, so there is no waste.
- There is also Reservoir tank, Water pump, Tubing, Growing media (for seedlings) and different nutrient solution for the plants.
- We have used coco peat as a growing media to support plants.
- There is space for 16 plants in our setup.
- Green net is used to cover the setup, to limit the amount of sunlight for the crop.

Results & Discussion

Screenshots:

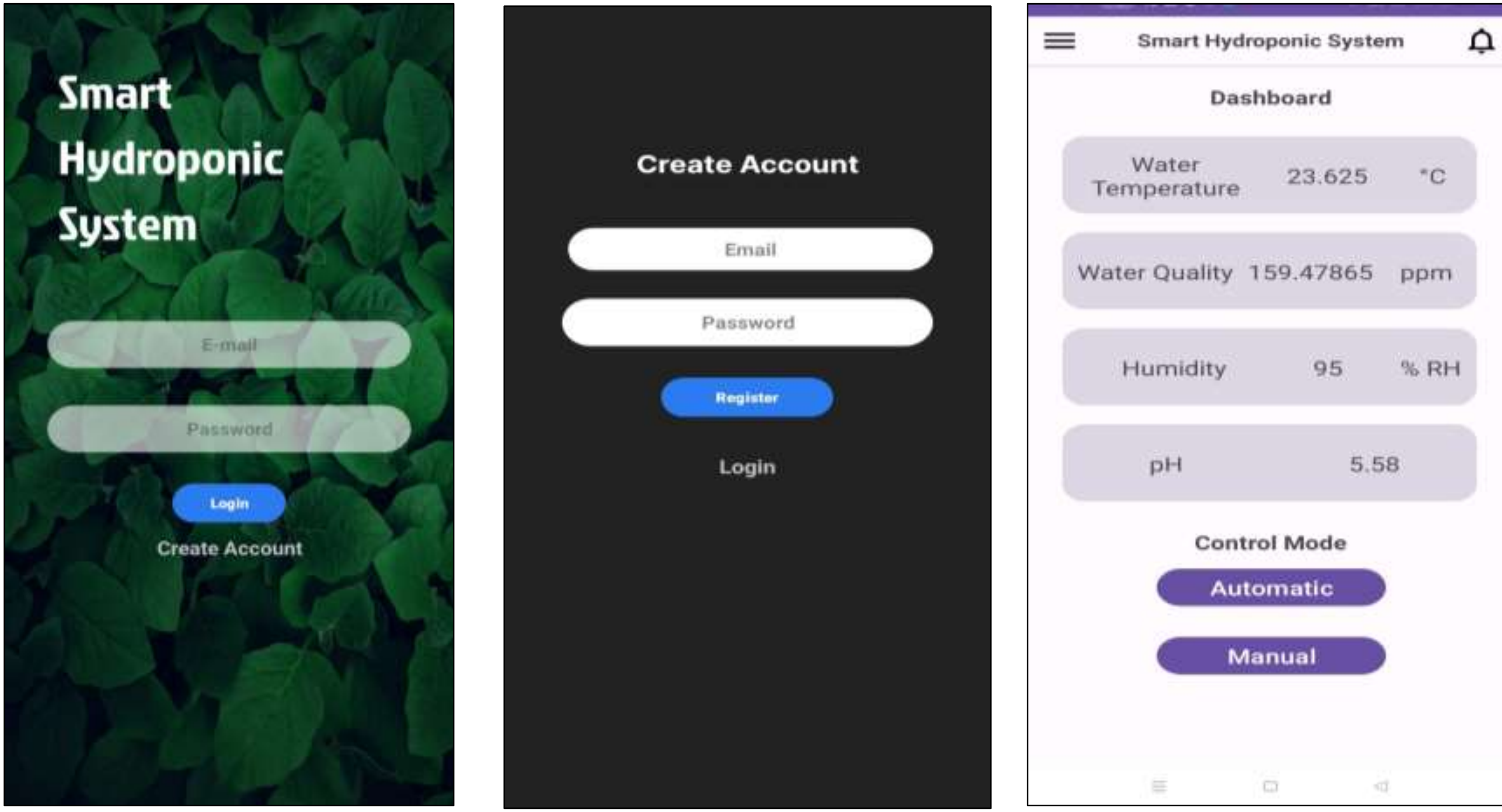

Fig 5.1: Software Application

Results & Discussion

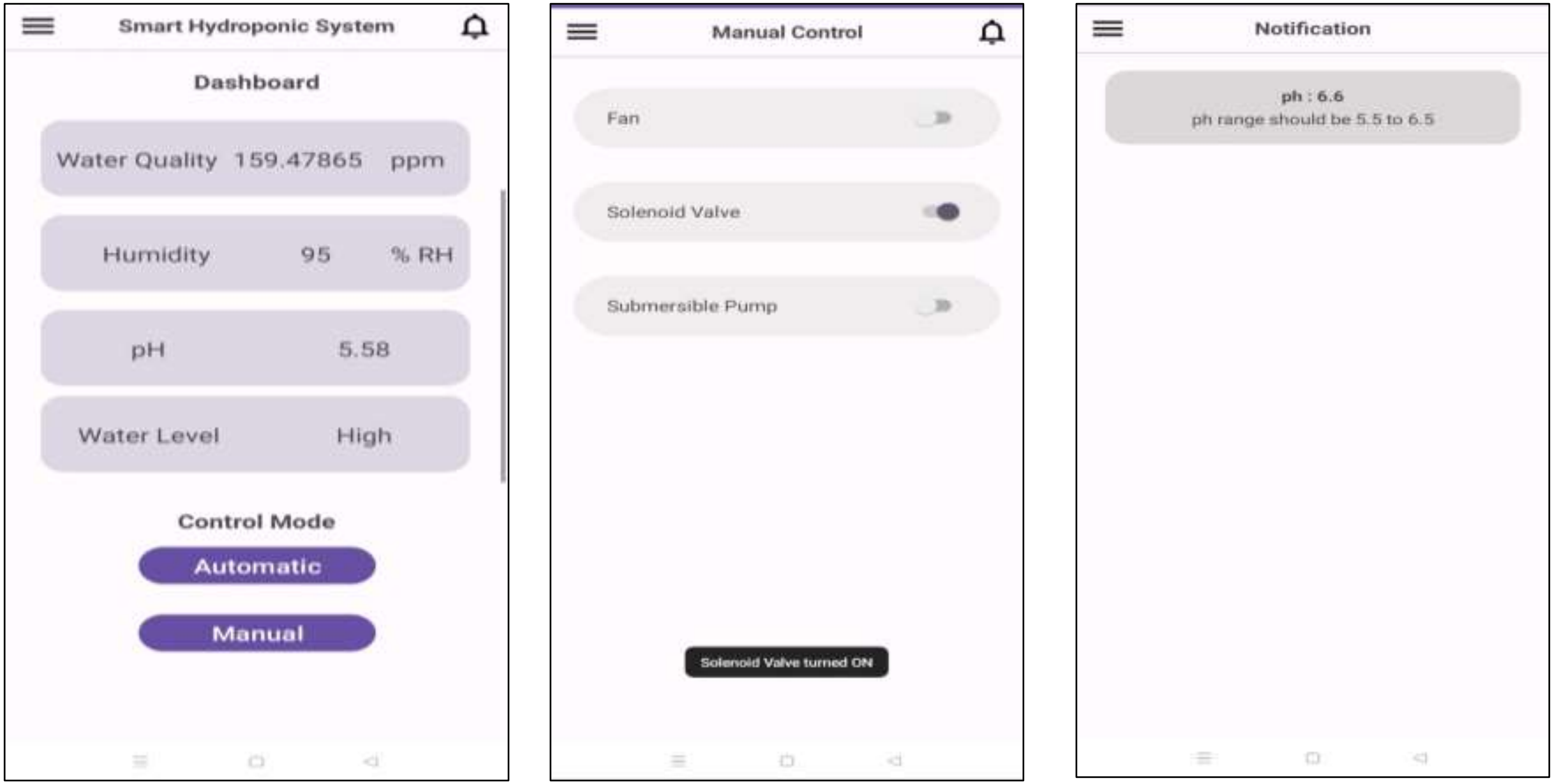

Fig 5.2: Software Application

Results & Discussion

- Upon initiating the application, a registration page is displayed. The users are prompted to create an account to access the application's functionalities.
- For existing users, a login option is available to directly access their accounts. This process ensures that new users can swiftly register while established users can conveniently log in.
- Once logged in, users are presented with a dashboard showcasing readings and values captured by various sensors. This centralized interface provides real-time data visibility.
- Users also have access to a control mode allowing them to seamlessly transition between different operational modes—such as automatic and manual settings.

Results & Discussion

- Upon opting for manual control within the system, users gain access to manual interface, designed for manual mode operation.
- This screen empowers users to directly oversee and adjust essential parameters like the fan, solenoid valve, and submersible pump. By offering this level of control, individuals can fine-tune these elements according to their preferences or requirements.
- The notification screen is pivotal for informing users about system alterations or alerts. This prompt notification mechanism ensures users are promptly informed of deviations, enabling timely action or adjustments.
- This feature emphasizes proactive user engagement, allowing for immediate responses to maintain optimal system conditions within the specified parameters.

Advantages & Applications

Advantages:

- Real-time data analysis and monitoring.
- Based on environmental parameters it will give readings accordingly.(for ex. Monitoring of temperature and humidity).
- Reduces Manual efforts Automation of nutrient delivery, continuous monitoring and adjustment of environmental parameters, efficient resource utilization.
- remote access and control for ease of management, and the potential for increased crop yields and quality through data-driven optimization.
- User can monitor and manage Hydroponic System anytime and anywhere.

Applications:

- Urban farming
- Climate Control in Greenhouses
- Hydroponic Hobbyists

Conclusion

- In conclusion, the integration of IoT into smart hydroponic systems marks a significant leap in agricultural innovation. With data analytics, remote monitoring, AI, and sustainable practices, it revolutionizes cultivation efficiency. Ensures scalability, user-friendly interfaces, and robust security
- One of the key advantages of hydroponic farming is its ability to maximize crop yields in limited spaces. Through vertical farming techniques and optimized resource utilization, hydroponics enables farmers to grow more food per square foot compared to traditional methods.
- This increased productivity not only contributes to food security but also presents economic opportunities for farmers and entrepreneurs.

Future Scope

- Automation and Remote Monitoring
- Improved Crop Yield and Quality
- Resource Efficiency
- Enhanced User Experience
- Integration and Connectivity
- Data-Driven Insights

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