REAL-TIME SYSTEM AND INTERNET OF THINGS FINAL PROJECT REPORT
DEPARTMENT OF ELECTRICAL ENGINEERING
UNIVERSITAS INDONESIA

FishHaven: SMART IOT MONITORING SYSTEM FOR FISH FARMING

GROUP 23

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PREFACE

In the ever-evolving landscape of technology, the rise of the Internet of Things (IoT) has allowed us to transform industries and enhance how we manage critical resources. As we introduce “FishHaven”, we embark on a mission to leverage IoT principles to redefine aquaculture practices and ensure a sustainable future for fish farming.

Water, the lifeblood of aquaculture, demands precise monitoring and proactive management to maintain the delicate balance necessary for aquatic life. The FishHaven project emerges as a response to the growing challenges in traditional fish farming, seeking to revolutionize how farmers monitor and optimize water quality parameters. By integrating advanced IoT technologies, we aim to create an intelligent system capable of real-time monitoring, automation, and timely intervention, ultimately fostering healthier aquatic ecosystems and improved productivity.

This document serves as a comprehensive guide through the conceptualization, development, and implementation phases of the FishHaven project. From the initial spark of innovation to the technical intricacies of sensor integration and remote monitoring, each section reflects the collective efforts of a passionate team dedicated to the intersection of technology and sustainable aquaculture.

Depok, December 10, 2024

Group 23

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CHAPTER 1

INTRODUCTION

1.1 PROBLEM STATEMENT

Traditionally fish farming practices often face many challenges in maintaining optimal water quality, which is critical for the health and growth of aquatic life. Challenges such as fluctuating water levels, unstable temperatures, and poor water clarity which can lead to stress, disease, or even loss of stock. These things will surely negatively impact productivity and profitability. These problems are caused by a lack of real-time monitoring and automation, farmers are required to rely on manual inspections, which are time-consuming, labor-intensive, and not immune to human error. Without timely interventions, deviations in water quality parameters can escalate into severe problems, resulting in reduced efficiency and sustainability of aquaculture operations.

As the global demand for fish grows, fish farmers are under increasing pressure to scale their operations while minimizing environmental impact. The absence of reliable tools to ensure water quality consistency adds complexity to achieving this balance. There is also a growing need for systems that can provide actionable insights, reduce operational costs, and support decision-making processes. This project addresses the need for an intelligent, automated, and user-friendly system to monitor and manage water conditions in real time, empowering fish farmers with the tools to optimize their operations while promoting sustainable practices.

1.2 PROPOSED SOLUTION

Our solution is FishHaven. FishHaven is a Smart IoT Monitoring System for Fish Farming designed to optimize aquaculture management through real-time monitoring and automation. It utilizes a Water Level Sensor Universal to track water height, a Dallas Temperature Sensor (DS18B20) for temperature measurement, and a Turbidity Sensor Module (AB147) to detect water clarity. These sensors transmit data to the Blynk application via Wi-Fi, enabling fish farmers to monitor critical water parameters remotely. Instant notifications are sent when parameters deviate from safe levels, such as high turbidity or unstable temperatures, allowing for prompt corrective actions. FishHaven ensures optimal water quality, reduces risks, and enhances productivity, making fish farming more efficient and sustainable.

1.3 ACCEPTANCE CRITERIA

The acceptance criteria for this project are as follows:

1. FishHaven must be able to accurately **measure water levels**, providing real-time data to ensure optimal conditions.
2. FishHaven must be able to **monitor water temperature** precisely, ensuring a stable environment for fish growth.
3. FishHaven must be able to **detect water clarity levels**, and identify issues such as contamination or waste buildup.
4. FishHaven must be able to **send instant notifications to users** when sensor readings deviate from the predefined safe thresholds.
5. FishHaven must **provide** users with an **intuitive interface** in the **Blynk app** to view sensor data and system settings in real time.

1.4 ROLES AND RESPONSIBILITIES

The roles and responsibilities assigned to the group members are as follows:

Roles	Responsibilities	Person
Coding	Developing and debugging software for sensor integration, data processing, and real-time monitoring via the Blynk app, ensuring secure and efficient system performance.	Darren Nathanael Boentara
		Muhammad Daffa Rizkyandri

Building	Assembling and calibrating hardware components, conducting tests, and troubleshooting to ensure proper functionality and seamless integration with the software.	Louis Benedict Archie
		Muhammad Abrisam Cahyo Juhartono
Report	Documenting all aspects of the project, including objectives, hardware and software integration, testing results, and final outcomes, ensuring clarity and comprehensiveness.	All Members

Table 1. Roles and Responsibilities

1.5 TIMELINE AND MILESTONES

Work	November		December	
	3rd Week	4th Week	1st Week	2nd Week
Planning				
Hardware Design				
Software Development				
Integration and Testing of Hardware and Software				

Final Product Assembly and Testing				

Table 2. Timeline and Milestones

CHAPTER 2

IMPLEMENTATION

2.1 HARDWARE DESIGN AND SCHEMATIC

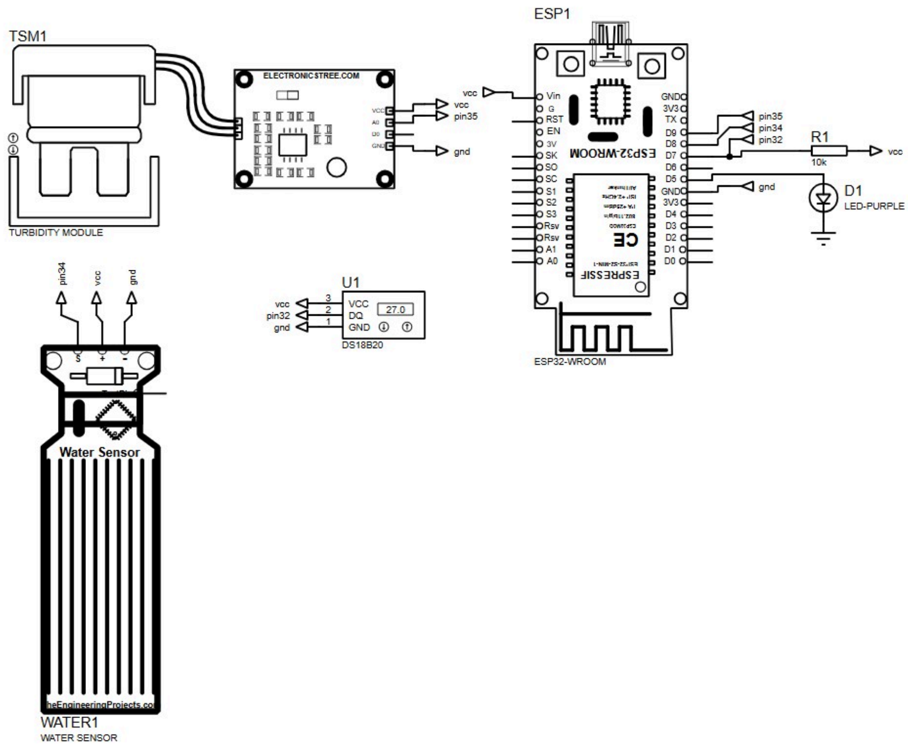

Fig 1. Project Schematics

This Project is built using the following hardware:

- **ESP32 Microcontroller:** The core of the system, handling data from sensors and enabling connectivity with the Blynk application.
- **Blynk App:** A user-friendly platform for monitoring sensor data, receiving notifications, and managing the system remotely.
- **Water Level Sensor Universal:** Measures water levels with high accuracy, helping maintain optimal conditions for fish farming.
- **Dallas Temperature Sensor (DS18B20):** Precisely monitors water temperature to ensure a stable and suitable environment for fish growth.
- **Turbidity Sensor Module (AB147):** Detects water clarity to prevent issues caused by poor water quality, safeguarding the health of aquatic life.

The ESP32 Microcontroller acts as the core of the FishHaven system, seamlessly integrating multiple sensors to provide real-time monitoring of aquaculture conditions. This central unit processes data efficiently and communicates it to the Blynk app, allowing fish farmers to oversee and manage their operations remotely. The Water Level Sensor Universal ensures stability by accurately measuring water levels, helping to maintain a consistent environment. The Dallas Temperature Sensor (DS18B20) monitors water temperature with precision, ensuring optimal conditions for fish health and growth.

Additionally, the Turbidity Sensor Module (AB147) evaluates water clarity, enabling timely interventions to maintain a clean and safe habitat. Together, these technologies form a cohesive system that simplifies fish farming through automation, real-time insights, and smart notifications, fostering sustainable and efficient aquaculture practices.

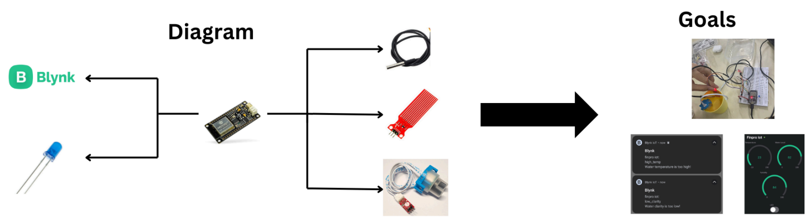

Fig 2. Diagram & Goals

2.2 SOFTWARE DEVELOPMENT

The FishHaven project integrates cutting-edge hardware and software to create a comprehensive smart aquaculture management system. At its core, the ESP32 microcontroller processes data from various sensors and facilitates seamless communication with the Blynk app, which enables users to monitor and control the system remotely. Upon powering up, the system establishes a Wi-Fi connection and connects to the Blynk server using the necessary authentication token. Once connected, it allow users to view real-time data and manage aquaculture operations through an intuitive mobile interface.

The system uses a range of sensors, each tasked with monitoring critical aspects of the aquaculture environment. The Dallas Temperature Sensor (DS18B20) plays a crucial role by ensuring precise monitor of water temperature. Maintaining an optimal temperature is vital for the health and growth of the fish, and this sensor continuously measures water temperature, providing real-time updates. The Turbidity Sensor Module (AB147) is another key component, monitor the clarity of the water. It detects changes in water quality, which can indicate issues such as contamination, algae blooms, or waste buildup, helping prevent harm to aquatic life. The Water Level Sensor Universal ensures stable water levels, allowing the system to track and maintain the ideal volume for fish farming.

Through the integration with the Blynk app, the FishHaven system offers enhanced interactivity. Users can set thresholds for each sensor, receiving notifications whenever conditions fall outside the desired range. This real-time monitoring provides immediate alerts, enabling swift corrective actions to maintain a stable and healthy environment for the fish. Virtual Pins in the Blynk app provide remote control, allowing users to activate specific features or adjust settings based on real-time conditions. Overall, the FishHaven project is designed to simplify aquaculture management, offering farmers a reliable and automated solution to optimize fish farming operations while promoting sustainability and efficiency.

2.3 HARDWARE AND SOFTWARE INTEGRATION

The FishHaven system seamlessly combines advanced hardware and software to create a smart aquaculture management solution. The ESP32 microcontroller acts as the system's core, integrating key sensors like the Dallas Temperature Sensor (DS18B20), Turbidity Sensor Module (AB147), and Water Level Sensor Universal. These sensors monitor critical parameters, including temperature, water clarity, and level, providing real-time data for maintaining optimal conditions.

The system connects to the Blynk app via Wi-Fi, enabling users to remotely monitor and control operations through an intuitive interface. Users can set thresholds for sensors, receive alerts for abnormal conditions, and adjust settings using Virtual Pins. This integration ensures precise monitoring, efficient data processing, and a user-friendly experience, simplifying aquaculture management while enhancing sustainability and efficiency.

CHAPTER 3

TESTING AND EVALUATION

3.1 TESTING

During the testing phase of the smart fish farming system, the first step was to connect all the sensors, such as Water Level Sensor, DS18B20 Temperature Sensor, and Turbidity Sensor Module to the ESP32 microcontroller. Using the Serial Monitor, the sensor readings were checked to ensure they accurately represented real-world conditions, confirming the system's ability to collect reliable data.

The next step was testing the Wi-Fi connectivity and Blynk platform integration. This included verifying that the system could connect to a Wi-Fi network and reliably send data to the Blynk app. Connection status, signal strength, and data transmission were closely monitored to ensure stable communication. The Blynk app was also tested for its ability to display real-time sensor data, send notifications when certain thresholds were exceeded, allowing users to control the threshold value for each sensor. and allow users to control features like turning on LED lights.

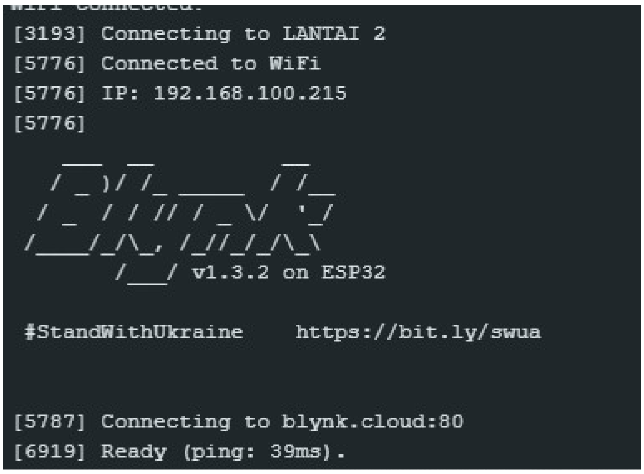

Fig 3.1.1. Blynk Connection Test

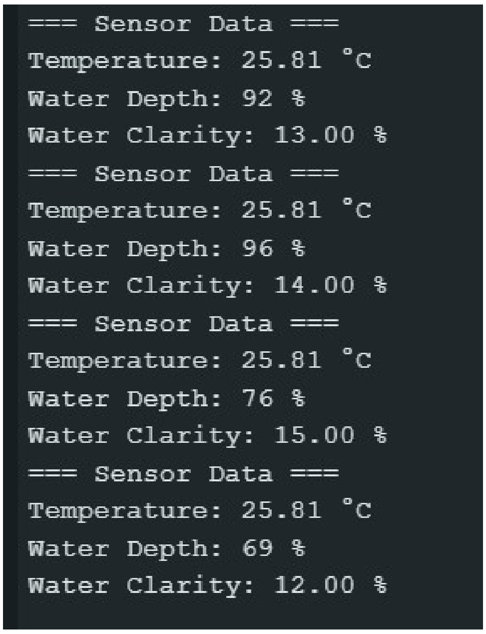

Fig 3.1.2. Sensors Reading Test

One of the key features tested was the notification system. The system was configured to send alerts through the Blynk app whenever a sensor reading crossed a preset threshold. For instance, if the water temperature exceeded a safe range or the turbidity levels became too high, a notification was triggered, enabling users to take immediate action.

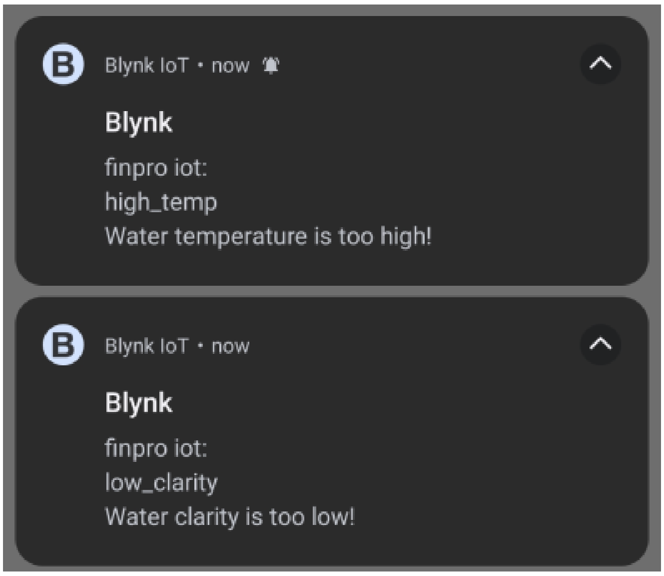

Fig. 3.1.3. Notifications Test

Another feature tested was the threshold control functionality. Through the Blynk app, users could adjust the threshold values for each sensor based on their specific requirements.

This feature was evaluated to ensure that changes made through the app were correctly implemented in the system and that the notifications responded accurately to the updated thresholds.

```
=== Sensor Data ===
Temperature: 25.87 °C
Water Depth: 19 %
Water Clarity: 52.00 %
Updated Min Clarity: 40.00
```

Fig. 3.1.4. Set Threshold Test

These testing steps demonstrated the system's reliability and effectiveness, from collecting accurate sensor data to sending timely notifications and allowing user customization through the Blynk app. This solid foundation ensures that the system meets user needs and supports further refinements.

3.2 RESULT

The results of the testing phase indicate that the system functions as intended with reliable sensor reading, data collection, communication, and user interaction. In Fig. 3.1.1, it can be seen that the sensor readings from Water Level Sensor, DS18B20 Temperature Sensor, and Turbidity Sensor demonstrated high accuracy, closely reflecting real-world conditions. The Wi-Fi connectivity and Blynk platform integration were also successfully validated, as shown in Fig. 3.1.2, thus the system relies on a seamless interaction between the ESP32 (Blynk Device), the cloud server (Blynk Cloud), and the user interface (Blynk App). The threshold control functionality, displayed in Fig. 3.1.3, allows users to adjust the sensor threshold from the Blynk app.

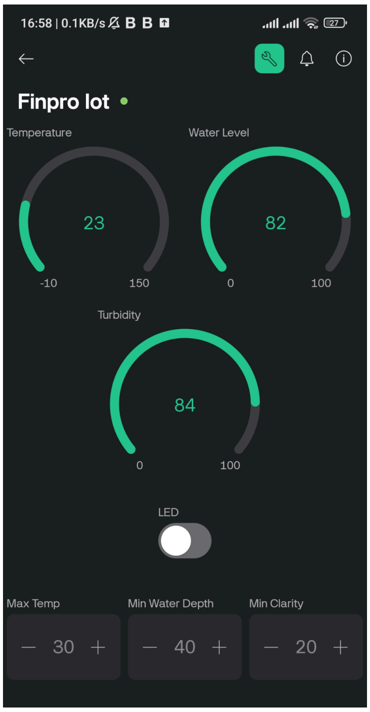

Fig. 3.2.1. User interface (Blynk App)

The user interface that's provided by the Blynk App allows users to see sensors reading in real-time, turn on/off LED lights, and set sensor threshold. For displaying sensor reading, we use a gauge display that provides visual and numerical representation. Each gauge is configured to show the current reading from a specific sensor, such as water temperature, turbidity, or water level. Additionally, we use a switch to toggle the LED on/off and numeric input to set the sensor threshold by entering a number or clicking the plus or minus icon.

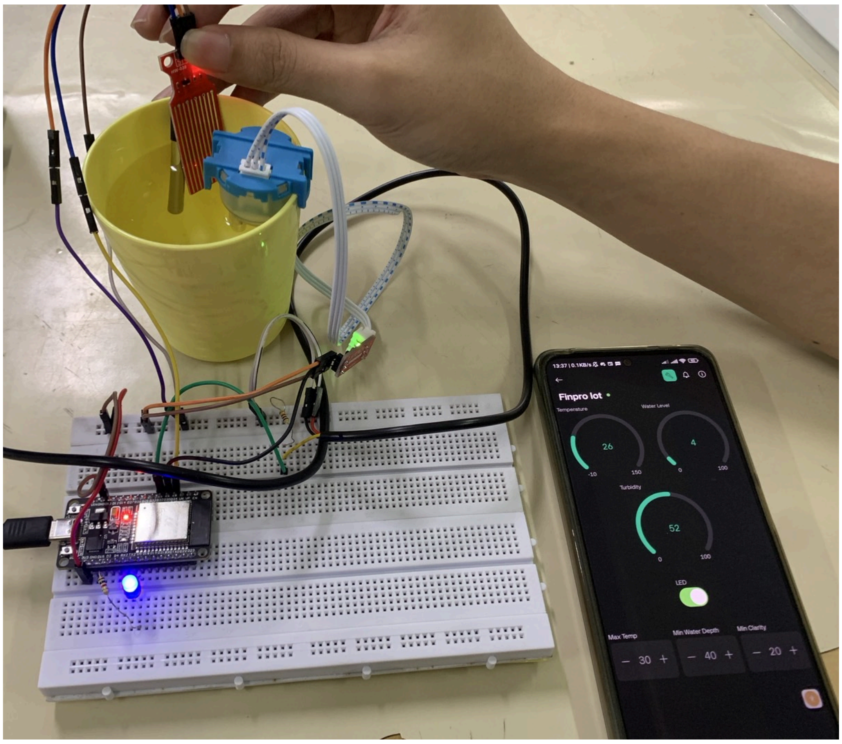

Fig. 3.2.2. Final Assembly

In the physical assembly, we put all the components together mounted on a breadboard, connected to multiple sensors for monitoring water conditions. The breadboard is used for assembly and providing a platform to connect the ESP32 with the sensors and other components. We also make sure that the wires are connected appropriately to ensure stable communication between components. The Blynk App, can be seen on the smartphone display showcasing real-time data such as temperature, turbidity, and water-level. From the app, users can turn on/off the LED lights, adjust sensor threshold, and receive notifications.

3.3 EVALUATION

During FishHaven's testing, the integration of Water Level, Temperature, and Turbidity sensors with the ESP32 was verified, ensuring accurate data outputs via the Serial Monitor. Wi-Fi connectivity and Blynk integration were also tested, confirming reliable data transmission and a user-friendly interface. There were failures, particularly with the DS18B20 temperature sensor, which sometimes failed to provide accurate readings. Simulated tests using Wokwi revealed that the issue was hardware-specific. However, more sensors and features could be added in order to bolster fish farming. PH sensors could be added and also other features such as an automatic fish feeder. With this evaluation, a more complete system can be developed to bolster efficient and save fish farming.

CHAPTER 4

CONCLUSION

The FishHaven project has successfully laid the groundwork for a smart, IoT-driven aquaculture management system. By integrating the ESP32 microcontroller with essential sensors for water level, temperature, and turbidity, the system effectively delivers real-time monitoring of critical parameters. This data is transmitted to users through the Blynk platform, enabling remote management and immediate insights into the aquatic environment. The testing phase demonstrated the system's ability to establish stable Wi-Fi connectivity, maintain seamless communication with the Blynk application, and provide user-friendly access to sensor data. These achievements highlight the system's practicality and reliability for modern fish farming needs.

There were failures, particularly with the DS18B20 temperature sensor, which sometimes failed to provide accurate readings. Simulated tests using Wokwi revealed that the issue was hardware-specific, as the sensor performed correctly in virtual environments. This learning will guide future iterations of the project, ensuring higher reliability and robustness in hardware integration.

For future work, the next phase of FishHaven's development will focus on enhancing its functionality through the introduction of an automated feeding system. This feature will utilize a servo-driven mechanism or similar technology to dispense precise amounts of feed at scheduled intervals. By automating this critical aspect of fish farming, the system aims to reduce manual labor, optimize feeding efficiency, and promote healthier aquatic life. Additional improvements, such as refining sensor calibration, expanding remote control capabilities, and integrating more advanced analytics, will further elevate the system's utility.

REFERENCES

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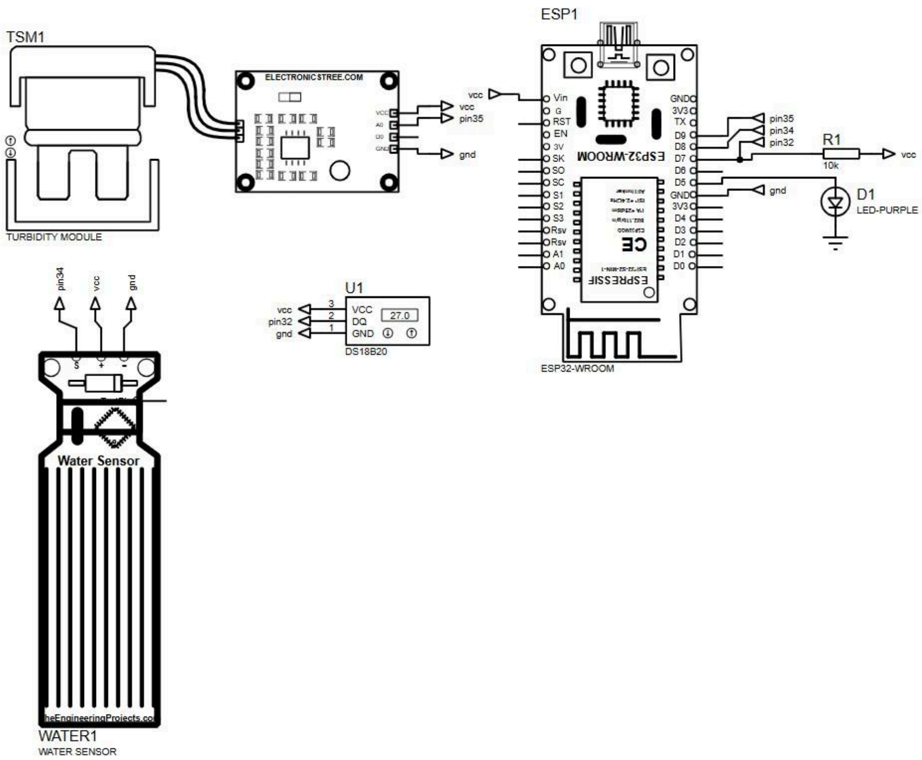
APPENDICES

Appendix A: Project Schematics



Appendix B: Documentation