Faculty of Information Technology

PROJECT Water Wise: Your Smart Water Companion

Group No: 07

Index number Name with initials

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Introduction

- Water scarcity, quality, and management are critical issues that communities around the world face, particularly in regions like Sri Lanka. The Smart Water Tank System is a pioneering solution designed to address these pressing challenges by leveraging advanced technologies to provide intelligent water storage solutions. Access to clean and reliable water is a fundamental necessity and this innovative project aims to offer a comprehensive approach to water management.

- By integrating microcontroller technology, sensors, and electronic components, the Smart Water Tank System delivers real-time monitoring and control capabilities, making it an essential tool for modern water management. This integrates advanced technologies to measure water level, assess water quality, and optimize water usage, providing users with a comprehensive solution to their water related concerns and provide real-time monitoring, alerts, and control over water usage, ensuring both conservation and cost-effectiveness.

Problem in Brief

- Sri Lanka, given its varied landscapes as well as climates, faces distinct problems in guaranteeing adequate access to pure water by all its regions. Scarcity of water is a problem faced by some parts of the country due to geographical issues while others experience poor quality water and inefficient supply infrastructure. In addition, there are also concerns about excessive consumption of motor pumps, giving rise to concerns on the issue of wasting water, high cost of living or rather huge bills and usage of unfit for consumption liquid.

- In various regions, the high dependence on unprocessed water mainly fetched from wells using motor pumps increases chances of contracting diseases through water. This examines how inappropriate water consumption is linked to the spread of diseases underlining the importance of effective water quality management. Unpurified may contain different **types of pathogens, bacteria contaminant, agricultural discharge, industrial release, include E-coli bacteria, viruses** or **parasites** and they cause diseases such as **diarrhea, cholera, typhoid** and **gastroenteritis**.
- Many households face a common challenge –Without a system to show us the water level, we might accidentally waste water during scarcity periods. Additionally, there's a **risk of the tank overflowing, causing damage to our property** and **wasting w**ater. Some homes may not even know **if their tanks are refilled after low water levels**. This lack of awareness can result in unintended consequences such as **water wastage, property damage from overflowing tanks, and increased water bills.**

- Water miss management and consumption of polluted water is a major challenge, that country is facing currently. Current market is yet to address this issue with an effective solution. The solutions that are currently present on the market are either too expensive for domestic usage or does not meet the user expectations. But conventional water supply methods and a more responsible and cost-effective approach to water usage has become unavoidable.

Literature Survey

Embarking on our literature study, we move into a world where the Internet of Things (IoT) and smart home technology merge, opening up a realm of possibilities for our project. In this research, we aim to understand the key principles and innovations that make homes smart and connected. Using existing research, we hope to understand the mechanisms by which this technology improves our daily lives. Our focus is not just on convenience but also on how this smart synergy can benefit water management. As we navigate through the literature, we seek insights to inform the development of our Smart Water Tank System, envisioning a future where simple, interconnected technologies contribute to more efficient and sustainable living.

Smart Water Tank System Project literature survey includes insights into relevant research areas related to water management, Internet of Things (IoT), and similar projects for integration into water systems, revealing the role of sensors, connectivity, communication, and data analytics in efficient water resource monitoring and of the major features, provides insights into challenges and innovations. Furthermore, research on the use of microcontrollers used in water-related projects clarifies the contribution of automation, control systems, and data role in water management issues.

Delving deeper into water quality monitoring, the literature explores the use of turbidity sensor and their importance in water quality assessment. Solenoid valves in water supply systems and their role in controlling water flow, preventing overflow and ensuring efficient use of water are discussed.

Ultrasonic sensor examines the real-time water level in the main tank and in small tank, enabling automated control of water pumps and solenoid valves based on known water levels. The water level sensor in this project is used to continuously monitor the real-time water level in the main tank. And water flow sensor examines and calculate the daily usage of water.

Dedicated research into power storage solutions for IoT-based systems includes research into challenges and possible ways to ensure continuity of service, especially for immovable power systems.

The study of the literature extends beyond technical aspects, including community-based water management. These projects exemplify how technology empowers communities to better management of water resources, providing valuable insights into the potential social impacts of smart water storage system.

Aim & Objectives

Aim: The objective of this project is to design, manufacture and deploy intelligent water storage systems that use microcontroller technology, sensors and electronic components to provide intelligent, a user-friendly website to monitor and easy-to-use solutions for water conservation.

Objectives:

- **Real-Time Water Level Monitoring:**
  An objective would be the goal to implement sensors for continuous water level monitoring, ensuring accuracy and real-time updates.
- **Water Quality Assessment:**
  The objective would be to integrate sensors for assessing water turbidity, providing insights into the water's suitability for various purposes.
- **To achieve Intelligent Control Mechanisms:**
  The objective is to develop and implement automated controls that intelligently manage the water pump, preventing overflow and optimizing water usage based on user-defined limits.
- **User-Defined Usage Limits:**
  The objective is to enable users to set personalized limits for water usage and implement a system that alerts users when these limits are approached or exceeded, so that users can maintain the units used and control excess bill.
- **Refill Alerts:**
  Hoping to Implement a notification system to inform users when the water tank has been refilled after reaching a low level.
- **Website:**
  Will be showing how much water is in the tank, displays the turbidity level of water, and even displays how much water you've been using. So, users can easily keep an eye on everything and make sure they are using water wisely. It's all about making life simpler and cooler

Analysis and design

1. Proposed Solution

Features of the Proposed Solution:

- **Water Level Measurement and Usage Alert:** This feature likely involves sensors to measure water levels in tanks or reservoirs. Users may receive alerts based on their water usage or when levels reach critical points.
- **Water Quality Assurance:** This feature suggests a mechanism to ensure the quality of the water being used, possibly through monitoring and reporting on turbidity level, Notification System: Implement an alert mechanism that notifies users or relevant authorities in case of water quality issues, ensuring prompt response. And here when the sensor sense low turbidity of water the solenoid valve will be closed automatically and the motor will be switched off.
- **Reducing Water Bills:** This feature implies the inclusion of tools or insights that help users identify ways to reduce water consumption by controlling and reducing unwanted overflow of water and customizing the units to be used for a day, which will lead to lower water bills
- **Sustainable Water Management:** Resource Optimization: Design the hardware to support data-driven decision-making for water management, encouraging users to adopt sustainable practices.
- **Automated Alerts:** This feature suggests an automated notification system to keep users informed about various aspects, such as water levels, quality issues, refilling or daily usage.
- **Affordable and Scalable Solution**: Modular Design: Develop a modular hardware architecture that allows for easy scalability, enabling users to expand the system to accommodate additional sensors or users as needed
- **Website:** displays water level, quality, usage level

2. Block Diagram

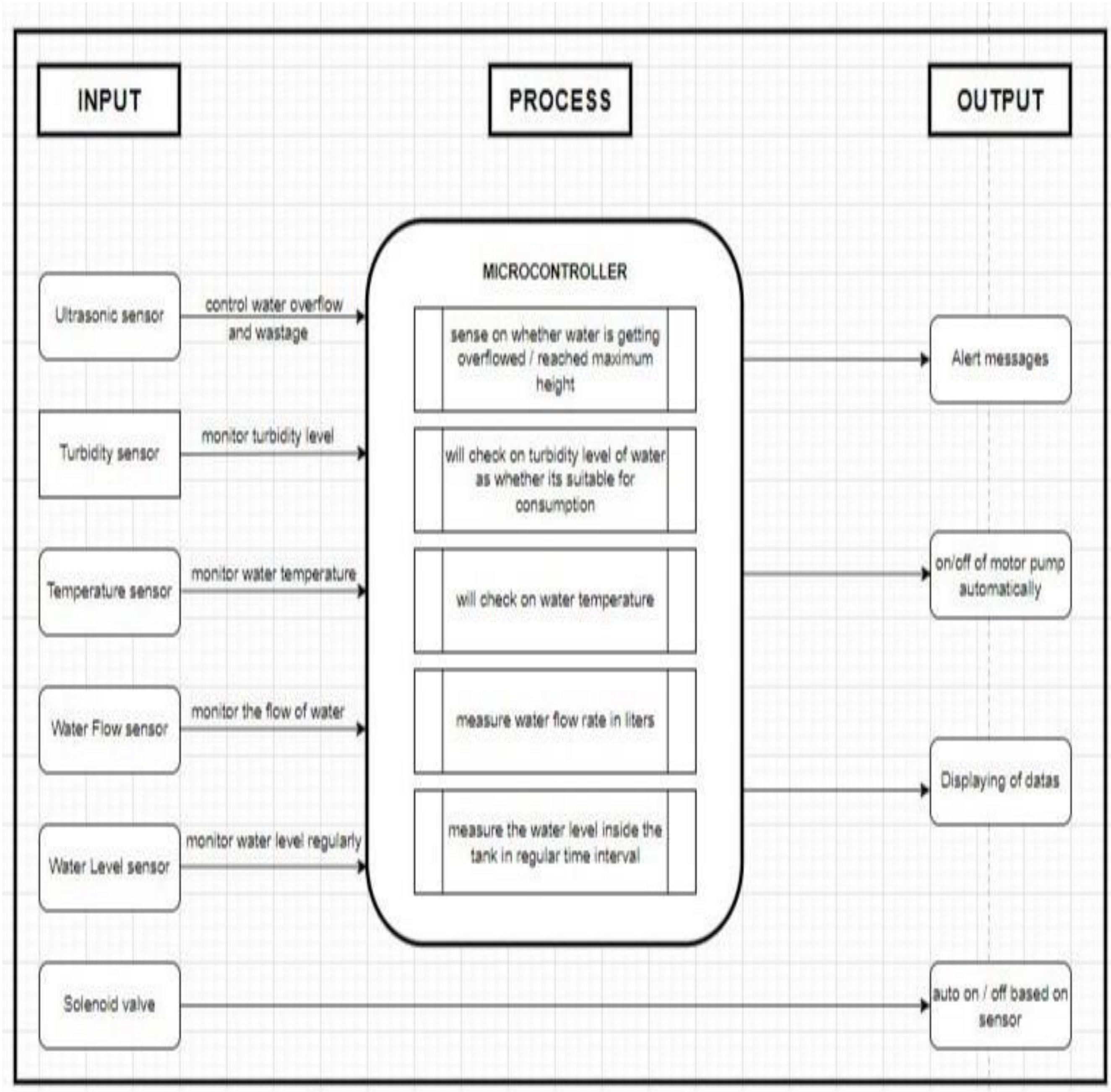

Figure 1 - Block Diagram

3. 3D diagram

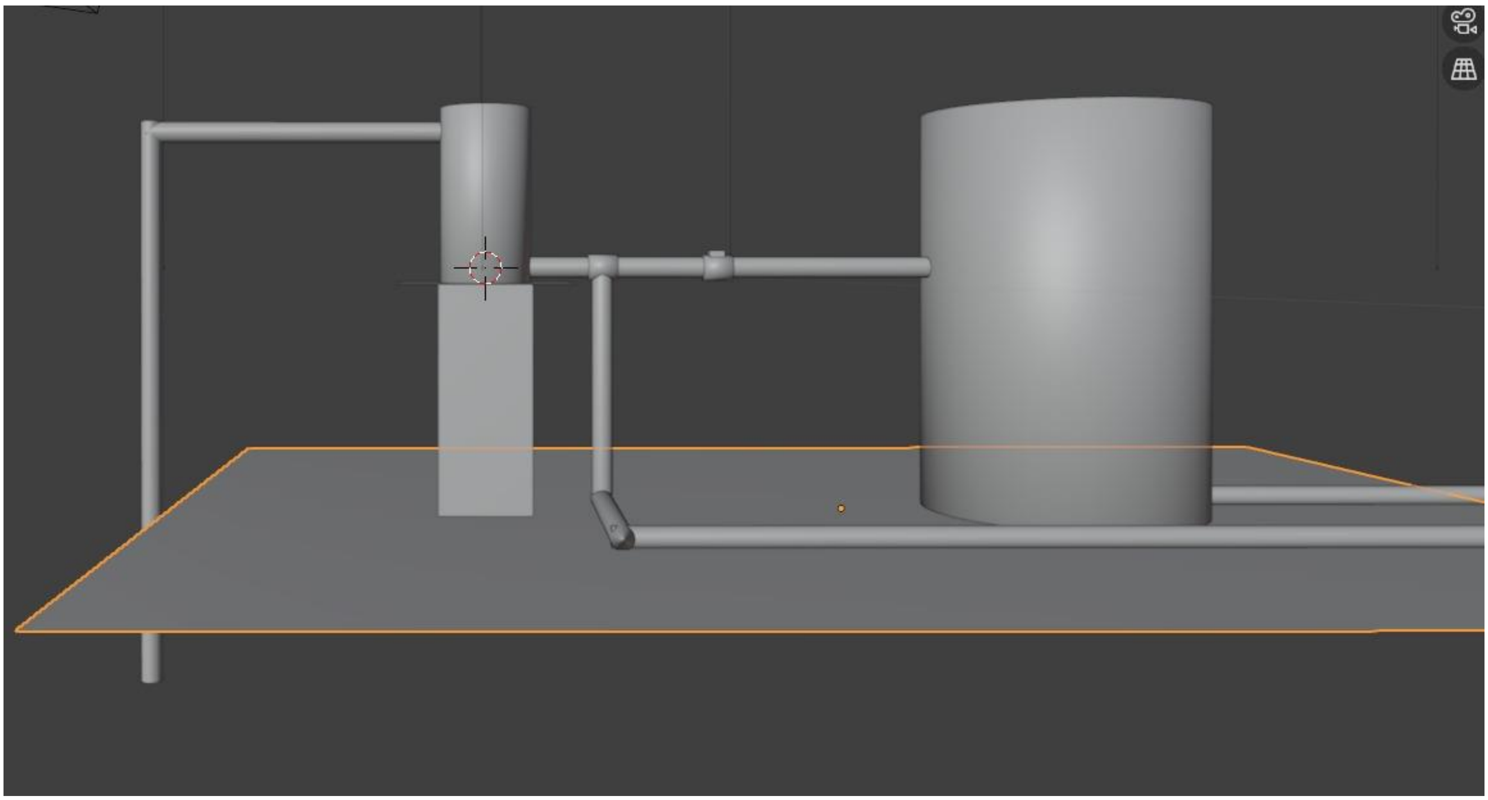

Figure 2 – 3D Diagram

4. Schematic Diagram of the System

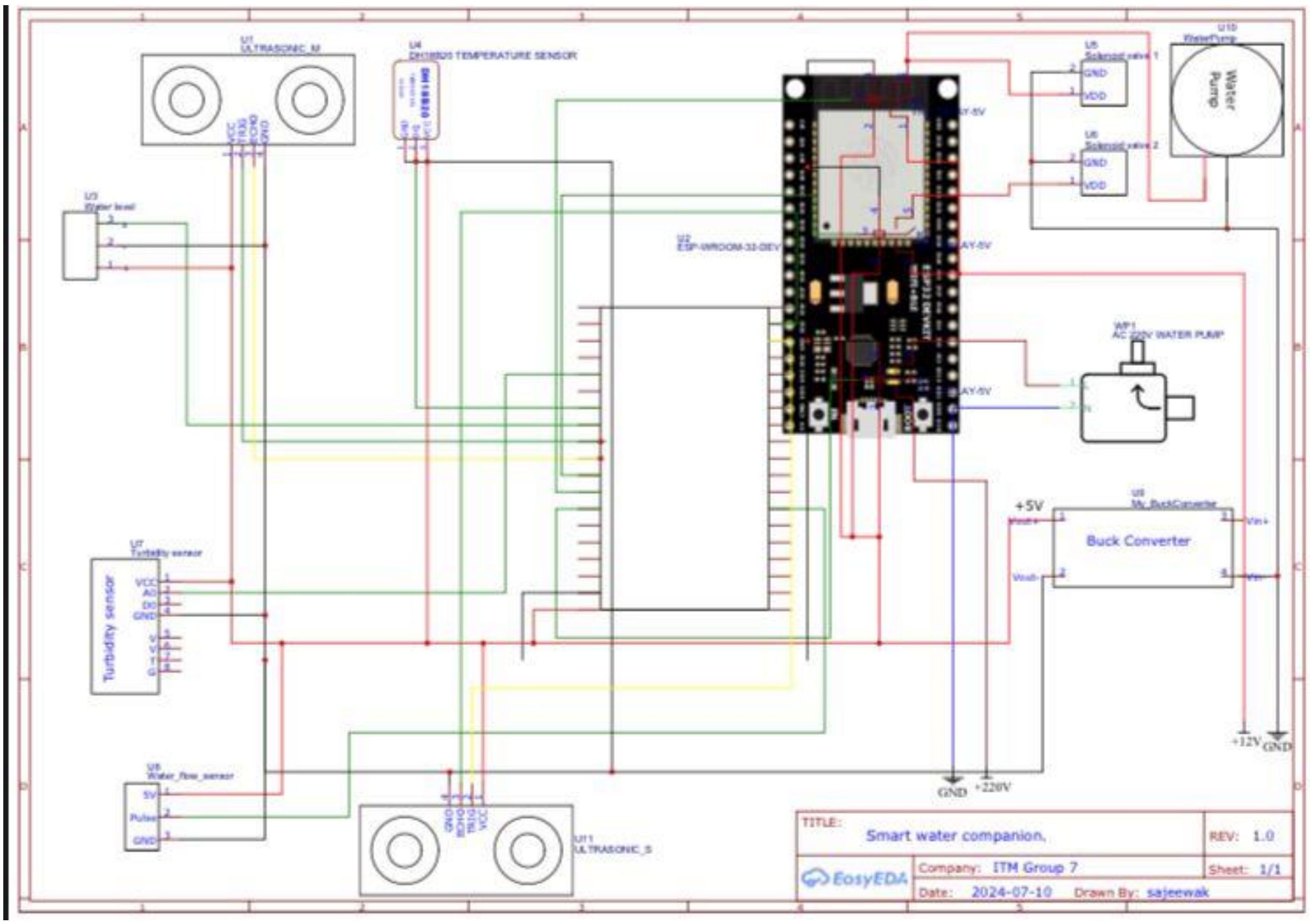

Figure 3 – Schematic Diagram

5. PCB Design of the System

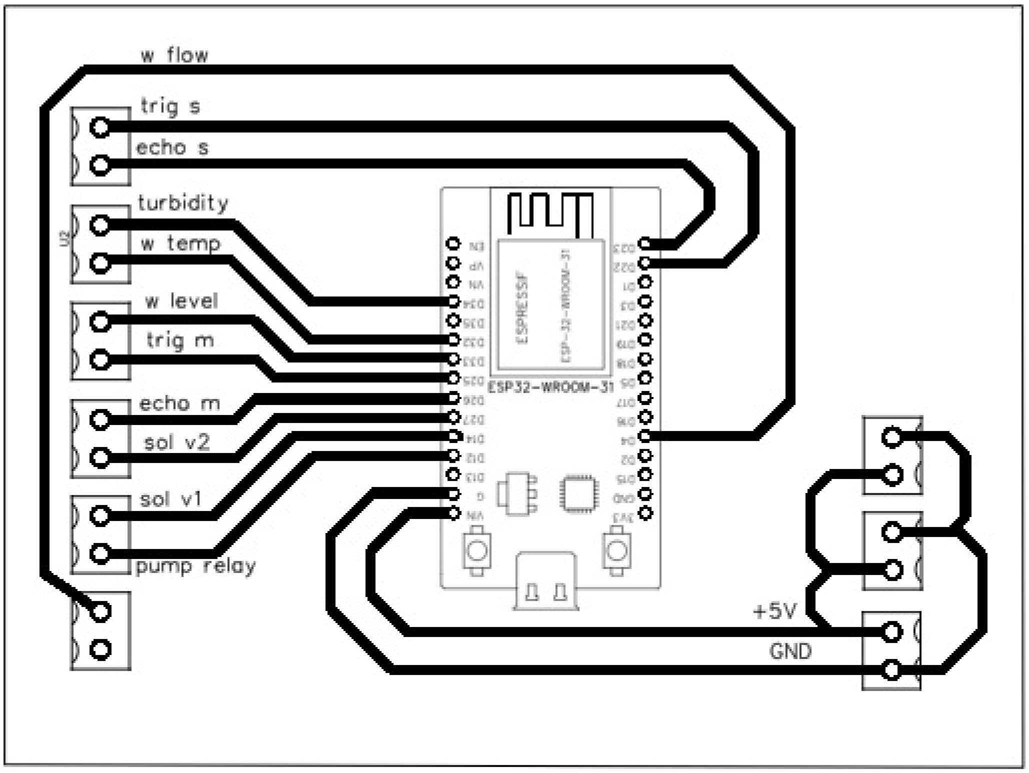

Figure 4 – PCB Diagram

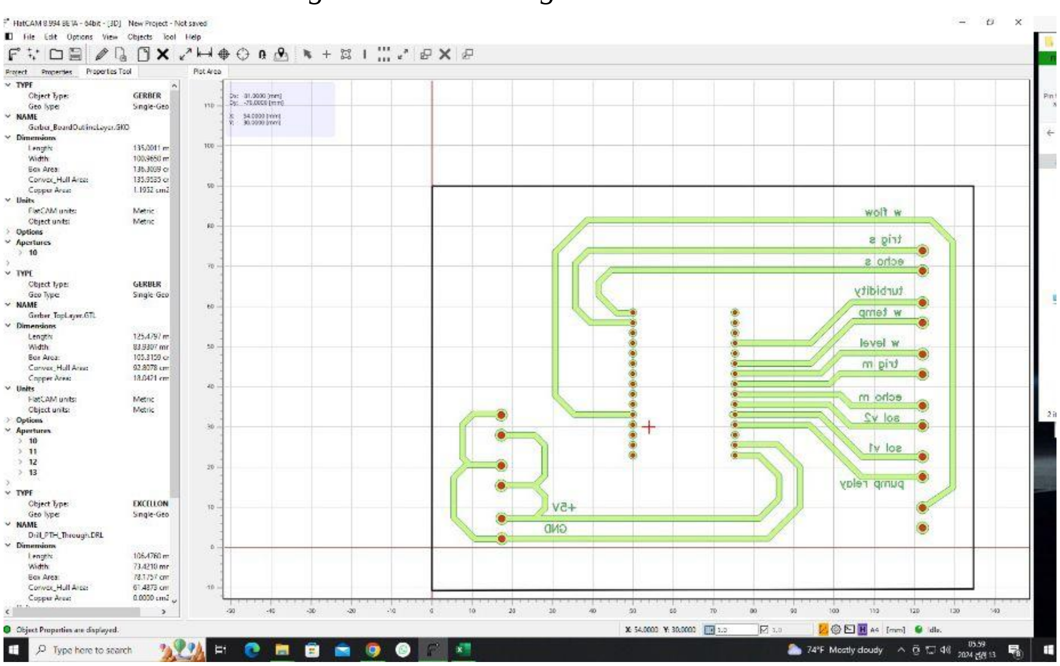

Figure 5 – PCB Diagram

5. User Interface of the Web page

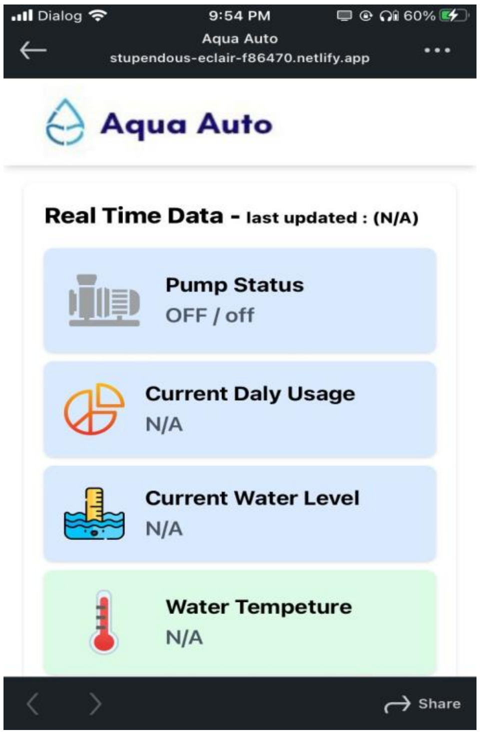

Figure 6 – User Interface

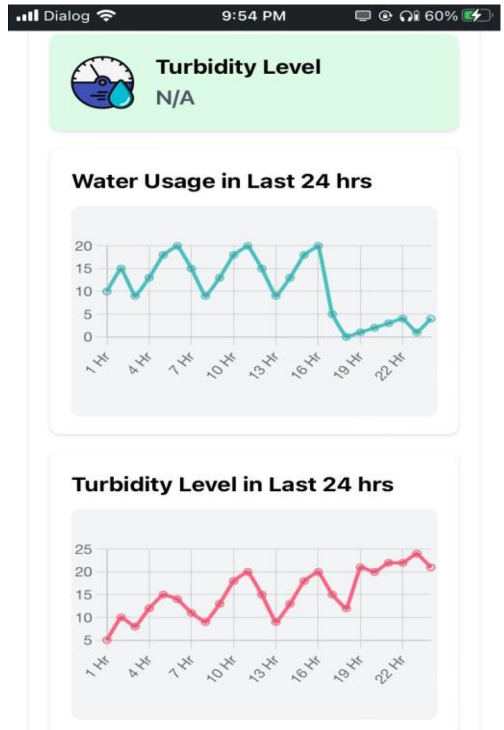

Figure 7 – User Interface

Figure 8 – User Interface

Resource Requirement & Technologies used

1. Hardware component

1. NodeMCU ESP32S Wi-Fi Bluetooth Dual Mode IoT Dev Board
2. Ultrasonic sensor
3. Turbidity sensor
4. Water flow sensor
5. Temperature sensor
6. Water Level sensor
7. Solenoid valve – 2
8. 220V Water Pump Motor
9. Backup power supply
10. Relays modules
11. AC to DC power adapter
12. Jumper wires
13. 12v to 5v converter
14. Breadboard
15. Circuit wires
16. Container

2. Software used

Figure 9 – Arduino

Figure 10– Firebase

Figure 11 –

– User Interface

EasyEDA

Components

1. Node MCU ESP32S – Microcontroller

The ESP32 board, equipped with 30 pins, serves as a centralized microcontroller in various applications due to its robust features and versatility. Developed by Espressif Systems, the ESP32 is a low-cost, low-power system on a chip (SoC) with integrated Wi-Fi and dual-mode Bluetooth capabilities. Its powerful dual-core Xtensa LX6 microprocessor, clocked up to 240 MHz, and 520 KB of on-chip SRAM make it capable of handling multiple tasks simultaneously. Additionally, it includes 4 MB of flash memory, which is expandable, providing ample space for data storage and application code.

Figure 13 – Node MCU ESP32S

Usage in project:

For smart tank systems, the ESP32 board acts as a central microcontroller, interfaces with sensors and components to efficiently manage water resources. It is connected with ultrasonic sensors for real-time water level measurement, turbidity sensors for water internal clarity checks, temperature sensors, solenoid valves, water flow sensors, and other important components. ESP32 processes data from these sensors, the water pump and solenoid valve to automate the operation. This ESP32's built-in Wi-Fi and Bluetooth capabilities make it easy real -time management and control via a web-based dashboard and ensures that the system can operate smoothly even in battery-powered environments, making it ideal for intelligent storage systems.

2. Ultrasonic sensor

Figure 14 – Ultrasonic sensor

Ultrasonic sensors are versatile devices widely used for remote measurement, object detection, and level monitoring in various applications. The module has an ultrasonic transmitter and receiver. The HC-SR04 ultrasonic sensor uses sonar to determine the distance to an object, like bats or dolphins do.

Ultrasonic Ranging Module HC-SR04 provides 2 cm–400 cm non-contact distance sensing capabilities and ranging accuracy up to 3mm. Operating voltage: +5V

Usage in project:

This project uses ultrasonic sensors to monitor the water level in the large and small tanks. By emitting ultrasonic waves and the time it takes for the echo to return, these sensors provide an accurate measurement of the distance from the sensor to the water surface This information is critical for water level determination and ensure proper functioning of the system. For example, if the water level in the main tank drops below a certain limit, the system can automatically activate the water pump and refill it. Similarly, if the water level in a small tank reaches a critical limit, the system can trigger an alert and take necessary measures to prevent damage The non-contact nature of ultrasonic sensors makes them ideal for this application.

3. Turbidity Sensor

Turbidity sensors are important devices for measuring the turbidity, usually of water, due to the presence of suspended particles. These particles can be sediment and microbes. Turbidity sensors work by reflecting a light into water and measuring the intensity of scattered light by particles.

Figure 15 –Turbidity sensor

- Working voltage: DC5V
- Operating Current: 30mA (MAX)
- Response time: 500ms

Usage in Project:

This project measures turbidity level and uses a turbidity sensor to evaluate water clarity and quality, which indicates the suspended particulate matter concentration. This sensor works by transmitting light to the water to detect the light level of particles content scattered. High turbidity levels indicate poor water quality with high suspended solids. If a turbidity sensor detects water with a turbidity above preset limits, the system can take appropriate action, such as sending an alert to notify users of water quality in addition to a water pump closure to prevent delivery of contaminated water into the system, increasing reliability and performance.

4. Water Flow sensor

Flow sensors are important devices for measuring the rate and quantity of water flowing through the system. They are typically operated by sensing flow through pipes, usually using a rotor or turbine mechanism. This product is light and flexible in appearance, small in size and easy to install. Rated operating voltage-DC4.5 5V-24V

Figure 16 – Turbidity sensor

Usage in Project:

This project uses a flow sensor to monitor the flow of water through the system. This sensor detects the flow rate and measures the speed at which water flows through the pipe, usually using a device that involves a rotor with embedded magnets that rotate as it flows past water , and consistent system performance is important. In addition, flow data can be imported into the database and displayed through the front-end interface, providing users with real-time insight into their water management system

5. Temperature Sensor:

A temperature sensor is a device that detects and measures heat energy or cold from a material or environment, converts temperature changes into electrical signals These sensors are important in a wide range of industries including industrial processes, materials including environmental monitoring and electronics

Figure 17 –Temperature sensor

Usage in project:

In this task, the temperature sensor plays a key position in monitoring the water temperature in the gadget. Specifically, a temperature sensor like the DS18B20 is used to correctly measure the temperature of the water, ensuring it remains in the favored range for secure and green operation. The temperature data gathered with the aid of the sensor is continuously monitored. Additionally, the temperature readings are dispatched to a database and displayed on a frontend interface, presenting customers with real-time insights to make knowledgeable selections and hold premiere water situations.

6. Water Level Sensor

Water level sensor is an easy-to-use, cost-effective high level/drop recognition sensor, which is obtained by having a series of parallel wires exposed traces measured droplets/water volume in order to determine the water level.

- Operating voltage: DC3-5V
- Operating current: less than 20mA
- Sensor Type: Analog

Figure 18 –Water level sensor

Usage in Project:

This project mainly uses the water level sensor in the main tank to monitor the water level in real time. The sensor provides continuous and accurate water level measurements, which are critical for system operation. This ensures that the main reservoir maintains adequate levels of water always. By monitoring water levels in real time, the sensor helps prevent issues such as tank overflow or water shortage, thereby increasing system reliability and performance. Information returned by sensors is collected into a database and displayed through a front-end interface

7. Solenoid Valve

Figure 19 – Solenoid valve

Solenoid valves are devices that use electricity to control the flow of liquid to create a magnetic field that opens or closes the valve Known for its quick timing, reliability and ease of assembly, solenoid valves are commonly used in many systems.

This project uses solenoid valves to control the flow of water between large and small tanks. They operate based on real-time sensor data, allowing for precise flow control.

For example, if the system determines that a small tank needs to be emptied due to high turbidity levels or other conditions, solenoid valve 1 is activated to remove the water and solenoid valve 2 is used to fill the main tank with fresh water when needed. The integration of the solenoid valve ensures system efficiency and automatic operation, maintaining efficient water management throughout the process.

8. 220V Water Pump Motor

Figure 20 – Water pump

A 220v submersible water pump is an efficient and powerful machine used mainly in applying water in various fields such as domestic water system, agricultural, and industrial use. Due to being directly connected to a220V power line, these pumps have a great capacity and efficiency in pumping large amounts of water.

Here in the project, the 220V water pump motor is applied to boost the low pressure of the solenoid valves, which could otherwise slow down water transfer.

Since the pump is added, the system is able to transfer water from one tank to another, and back, more rapidly, making the procedure quicker and improving the entire system overall. Water management is handed over the system and its operation is made efficient in that the pumps are activated and controlled based on the preset operational transformation.

9. Relays modules

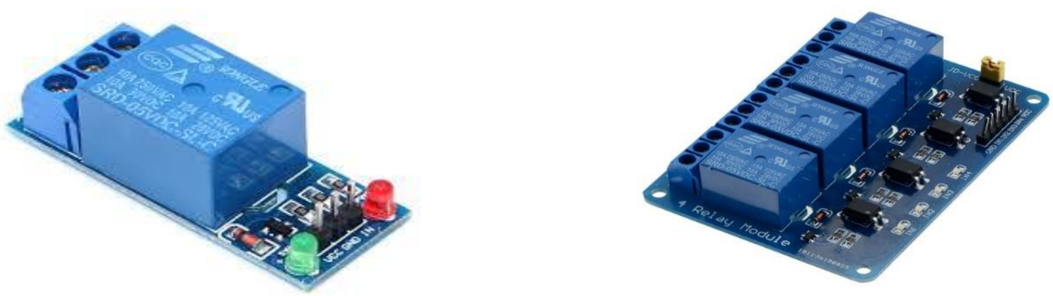

Figure 21 – relay modules

5V 4-channel relay interface board and each channel needs a 15-20mA driver current. It can be used to control various appliances and equipment with a large current.

It is equipped with high-current relays that work under AC250V 10A or DC30V 10A. It has a standard interface that can be controlled directly by the microcontroller. This module is optically isolated from the high voltage side for safety requirements and also prevents ground loop when interfaced with the microcontroller.

In this project, the relay module plays an important role in controlling the 220V water pump motor and solenoid valve. The relay acts as an electronic switch, allowing a low-power microcontroller to safely control these high-power devices. When the system detects that the water level in the main tank is below a certain threshold, a relay module is activated to energize the water pump, ensuring that the tank is refilled as well as fed by the relay module function to control solenoid valves and control the flow between system components.

10. AC to DC power adapter

AC to DC power adapters are an important device that converts alternating current (AC) from the mains power supply to direct current (DC) required by electronic components. These adapters ensure that the sensitive electronics receive a stable and adequate voltage, protect them from tampering and ensure reliable capacity for continuous operation.

Figure 22 – AC to DC power adapter

The project uses an AC to DC power adapter to power the ESP32 microcontroller, sensors, and other low voltage components, check for proper and safe operation High-voltage AC input Required DC. Turning to level, the adapter provides seamless integration of various electronic modules, such as water level sensor, turbidity sensor, ultrasonic sensors, relay module and additionally ensures system stability and operation, even during 220V water pump motor by the relay module and solenoid valves and other high voltage devices are controlled.

In order to maintain the reliability and robustness of the entire plumbing system it is necessary to use an AC to DC power adapter, which it provides a reliable source of energy that supports monitoring and maintenance of various aspects of the project.

11. 12v to 5v converter

An AC to DC power adapter is a device that converts alternating current (AC) from a wall outlet to direct current (DC) suitable for powering electronic devices.

This adapter is necessary to provide adequate voltage and current for products requiring DC to low-power electronic devices.

Figure 23 – 12v to 5v converter

This project uses an AC-to-DC power adapter to provide stable and reliable power for microcontroller, sensors, relay modules, and other DC-powered components by converting AC power from the supply to the appropriate DC voltage, the adapter ensures proper and continuous operation of all electronic components in the system. This is necessary to the performance and reliability of automated water management systems have been maintained, as they provide the power required for control logic and sensor operation

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Testing and Implementing

Figure 24 – Testing & Implementing

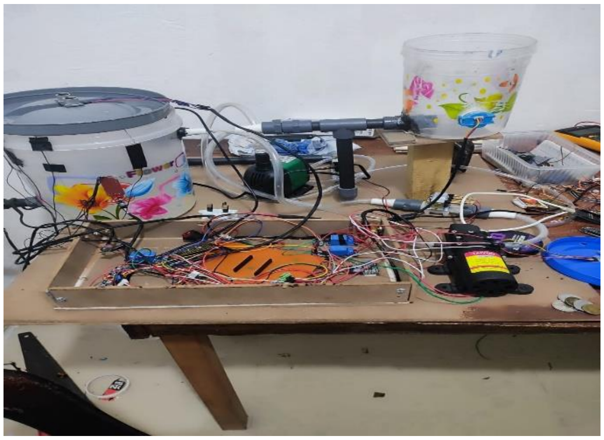

Figure 25 – Testing & Implementing

Figure 26– Testing & Implementing

Figure 27 – Testing & Implementing

Figure 88 – *Testing & Implementing*

Figure 29 – *Testing & Implementing*

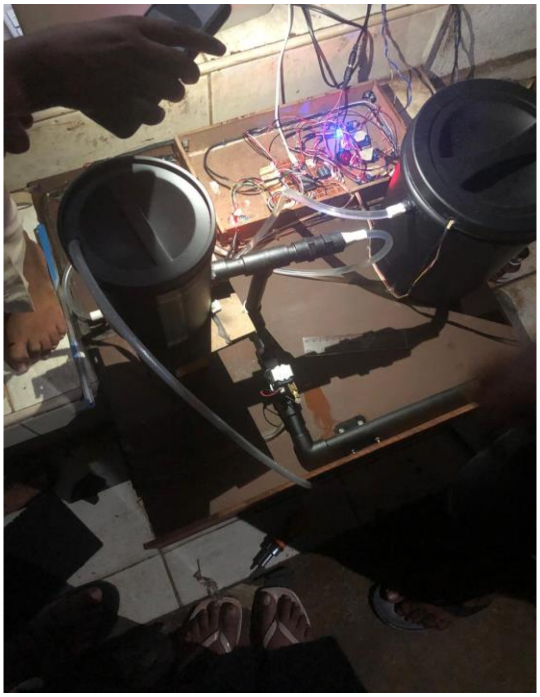

Figure 30 – *Testing & Implementing*

Figure 31 – *Testing & Implementing*

Budget

Component	Quantity	Unit price (Rs)	Amount (Rs)
Node MCU ESP32S	1	1480.00	1480.00
Ultrasonic sensor	2	260.00	520.00
Temperature sensor	1	350.00	350.00
Water level sensor	1	1800.00	1800.00
Turbidity sensor	1	4350.00	4350.00
Water flow sensor	1	600.00	600.00
Solenoid valve	2	850.00	1700.00
220V Water Pump Motor	1	1900.00	1900.00
Relay Modules	3		840.00
AC to DC power adapter	1	1500.00	1500.00
12v to 5v converter	1	850	850
Container	2	500.00	1000.00
Level shifter	1	200.00	200.00
Jumper wires, breadboard			600.00
Pipes, sockets and other			3000.00
Miscellaneous			3000.00
TOTAL			

Table 01

Individual Contribution

INDEX NO	NAME	CONTRIBUTIONS
225050M	Sajeewa Karalliyadda	• Connecting DC Converter • Water Level Sensor : ✓ Interfacing the sensor with ESP 32 microcontroller ✓ Measuring the water level • Establishing 3.3 to 5V level shifter • Designing PCB • Building overall structure
225075T	T.M.A Muski	• Water flow sensor : ✓ Connecting the sensor with ESP 32 microcontroller ✓ Measuring the water flow rate • Connecting 220v AC water pump • Relay Module • Building overall structure
225039M	Hiba A.R	• Temperature Sensor : ✓ Connecting the sensor with ESP 32 microcontroller ✓ Measuring the Temperature of water • Connecting Solenoid valve to the system and coding • Backend of the web • Building overall structure

225101X	S.T.S Senadheera	• Turbidity Sensor : ✓ Interfacing the sensor with ESP 32 microcontroller ✓ Measuring the Turbidity level and cleanliness of water • Created Frontend of the website • Building overall structure
225103F	S.M.R.D Senavirathna	• Ultrasonic Sensor: ✓ Interfacing the sensor with ESP 32 microcontroller ✓ Controlling water level and pumping based on sensor reading • Created Frontend of the website • Building overall structure

Table - 02

1. Sajeewa Karalliyadda [225050M]

The task of assembling the 12V-5V DC converter was one of my main responsibilities in this project. I ensured that the converter provided stable power to the microcontroller and other low-power components, enabling efficiency throughout the system.

In addition to it, I was responsible for studying the water level sensor and programming it accordingly with ESP32 microcontroller. This required an in-depth analysis of sensor operation and calibration, followed by the writing and testing of codes for accurate real-time monitoring of water levels in the large reservoir

I also helped build the physical architecture of our proposed solution, ensuring that all hardware components including sensors, valves and pumps were safely and efficiently installed in the system.

Another important responsibility was the planning and designing of PCB for the project, where I translated the circuit plan into action. After making on the printed circuit board layout, ensuring proper connections, and reducing distracting noise.

Furthermore I worked on implementing a 3.3V to 5V level shifter to facilitate connections to various components that operates at different voltage levels, throughout the system, ensuring reliable data transfer and control.

And, as a leader, my responsibility included assigning tasks, ensuring timely completions, ensuring collaboration and alignment with project goals and each of these contributions was necessary to get the job done, both in terms of hardware design and system operation.

2. T.M.A Muski [225075T]

Studying the water flow sensor and programming it for integration with ESP32 is one of my main responsibilities in this project. I thoroughly researched the principles of operation of the sensor, such as how it detects the movement of water through its turbine and measures its flow velocity.

After the sensor work, I was responsible for connecting the 220V AC water pump to our project.

Assembling such a powerful component required careful consideration of electrical safety and compatibility with the rest of the system. I checked that the pump specifications met the water installation and pressure control requirements of our project, in particular, due to the limitations of the solenoid valves to automate the pump operation I added a relay module, so that the low-power signals from the ESP32 safely control the high-voltage pump could do.

This automation enabled better flow control.

Building the physical structure of the proposed solution was another important part of my project. I was involved in hardware design and assembly, ensuring that all components from sensors to pump valves were arranged in a way that improved performance and durability.

3. Hiba A.R [225039M]

One of my main responsibilities was to study the temperature sensor and program it to communicate with the ESP32. This required an in-depth analysis of how the sensor worked, making sure it could accurately measure the water temperature and send that information to the microcontroller.

I wrote the necessary code for the ESP32 to read temperature data from a sensor. This was critical for monitoring the condition of the water and ensuring it met performance standards. Testing and calibration were necessary to ensure that the sensor provided reliable data for decision making in the system.

Another major contribution was working with the backend of the website. I focused on creating a robust and efficient interface between the hardware system and the web interface, which enabled real-time data presentation. Ensuring that the data from the ESP32 is properly loaded into the database and properly displayed on the front end is an important part of my backend development role.

Furthermore after checking the water conditions, I developed and implemented the logic of controlling the solenoid valve to drain or send water to the main tank. This automated process required accurate monitoring of the solenoid valve based on sensor readings, ensuring smooth and accurate water flow management within the system.

Additionally, I played a key role in creating the physical design of our proposed solution and I also took the partial responsibility for preparing the final report and presentation for our project.

4. S.T.S Senadheera [225101X]

Studying the turbidity sensor and integrating it with the ESP32 was one of the main responsibilities that I handled in our project. I delved into how the sensor worked and developed the code needed to get an accurate reading.

To ensure sensor data was processed reliably, I combined this into a complete system, so that the ESP32 could automatically respond based on water quality readings.

Another highlight of my contribution was that I designed the frontend of the website.

I focused on creating a user-friendly interface that allowed real-time monitoring and control of the system using React. By incorporating the data from the ESP32, I ensured that users could visually monitor the performance of sensors and parameters such as turbidity levels and flow rates. The design emphasized ease of use, real-time updates and responsiveness, making it available across devices.

Additionally, I played a key role in creating the physical design of our proposed solution and I also took the partial responsibility for preparing the final report and presentation for our project.

5. S.M.R.D Senavirathna [225103F]

The study of the ultrasonic sensor and its integration with the ESP32 was one of my main accomplishments in this project. I carefully analyzed how the ultrasonic sensor worked and used rules to accurately monitor the amount of water in our system.

Another highlight of my contribution was that I designed the frontend of the website.

I focused on creating a user-friendly interface that allowed real-time monitoring and control of the system using React. By incorporating the data from the ESP32, I ensured that users could visually monitor the performance of sensors and parameters such as turbidity levels and flow rates. The design emphasized ease of use, real-time updates and responsiveness, making it available across devices.

I also contributed significantly to the physical design of the proposed solution and I also took the partial responsibility for preparing the final report and presentation for our project.

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