IoT

PROJECT REPORT

ON

"SMART WATER MANAGEMENT SYSTEM"

Department of

Artificial Intelligence & Machine Learning

School of Engineering & Technology (SET)

SANJIVANI UNIVERSITY

2024-2025

CERTIFICATE

This is to certify that the project report entitled,

"Smart Water Management System"

By,

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for the partial fulfilment of the requirements of subject Internet of Things [24UMLOE401], Pune embodies the work done by them under our guidance and supervision in the academic year 2024-25.

Dr. K. N. Wakchaure	**Dr. Devyani Jadhav**
Guide	**Head of Dept**

DECLARATION

We declare that this written submission represents our ideas in our own words; we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated any idea/data/fact/source in our submission. We understand that any violation of the above may cause disciplinary action by the Institute and can also evoke penal action from the sources which have not been properly cited.

Date:-09/05/2025
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ABSTRACT

In many rural areas, water distribution systems are still managed manually, leading to inefficiencies such as water wastage due to tank overflows, delayed supply, and a lack of transparency in water availability. Moreover, the absence of real-time monitoring and quality checks poses serious health risks from contaminated water. To address these challenges, this project presents an IoT-based Smart Water Management System aimed at automating and optimizing water supply processes in villages.

The system uses water level sensors to monitor tank status and control pump operations automatically. Solenoid valves are integrated to manage water distribution, while an ESP32 microcontroller collects sensor data and communicates with Firebase Realtime Database. A mobile application developed using MIT App Inventor allows remote monitoring and control by the admin. The system displays the current water level, pump status, and allows valve operations based on real-time data. Pump 1 is controlled automatically based on tank levels, whereas Pump 2 operates when any of the valves are opened.

This project reduces manual intervention, prevents overflow, and ensures timely and safe water supply. Although features like turbidity monitoring and SMS notifications are part of the future scope, the current implementation successfully demonstrates an efficient and scalable solution for smart village water management.

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ABBREVIATIONS

- **IoT** – Internet of Things
- **ESP32** – Espressif Systems 32-bit Microcontroller
- **GPIO** – General Purpose Input/Output
- **SMPS** – Switched-Mode Power Supply
- **LED** – Light Emitting Diode
- **DC** – Direct Current
- **VCC** – Voltage at Common Collector (Power Supply Pin)
- **GND** – Ground
- **Wi-Fi** – Wireless Fidelity
- **API** – Application Programming Interface
- **URL** – Uniform Resource Locator
- **HTTP** – Hypertext Transfer Protocol
- **UID** – User Identifier
- **MIT** – Massachusetts Institute of Technology (MIT App Inventor)
- **RTDB** – Realtime Database
- **GUI** – Graphical User Interface
- **DB** – Database
- **PWM** – Pulse Width Modulation

CHAPTER 1

INTRODUCTION

1.1 Introduction

Water is a fundamental resource essential for the survival of all living beings. Efficient water management plays a pivotal role in sustaining communities, especially in rural areas where water resources are often limited and difficult to manage. In many rural villages, the water distribution systems are manual, leading to inefficiencies, inconsistent water supply, and potential health hazards due to poor water quality monitoring.

The lack of automation in water management has led to severe issues such as overflowing water tanks due to delayed refilling and shortages when tanks are not refilled on time. In addition, water quality monitoring remains a major concern as contaminated water can often be supplied to households, causing health risks like waterborne diseases. Furthermore, villagers often remain unaware of water availability, making it difficult for them to plan their daily water usage effectively.

The integration of IoT (Internet of Things) in water management offers a promising solution to these issues by providing real-time data, automation, and remote control features. This project proposes a Smart Water Management System, aimed at automating the water distribution process, monitoring water levels, ensuring water quality, and enhancing the overall efficiency of water management in rural villages.

1.2 Problem Overview

In rural villages, water management processes are often manual, resulting in multiple problems that hinder the effective distribution and use of water:

- **Inefficient Water Supply**: The water filling process is manual, leading to delays in tank refilling, overflows, and water wastage.
- **Water Quality Issues**: There is a lack of real-time water quality monitoring, and contaminated water can easily enter households, leading to health risks.
- **Unawareness of Water Availability**: Villagers are often unaware of when water will be available or the current status of the water supply, leading to poor planning and misuse.
- **Manual Control**: The entire water management system depends on human intervention, making it unreliable and prone to errors and delays.

- **Dependency on a Single Admin**: Water distribution is often managed by a single admin, making the system inflexible and vulnerable to disruptions.

These problems necessitate the development of an automated system that can monitor, manage, and distribute water effectively while ensuring safety and sustainability.

1.3 Need for the Proposed System

The need for an automated, real-time water management system is essential to address the challenges faced by rural communities. An IoT-based solution will help reduce manual labor and ensure efficient water distribution. This system will also provide an avenue for monitoring water levels and water quality in real time, eliminating the need for frequent manual checks.

Furthermore, the system can prevent water wastage by automatically turning off pumps when the tank is full and redirecting poor-quality water to non-drinking purposes such as irrigation. By integrating cloud-based technology like Firebase and mobile applications, the system will allow administrators to remotely monitor and control the system, thereby improving the responsiveness and reliability of water management.

Moreover, the real-time monitoring and alerts will keep villagers informed about water availability and prevent unexpected shortages, thus contributing to better planning and resource management. With these features, the Smart Water Management System will help establish a sustainable, efficient, and safer water management process for rural areas.

CHAPTER 2

OVERVIEW OF LITERATURE

2.1 Introduction

The field of water management has seen significant advancements with the integration of technology, particularly in the form of IoT-based solutions. Traditional water management systems have been largely manual, leading to inefficiencies and inconsistencies in water distribution, quality monitoring, and overall management. Over the past decade, the rise of smart technologies has offered innovative solutions to these problems, contributing to more efficient, sustainable, and reliable water management practices.

Several studies and systems have explored the application of Internet of Things (IoT) for real-time water level monitoring, quality assessment, and automated distribution. These systems not only provide efficiency but also ensure sustainability by reducing wastage and ensuring the quality of water. In this chapter, we explore the literature on various water management systems, IoT technologies, and their successful implementations, providing a foundation for the present study.

- **IoT in Water Management**

  The application of IoT in water management systems has proven to be transformative, especially in rural areas with limited resources. Researchers have designed smart water meters, sensor-based monitoring systems, and automated control systems to optimize water usage and reduce wastage. IoT enables real-time monitoring of water quality and levels, ensuring a proactive response to potential issues such as contamination, overflow, or water shortages. Wireless communication technologies like LoRa and Wi-Fi are commonly used to transmit data from sensors to cloud-based systems for real-time decision-making.

  Studies, such as those by W. M. Azam, Syed Muhammad Sayem Hasan [2019], highlight the efficiency of IoT-based water management in urban and rural areas, demonstrating the system's capacity to detect water contamination and ensure adequate water supply while optimizing usage. The integration of smart pumps and valves for automated control is also widely studied, showcasing how IoT can eliminate the dependency on manual operation and reduce human error.

- **Water Quality Monitoring Using IoT**

  Water quality monitoring is a critical component of any water distribution system, especially in rural areas where access to clean and safe drinking water is limited. The application of IoT-based sensors for real-time monitoring of water quality parameters such as turbidity, pH levels, and temperature has been explored in various studies. By integrating these sensors into a water distribution system, authorities can receive immediate notifications about contamination or changes in water quality, facilitating quick intervention.

  Research by Varsha Lakshmikantha, Anjitha Hiriyannagowda [2021], outlines several turbidity sensors and chemical sensors used to assess water quality. These sensors can detect even minute changes in water composition, allowing for timely detection of contaminants such as bacteria, heavy metals, and pollutants. IoT systems can automatically divert contaminated water to non-potable usage or trigger the activation of filtration systems, reducing health risks associated with unsafe water consumption.

2.2 Need for Present Study

Despite the advancements in IoT-based water management, many rural areas still face challenges related to inefficient water distribution and poor water quality monitoring. Existing systems often lack automation or real-time monitoring features, leaving them vulnerable to issues like water wastage, contamination, and delays in water distribution. Additionally, there is a lack of integration between various components such as water level sensors, quality sensors, and automated valves that can ensure a seamless water management process.

The need for an integrated system that can address these challenges while being cost-effective and scalable is imperative. This study focuses on developing a Smart Water Management System that not only automates water distribution but also ensures the safety and quality of water in rural villages, ultimately improving the overall sustainability and efficiency of water management practices.

2.3 Proposed Approach

This study proposes an IoT-based Smart Water Management System that integrates various sensors and actuators to automate water distribution, monitor water levels, and assess water quality in real time. The proposed system will utilize conductive water level sensors, turbidity sensors, and solenoid valves to enable automated tank refilling, real-time water quality monitoring, and control over water distribution.

The system will be designed to send data to the cloud using Firebase, enabling remote monitoring and control via a user-friendly mobile application. The system will also send notifications to villagers and administrators regarding water availability, quality, and distribution schedules. The proposed system aims to address current gaps by offering a holistic, automated solution for water management, which is scalable and adaptable to various rural settings.

2.4 Objectives and Scope

Objectives:

1. To design and implement an IoT-based automated water distribution system that ensures efficient water supply and water quality monitoring in rural villages.
2. To automate water level monitoring, ensuring timely refilling and preventing overflows.
3. To develop a real-time water quality monitoring system, detecting contaminants and enabling quick corrective actions.
4. To design a mobile application for remote monitoring and control of the system, allowing administrators and villagers to receive updates and manage water distribution.
5. To provide cost-effective, scalable solutions for rural water management that can be adapted to different village sizes and requirements.

Scope:

The scope of this study includes the development of an IoT-based Smart Water Management System for rural villages with the following considerations:

- Integration with existing water tanks and infrastructure where possible.
- Wireless communication for easy installation and minimal maintenance.
- Real-time monitoring and notifications for both water levels and water quality.
- The system will focus on basic water distribution and quality management, with further enhancements such as filtration or purification to be explored in future versions.

CHAPTER 3

PROJECT DEFINITION AND SPECIFICATIONS

3.1 Introduction

This chapter presents an in-depth overview of the Smart Water Management System, a cutting-edge solution designed to automate and optimize water usage in rural and urban settings. It elaborates on the core concept of the system, which leverages Internet of Things (IoT) technology to monitor, control, and manage water resources effectively.

The chapter defines key terminologies and outlines the mathematical principles that govern the system's operation. The goal is to ensure real-time monitoring and automatic control of water pumps and valves based on water levels and quality, thereby minimizing water wastage and improving water management practices.

3.2 Project Definition

3.2.1 The Concept

The Smart Water Management System is designed to automate and optimize the water management process in rural areas. The system leverages the Internet of Things (IoT) to monitor and control the water level in storage tanks, assess the quality of water, and ensure the effective distribution of water resources. Key components of the system include water level sensors, water quality sensors, valves, and automated pumps.

The concept behind the system is to ensure sustainability by reducing water wastage, maintaining water quality, and providing real-time insights on water usage. The system operates by detecting water levels (low, medium, high) to control the pumps, sending real-time data to the cloud (using Firebase) for remote monitoring, and providing users with notifications regarding water levels and quality.

3.2.2 Definitions and Notations

- **Water Level:** Represents the amount of water present in a storage tank, measured using a low-level sensor and a high-level sensor.
- **Pump1 and Pump2:** Refers to the automated pumps that control the flow of water. Pump1 is used to fill the tank, while Pump2 distributes water based on valve statuses.

- **Valves (Valve1, Valve2, Valve3):** These valves are connected to water pipelines and are used to control the flow of water from the tank to different areas.
- **Turbidity:** A measure of the clarity of water, which indicates the presence of particles and contaminants. It is monitored using a turbidity sensor.
- **Firebase:** The cloud-based platform that stores and synchronizes sensor data in real time, enabling remote access to water data.

3.2.3 Mathematical Formulation

The mathematical formulation that governs the control of water management is primarily based on conditional logic that governs the operation of the pumps and valves. Below is a simplified version of the key formulae:

1. **Water Level Control:**
    - If high-level sensor = HIGH, then Pump1 = OFF.
    - If low-level sensor = HIGH, then Pump1 = ON.
    - Otherwise, Pump1 = ON (for medium water level).

2. **Pump2 Control:**
    - If Valve1 = ON or Valve2 = ON or Valve3 = ON, then Pump2 = ON.
    - Else, Pump2 = OFF.

3. **Turbidity Monitoring:**
    - If Turbidity > Threshold, send a notification (indicating contamination).

These conditions will drive the system's operation based on sensor inputs, ensuring real-time, automated water management.

3.3 System Requirements

3.3.1 Input and Output Specifications

- **Inputs:**
  - Water Level Sensors (Low and High): Detect the water level in the tank.
  - Turbidity Sensor: Measures the clarity of water, used to detect potential contamination.
  - Valve Status: Input from the mobile application that controls the Valve1, Valve2, and Valve3.
  - User Input (Mobile App): Users can provide input to control the system remotely (e.g., switching valves on/off).
- **Outputs:**
  - Pump Control: Outputs to Pump1 and Pump2, to automate filling and distribution based on water levels and valve statuses.
  - Water Level Display: Visual feedback on the mobile app to show current water levels (Low, Medium, High).
  - Turbidity Notification: If the turbidity exceeds the threshold, the system will send an alert to the user through the mobile app.
  - Valve Control Feedback: Display the status of valves on the mobile app, reflecting their real-time state.

3.3.2 Hardware Specifications

1. **Microcontroller: ESP32** – Acts as the main controller, interfacing with sensors, valves, and pumps.
2. **Water Level Sensors (Low and High)** – Used to detect the water level inside the tank.
3. **Turbidity Sensor** – Used to measure water quality (turbidity level)**.**
4. **Solenoid Valves (Valve1, Valve2, Valve3)** – Electrically controlled valves used to manage water flow.
5. **Water Pumps (Pump1 and Pump2)** – Pump1 fills the tank, and Pump2 distributes water based on valve statuses.

6. **Relay Module –** Used to control the switching of pumps and valves.
7. **Wi-Fi Module –** Integrated in the ESP32, provides internet connectivity to send data to the cloud.
8. **Power Supply:** Adequate power supply to support the ESP32, sensors, pumps, and valves.

3.3.3 Software Specifications

1. Programming Language: C++ using the Arduino IDE for the ESP32 microcontroller.
2. Firebase Database: Real-time database for storing and synchronizing water level, pump status, and valve status.
3. Mobile App Platform: MIT App Inventor, providing a user-friendly interface for interacting with the system.
4. Libraries:
    - Firebase ESP32 Client Library for Firebase integration.
    - Wi-Fi library to enable internet connectivity for the ESP32.
    - Turbidity Sensor Libraries for accurate readings.
5. Cloud Platform: Firebase for data synchronization, ensuring remote access to real-time data.
6. Notifications: The app will send push notifications based on predefined conditions (e.g., low water level, high turbidity).

CHAPTER 4

HAREWARE AND SOFTWARE DESIGN

4.1 Block Diagram and Its Explanation

The block diagram provides a high-level overview of the system architecture. It illustrates the interaction between the various hardware components and the control logic implemented in software.

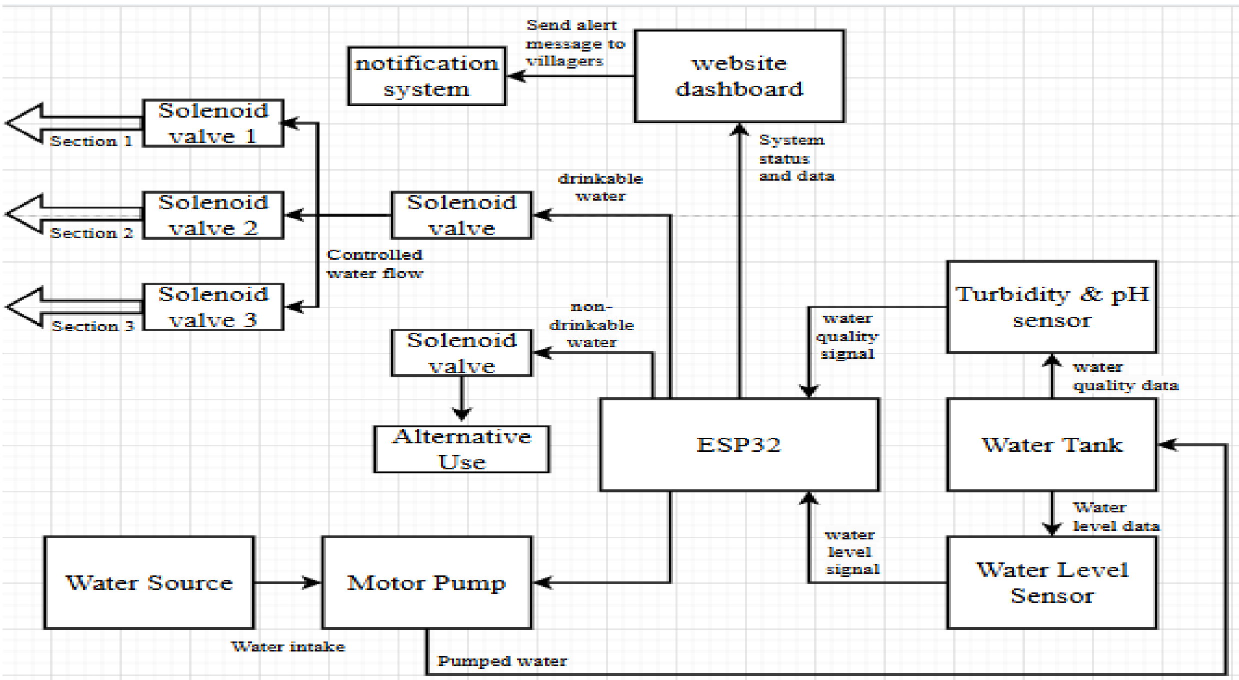

Fig. 1 Block Diagram

Block Diagram Components:

- **ESP32 Microcontroller**: Central processing unit that interfaces with all sensors and actuators.
- **Water Level Sensors (Low and High)**: Monitor the water level in the tank.
- **Turbidity Sensor**: Detects the quality of water.
- **Solenoid Valves (Valve1, Valve2, Valve3)**: Used to control the flow of water.
- **Pump1**: Automatically activated to fill the tank based on level sensors.
- **Pump2**: Distributes water when any of the valves are active.
- **Relay Module**: Interfaces pumps and valves with the ESP32 for switching operations.
- **Firebase**: Cloud database that stores real-time sensor data and control commands.

- **Mobile Application**: Developed using MIT App Inventor to visualize and control system remotely.

The system continuously reads sensor values and updates the Firebase database. Based on level and valve statuses, it decides when to turn pumps on or off, automating the process of water management.

4.2 Choice of Processor and Its Working

Processor Chosen: **ESP32**

The ESP32 is a low-cost, low-power microcontroller with integrated Wi-Fi and Bluetooth, making it ideal for IoT-based applications. Its key advantages include:

- Dual-core 32-bit processor
- Integrated Wi-Fi module for Firebase connectivity
- Multiple GPIO pins for sensor/actuator interfacing
- Built-in ADC for analog sensors like turbidity

Working:
The ESP32 continuously monitors the status of level and turbidity sensors. It processes these inputs and performs the following:

- Sends real-time data to Firebase.
- Reads control commands (valve statuses) from Firebase.
- Controls pumps and valves accordingly through relays.

4.3 Design Stages

4.3.1 Power Supply Design

The system uses **dual power sources**:

- **SMPS (Switched Mode Power Supply)**: Supplies regulated 12V DC to solenoid valves. It ensures stable current and voltage, suitable for actuators that require consistent performance.
- **Battery Cells (2 per motor)**: Each pump (Pump1 and Pump2) is powered using battery cells to ensure portability and eliminate overload risks on the ESP32. The batteries are connected in series to provide required operating voltage.

Additional components:

- **Relay Module**: Interfaces between ESP32 and high-voltage devices.
- **Voltage Regulators**: Ensure stable 5V/3.3V for ESP32 and sensors.

4.3.2 Design of Signal Conditioning Circuits

- **Water Level Sensors**: Digital switches or float-based sensors connected to GPIO pins with pull-down resistors to prevent floating values.

4.3.3 Circuit Diagram and Its Working

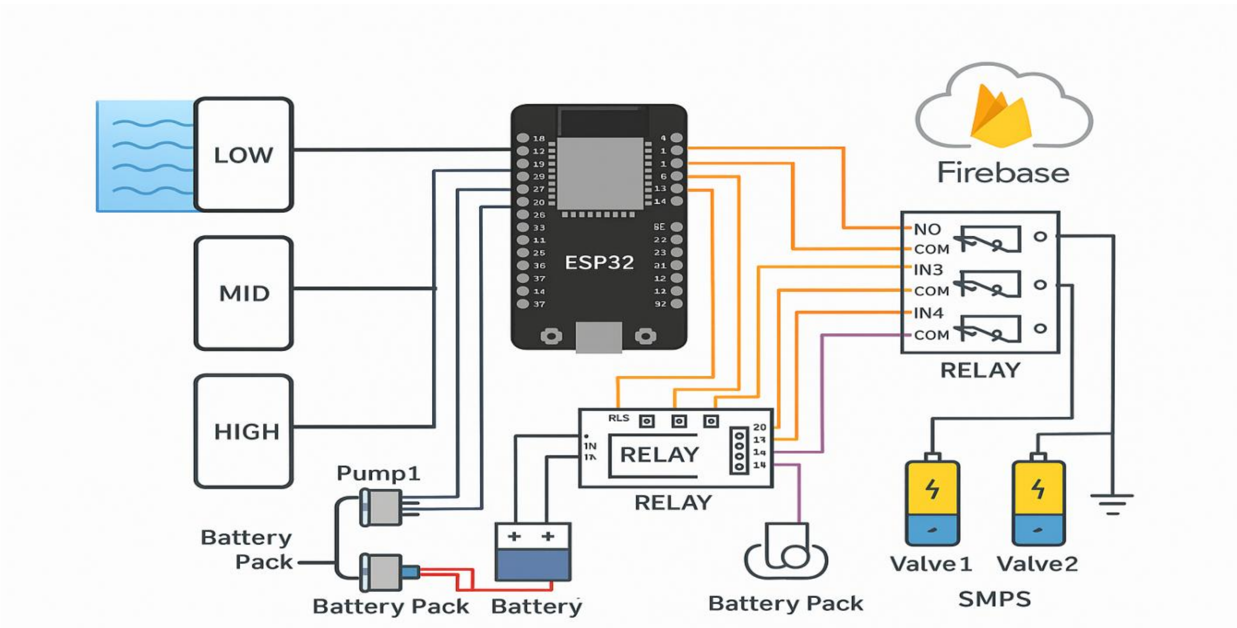

Fig. Circuit Diagram

The circuit consists of:

- ESP32 connected to:
  - Water level sensors via digital GPIOs
  - Relay module via digital outputs
  - Firebase via Wi-Fi

- Relay module controls:
  - **Pump1 and Pump2** (powered by battery cells)
  - **Solenoid Valves 1, 2, and 3** (powered by SMPS)

Working:

- ESP32 reads water level
- If level is LOW, Pump1 turns ON
- If level is HIGH, Pump1 turns OFF
- If any valve is ON (based on Firebase), Pump2 is activated
- Firebase updates are reflected in MIT App in real time

4.3.4 PCB Layouts

The printed circuit board is designed to accommodate:

- ESP32
- Relays (opto-isolated)
- Terminal blocks for connecting pumps, valves, and sensors
- SMPS input terminals
- Separate power rails for 3.3V, 5V, and 12V
- Clear isolation between high and low voltage areas

Safety measures:

- Fuses for overcurrent protection
- Proper trace width for high-current lines
- Heat sinks near relay switching terminals (if needed)

4.4 Software Design

4.4.1 Tasks Assigned to Software

- Read sensor values (water level)
- Update Firebase database with current status
- Fetch valve status from Firebase
- Control relays based on logic
- Communicate with MIT App for user interface and remote control
- Manage safety conditions (e.g., overflow prevention)

4.4.2 Algorithms

Pump1 Auto-Control Based on Water Level:

```
IF (Water_Level == HIGH)
    Pump1 = OFF
ELSE IF (Water_Level == LOW)
    Pump1 = ON
```

Pump2 Control Based on Valve Status from Firebase:

```
IF (Valve1 == ON OR Valve2 == ON OR Valve3 == ON)
    Pump2 = ON
ELSE
    Pump2 = OFF
```

4.4.3 Flow Charts

Flowchart 1: Sensor Data and Pump1 Logic

[Start]
↓
[Read Level Sensors]
↓
[Update Firebase /sensor/water_level]
↓
[IF level LOW → Pump1 = ON]
[IF level HIGH → Pump1 = OFF]
↓
[Loop]

Flowchart 2: Firebase Command and Pump2 Control

[Start]
↓
[Read Firebase Valve Status]
↓
[IF any valve == ON → Pump2 = ON]
[Else → Pump2 = OFF]
↓
[Loop]

CHAPTER 5

EXPERIMENTAL OBSERVATIONS AND DISCUSSION

5.1 Experimental Observations

To evaluate the effectiveness of the Smart Water Management System, a series of real-time experiments were conducted after the hardware and software components were integrated. The ESP32 microcontroller was connected to Firebase Realtime Database, and data was continuously monitored from the sensors and actuators.

Key observations are as follows:

- **Water Level Detection:**
    - When the water level was below the low sensor, the system labeled it as LOW and Pump 1 was activated automatically.
    - When the level reached the high sensor, it was recorded as HIGH, and Pump 1 was automatically turned off, preventing overflow.
    - Intermediate water levels were marked as MID, keeping Pump 1 active to maintain adequate supply.

- **Pump Operation:**
    - Pump 1 responded accurately to level changes, ensuring the tank never overflowed or dried up.
    - Pump 2 activation was observed only when at least one of the solenoid valves (valve1, valve2, valve3) was set to ON via Firebase.
    - This ensured water was pumped only when required, minimizing unnecessary energy use.

- **Valve Control:**
    - All three solenoid valves operated correctly based on commands from the MIT App, responding in under a second.
    - Manual changes made in Firebase (ON/OFF) were reflected accurately in hardware behavior.

- **Real-time Data Monitoring:**
    - Firebase successfully updated sensor readings and pump/valve statuses with negligible delay.
    - Water level (/water/level) and pump state (/water/pump_status) were reliably displayed on the Firebase dashboard.

- **Reliability and Consistency:**
    - Over 10+ test cycles, the system consistently responded with accurate actuation, highlighting stability and real-world applicability.

5.2 Discussion

The experiment results validate that the proposed system achieves efficient and automated water distribution. The integration of water level sensors, solenoid valves, and pumps with Firebase and ESP32 allowed for real-time remote monitoring and control, meeting the project objectives effectively.

Key insights include:

- **Automation Efficiency:**
  Automatic motor control based on sensor readings reduced manual effort and eliminated human error in tank management.

- **Water Conservation:**
  Overflow prevention and controlled valve operation led to measurable reduction in water wastage.

- **System Responsiveness:**
  Low-latency Firebase communication ensured immediate actuation, a critical feature for real-world rural deployment.

- **Scalability:**
  The modular design of the system allows easy expansion—more valves, sensors, or tanks can be integrated without affecting core functionality.

Overall, the system demonstrates that an IoT-based approach can offer sustainable, efficient, and smart solutions for rural water distribution challenges.

CHAPTER 6

CONCLUSION AND FUTURE SCOPE

6.1 Conclusion

The Smart Water Management System presented in this project represents a practical and scalable solution to address water distribution challenges in rural and semi-urban areas. The system integrates IoT-based automation using the ESP32 microcontroller, ultrasonic sensors, and solenoid valves, all managed through Firebase and monitored via a custom-built mobile application using MIT App Inventor.

The system's core functionality—automatic control of Pump 1 based on real-time water levels and remote activation of Pump 2 through valve status—was successfully implemented and validated through experimental testing. The real-time updates in the Firebase Realtime Database ensure immediate reflection of sensor readings and actuator statuses, promoting quick response and efficient resource use.

6.2 Advantages / Disadvantages

- **Advantages**

  Enables automatic tank refilling based on real-time water level
  Prevents water overflow and reduces wastage
  Supports remote monitoring and control via Firebase
  Easy to expand and integrate with more valves or sensors

- **Disadvantages**

  Dependent on stable internet connectivity
  Initial setup requires basic technical skills
  Limited to predefined sensor thresholds
  Power supply backup may be needed in remote areas

6.3 Applications

- Rural water tank automation
- Agricultural irrigation systems
- Overhead tank management in housing societies
- Industrial fluid level monitoring
- Smart city water infrastructure

6.4 Future Scope

- Integration of turbidity sensors to ensure water quality monitoring.
- Adding push notifications or SMS alerts for overflow, dry tank, or valve failure.
- Enabling AI-based predictive analytics for pump scheduling based on usage trends.
- Developing a solar-powered version for off-grid applications.
- Connecting to Google Assistant or Alexa for voice-based control in smart homes.

CHAPTER 6

TIME PLAN OF ACITIVITIES

A well-organized time plan was essential to manage the development of our Smart Water Management System effectively. The semester-long journey was broken down into multiple structured phases, beginning with requirement gathering and concluding with system validation. Two formal project reviews were conducted during the course to evaluate progress and refine the system based on feedback.

Table 1. Time Plan Activities

Sr. No.	Phase / Activity	Duration	Details of Work Done
1	Requirement Gathering	21 Jan – 25 Jan	Identified key problems related to rural water supply through field visits and stakeholder interactions. Finalized project theme.
2	Literature Survey	26 Jan – 31 Jan	Reviewed existing research papers and IoT applications for water management. Compared various sensors, control systems, and data platforms.
3	Finalization of Project Idea	1 Feb – 4 Feb	Finalized system architecture integrating ESP32, IR sensor, Ultrasonic sensor, solenoid valves, Firebase, and MIT App Inventor.
4	Hardware Component Selection	5 Feb – 9 Feb	Selected appropriate components including sensors, SMPS, motors, valves, and microcontroller. Sourced from local and online vendors.
5	Circuit Design and Simulation	10 Feb – 14 Feb	Created preliminary circuit diagram and simulated input/output behavior. Planned wiring and power supply requirements.
6	Firebase and App Planning	15 Feb – 19 Feb	Defined Firebase Realtime DB structure. Designed the app UI layout and finalized key features such as live monitoring and valve status display.
7	Review 1	20 Feb – 21 Feb	Presented initial problem statement, literature review, and system architecture to faculty. Received feedback on component choice and logical design.

8	Hardware Assembly and Integration	22 Feb – 27 Feb	Connected ESP32 with sensors and relay module. Assembled complete circuit with SMPS powering solenoid valves and dual cells used for motor operation.
9	Firebase Connectivity & Testing	28 Feb – 3 Mar	Verified real-time sensor data updates on Firebase. Configured ESP32 logic for dynamic water level status and pump control.
10	App Development using MIT App Inventor	4 Mar – 9 Mar	Built the app interface showing tank level and valve statuses. Synced Firebase paths with app components for real-time feedback.
11	System Integration and Testing	10 Mar – 14 Mar	Integrated all software and hardware components. Tested pump1 automation and valve-controlled pump2 logic in real time.
12	Review 2	15 Mar – 16 Mar	Demonstrated working prototype to faculty. Reviewed testing outcomes and discussed improvements related to power supply optimization and app visuals.
13	Final Hardware Adjustment	17 Mar – 20 Mar	Refined hardware setup and secured components on a baseboard. Ensured stable power flow and corrected wiring inconsistencies.
14	Full System Testing and Validation	21 Mar – 26 Mar	Conducted extensive testing under different water level scenarios. Validated Firebase and app synchronization with hardware responses.
15	Documentation – Technical Chapters	27 Mar – 2 Apr	Drafted Chapters 4 and 5 with detailed hardware-software design, flowcharts, circuit diagrams, and test results.
16	Documentation – Conceptual Chapters	3 Apr – 7 Apr	Finalized Chapters 1 to 3 (Introduction, Literature Review, Project Definition). Included diagrams and explanation of project scope.
17	Conclusion, Scope & Final Drafting	8 Apr – 15 Apr	Prepared Chapters 6 and 7. Added advantages, applications, and time plan. Performed language refinement and layout formatting.

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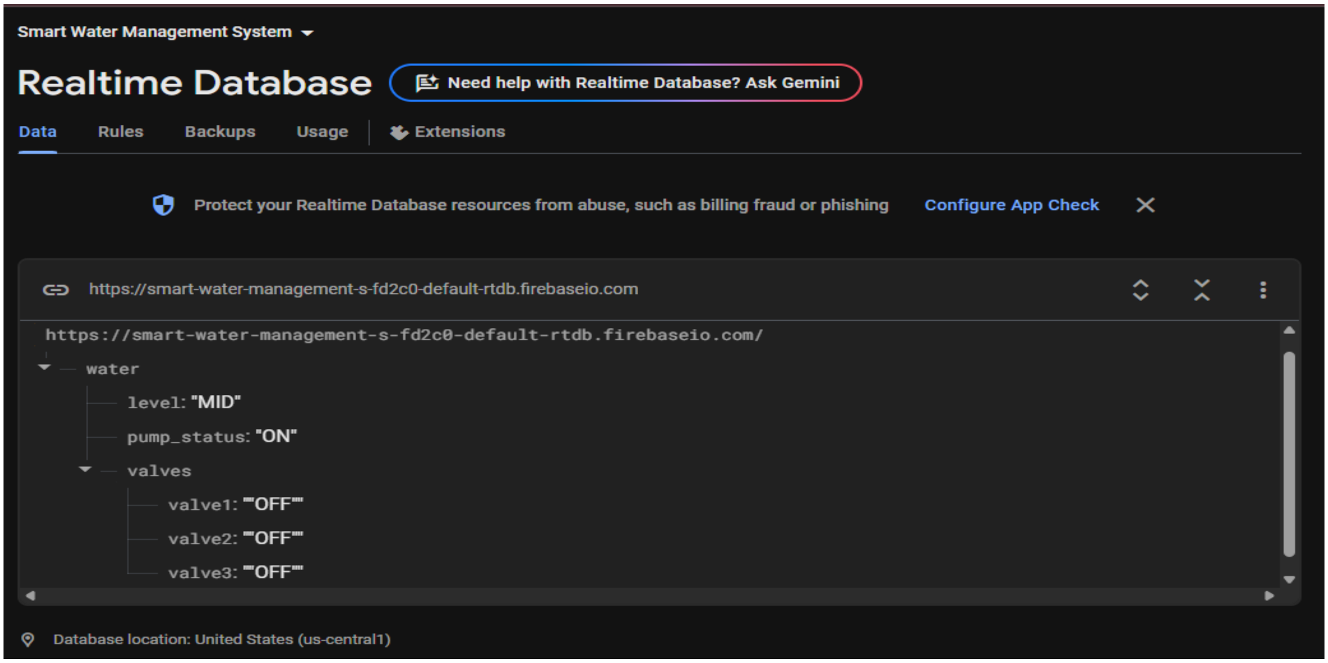
APPENDIX

1. Screenshot of firebase



2. Screenshot of APP