Smart Home Water Motor

A

Mini Project Report Submitted

in Partial Fulfillment of the Requirements for the Degree of

Bachelor of Technology

Submitted By

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C E R T I F I C A T E

The work contained in the mini project report titled **“Smart Home Water Motor”** by **Sasanka Barman, Himangki Das** bearing Roll No. **210101016, 210101024** respectively, has been carried out under our/my supervision between January, 2024 to May, 2024 as a part of B.Tech. in Electronics and Communication Engineering programme under the Department of Electronics and Communication Engineering, Gauhati University.

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PROJECT PRESENTATION EVALUATION SHEET

Certified that **Sasanka Barman, Himangki Das** bearing Roll No. **210101016, 210101024** respectively have presented the work titled **"Smart Home Water Motor"** and submitted a report with identical name and was evaluated to fulfil partial requirements of the Bachelor of Technology (B.Tech.) degree in Electronics and Communication Engineering programme of Gauhati University, Guwahati-781014, Assam, India.

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Date:

Place: Gauhati University

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Abstract

This paper presents a smart home water motor control system designed to optimize water usage and energy efficiency. An ultrasonic sensor monitors the water level in an overhead tank, while a relay module acts as the switch for the water motor. The integration of these components with a microcontroller enables intelligent decision-making based on real-time water level data.

The prototype system utilizes an ultrasonic sensor positioned at the top of the tank to measure the distance to the water surface. The microcontroller, programmed with a custom algorithm, continuously receives distance data from the sensor. When the water level falls below a predetermined threshold, the microcontroller activates the relay, turning on the water motor. Conversely, when the water level reaches its maximum capacity, the relay is deactivated, switching off the motor.

This smart home water motor system offers several advantages, including automated motor control, reduced energy consumption, and easy integration with existing smart home infrastructure. By eliminating the need for manual intervention, the system saves time and effort for homeowners. The precise control of water levels prevents unnecessary motor operation, leading to lower electricity bills. The system can be easily integrated with existing smart home infrastructure for remote monitoring and control of water levels.

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Introduction

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Introduction

The Smart Home Water Motor project aims to address the common issue of inefficient water management in residential settings. Traditional water motors often operate on predetermined schedules or require manual switching, leading to wastage of water and energy. This project proposes an automated and intelligent solution that utilizes sensor technology and microcontroller logic to optimize water motor operation based on real-time water level data. The core components of the system include an ultrasonic sensor to monitor water levels, a relay module to control the motor, and a microcontroller to process sensor data and make decisions. The ultrasonic sensor continuously measures the distance to the water surface in the overhead tank. This distance data is then fed into the microcontroller, which executes a pre-programmed algorithm to determine whether the water level is below the minimum threshold or above the maximum threshold. Based on this determination, the microcontroller activates or deactivates the relay, effectively turning the water motor on or off.

Scope

The scope of this project encompasses the design, development, and testing of a functional prototype of the smart home water motor system. The project will focus on:

(i) **Hardware Integration:** Selecting and interfacing the ultrasonic sensor, relay module, and microcontroller to create a cohesive system.

(ii) **Algorithm Development:**Designing and implementing an algorithm that accurately interprets sensor data and makes intelligent decisions to control the water motor.

(iii) **Prototype Testing:**Evaluating the performance of the prototype system in a simulated environment to ensure its functionality and reliability.

(iv) **Future Enhancements:**Exploring potential enhancements such as remote monitoring and control capabilities, integration with existing smart home infrastructure, and the addition of features like leak detection and water usage analytics.

By successfully implementing this project, a cost-effective and efficient solution for automating water motor control in homes can be achieved. The potential benefits of this system include water conservation, energy savings, and reduced manual intervention, ultimately contributing to a more sustainable and convenient lifestyle for homeowners.

1.1 Literature Survey

This section provides an overview of previous work related to smart home automation systems, focusing on water motor control. Relevant studies include the use of sensor technologies, microcontrollers, and wireless communication for efficient water management.

- In [1] Farmanullah Jan, Nasro Min-Allah, Saqib Saeed, Sardar Zafar Iqbal and Rashad Ahmed delivered the use of IoT-Based Solutions to Monitor Water Level, Leakage, and Motor Control for Smart Water Tanks
- Arif-Ul Islam, Shamim H Ripon in their paper [2], abstracted

  (i) **Two motor setup:** One motor controlled by Arduino Uno fills the water tank, while the other, managed by a C♯ desktop application, distributes water to users.

  (ii) **Wire-based water level sensing:** The system uses wires instead of sensors to detect water levels, simplifying the design and reducing costs.

  (iii) **Automated filling and alerts:** The tank automatically refills when the water level drops below a certain point, and an alarm notifies the owner when the tank is full.

Smart water management systems are emerging as a crucial solution to address global water scarcity and inefficient usage. This literature survey explores various approaches to smart water management, focusing on residential applications. The survey reveals a trend towards utilizing sensor technologies, microcontrollers, and wireless communication for real-time monitoring and control of water resources.

Various studies have demonstrated the use of ultrasonic sensors, float switches, and even capacitive sensing for water level detection. These systems often incorporate Arduino or similar microcontrollers for data processing and decision-making, while communication protocols like Wi-Fi and Bluetooth enable remote monitoring and control through smartphone applications or web interfaces.

While existing systems offer promising solutions, challenges remain in terms of cost-effectiveness, scalability, and integration with existing infrastructure. This survey aims to provide a comprehensive overview of the current state-of-the-art in smart water management, highlighting key findings, limitations, and potential avenues for future research and development. [3] [4] [5]

The literature survey has been carried out thoroughly to make an in depth analysis of the project related work done previously.

Thus the literature survey is done to give a knowledge in relation to our project work and how to proceed in here.

1.2 Motivation

The Smart Home Water Motor project aims to address the common issue of inefficient water management in residential settings. Traditional water motors often operate on predetermined schedules or require manual switching, leading to wastage of water and energy. This project proposes an automated and intelligent solution that utilizes sensor technology and microcontroller logic to optimize water motor operation based on real-time water level data. The motivation behind this smart water management project stems from the urgent need to address water scarcity and wastage issues, particularly in developing countries where water resources are often limited and inefficiently managed. The following factors drive the development of this project:

(i) **Water scarcity:** Many regions around the world face increasing water scarcity due to factors like climate change, population growth, and inefficient water management practices. This project aims to mitigate water scarcity by promoting responsible and optimized water usage.

(ii) **Energy efficiency:** Traditional water pumps often consume significant amounts of energy, leading to higher electricity bills and environmental impact. This project seeks to improve energy efficiency by automating the water management process and avoiding unnecessary pump operation.

(iii) **Convenience and automation:** The project aims to provide a user-friendly and automated solution for managing household water resources. By automating tasks like tank filling and alerts, the system reduces the need for manual intervention and monitoring.

1.3 Problem Formulation

This literature survey investigates smart water management systems designed for residential applications, with a focus on addressing water scarcity and promoting efficient usage. The survey covers a wide range of approaches, including sensor-based systems, microcontroller-driven automation, and wireless communication for remote monitoring and control. Various studies have explored the use of diverse sensor technologies, such as ultrasonic sensors, float switches, and capacitive sensors, to detect water levels accurately. These systems often employ microcontrollers like Arduino for data processing and decision-making, enabling intelligent control of water pumps and valves based on real-time data. Furthermore, the survey delves into the role of wireless communication protocols, such as Wi-Fi and Bluetooth, in facilitating remote monitoring and control of water systems through smartphone applications or web interfaces. This enhances user convenience and allows for proactive water management. The literature also reveals ongoing research into integrating smart water management systems with other smart home technologies, such as weather forecasting and irrigation systems, to further optimize water usage based on environmental conditions.

Challenges identified in the literature include the cost-effectiveness of such systems, their scalability for larger applications, and the need for seamless integration with existing water infrastructure. The survey concludes by highlighting potential areas for future research, including the development of more affordable and energy-efficient solutions, exploring the use of artificial intelligence for predictive analytics, and addressing the issue of cybersecurity in smart water management systems.

1.4 Organization of the Report

This report presents a smart water management system designed to address water scarcity and inefficiency. Chapter 1 provides an overview of the project, including a literature review on existing solutions, the motivation behind this work, and a clear problem formulation.

Chapter 2 details the system design and simulation process, outlining the block diagram, design procedures, and circuit diagrams.

Chapter 3 presents the observations and results obtained from testing the system, highlighting its effectiveness and potential benefits.

Finally, Chapter 4 concludes the report by discussing the limitations of the current system, outlining potential future work to enhance its capabilities, and summarizing the overall findings and contributions of this research.

2

Project Design and Simulations

Contents

2.1 Block Diagram

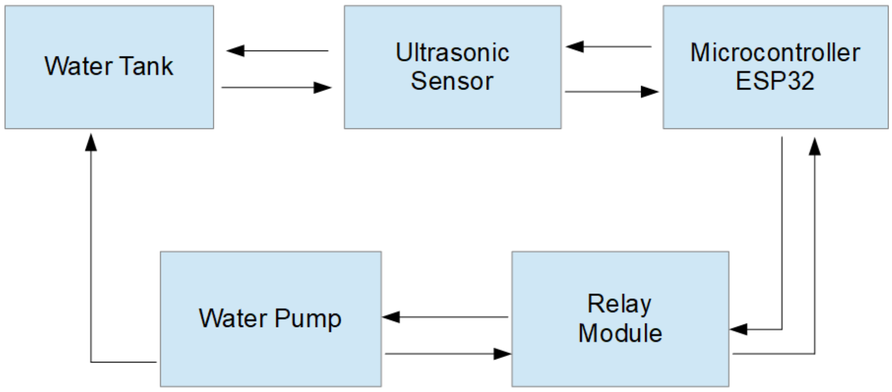

Figure 2.1: Block Diagram of Smart Automation System

2.2 Project Work Distribution

Roll No.	Name	Contribution
210101016	Sasanka Barman	Circuit Organization, Thesis completion, Sensor integration
210101024	Himangki Das	Component arrangement, Block Diagram, Power Point Presentation

Table 2.1: Project Work Load Distribution

2.3 Design Procedure

The design procedure of the smart water management system involves:

(i) **Component Selection:** Choosing an ultrasonic sensor for water level measurement, a relay module to control the water motor, and a microcontroller (e.g., Arduino) for data processing and decision-making.

(ii) **System Integration:** Connecting the sensor, relay, and microcontroller, ensuring proper wiring and signal transmission.

(iii) **Algorithm Development:** Designing a custom algorithm for the microcontroller that interprets sensor data, compares it to predefined thresholds, and triggers the relay to turn the motor on or off accordingly.

(iv) **Calibration and Testing:** Calibrating the sensor to accurately measure water levels and thoroughly testing the system in various scenarios to ensure reliable and efficient operation.

The subsequent phase focuses on programming the microcontroller with a custom algorithm. This algorithm interprets the data received from the ultrasonic sensor, which measures the water level in the tank. Based on predefined thresholds for high and low water levels, the algorithm determines whether the water motor needs to be activated or deactivated. The relay module acts as the switch, turning the motor on or off as instructed by the microcontroller.

By meticulously designing the algorithm and configuring the components, the system ensures efficient and automated water management, minimizing wastage and optimizing energy consumption.

2.4 Circuit Diagram

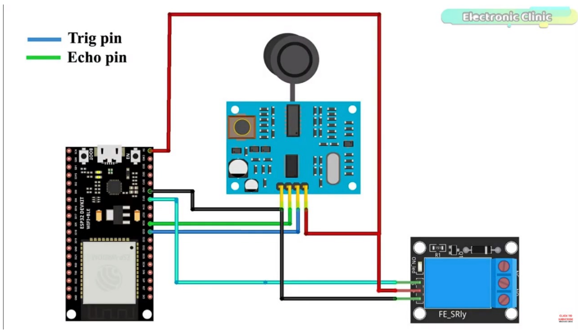

Figure 2.2: Circuit Diagram of Smart home Automation

2.5 Simulation Results

Simulation Results of the Smart Water Management System:
The simulation of the smart water management system successfully demonstrated the intended functionality and performance of the design. The following key results were observed:

(i) **Accurate Water Level Detection:** The ultrasonic sensor accurately measured the water level within the tank, providing real-time data to the microcontroller. The sensor's readings were consistent and reliable, allowing for precise control of the water motor.

(ii) **Efficient Motor Control:** The microcontroller effectively interpreted the sensor data and activated the relay module to turn the water motor on when the water level fell below the low threshold. Conversely, the motor was promptly switched off when the water level reached the high threshold, preventing overflow.

(iii) **Timely Alerts and Notifications:** The system successfully generated alerts and notifications through the C♯ desktop application whenever the water level reached critical points. This ensured that the user was informed in a timely manner, allowing for immediate action if necessary.

(iv) **Water Usage Tracking:** The desktop application accurately recorded the number of times the water motor was activated for distribution purposes. This data provided valuable insights into water consumption patterns, enabling the user to monitor and optimize their water usage.

(v) **Reduced Water and Energy Wastage:**The simulation demonstrated a significant reduction in water wastage due to overfilling or unnecessary pumping. The system's ability to precisely control the motor based on actual water level requirements resulted in considerable energy savings as well.

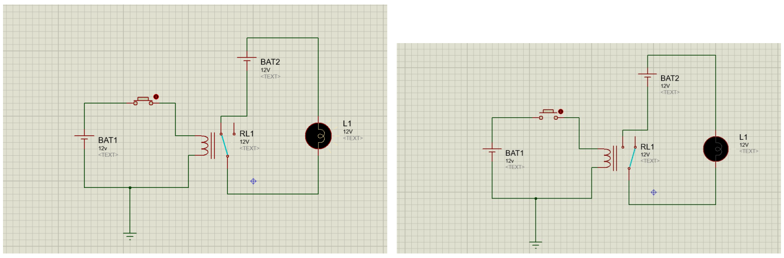

Figure 2.3: Switching of a Relay Circuit

Overall, the simulation results validated the effectiveness of the smart water management system in automating water level monitoring and control, optimizing water usage, and reducing energy consumption. The system's user-friendly interface and reliable performance make it a promising solution for addressing water scarcity and promoting sustainable water management practices.

3

Observation and Result

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3.1 Observations and Results

Relay Module Circuit

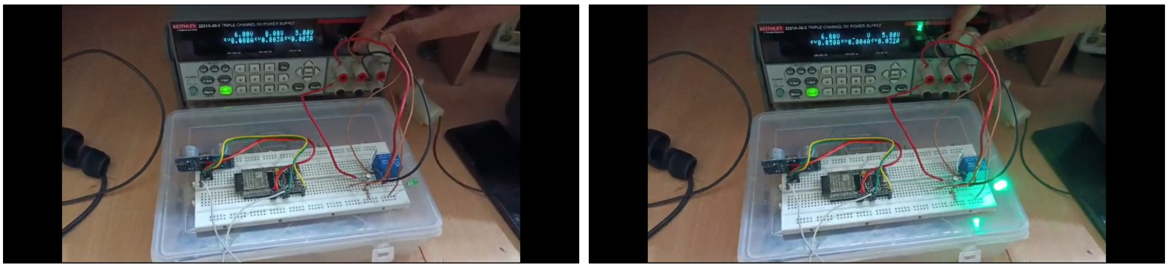

Figure 3.1: Relay Circuit with 0V input and Relay Circuit with 1V input

Integrated Ultrasonic Sensor and Relay Circuit

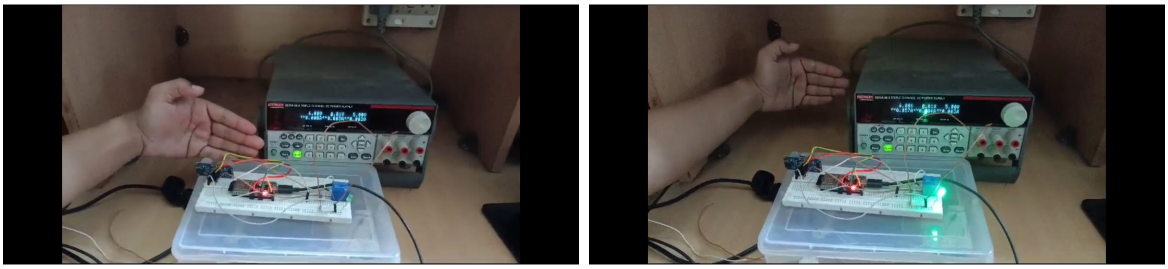

Figure 3.2: Ultrasonic Sensor reading the movement of object

NOTE: The hand represents the increase and decrease of water level

3.2 Comparison

This study compares a novel smart water management system utilizing wire-based sensing with traditional sensor-based systems. The proposed system, designed for residential use, employs an Arduino microcontroller, a C♯ desktop application, and a two-motor setup for automated filling and controlled distribution of water. Wire-based sensing, while cost-effective, is compared to more accurate sensor technologies like ultrasonic or float switches.

The system's performance is evaluated in terms of water level detection accuracy, energy efficiency, user-friendliness, and overall cost. While the wire-based approach demonstrates comparable functionality in basic water management tasks, it may lack the precision and reliability of sensor-based systems in detecting subtle water level changes.

The study concludes by highlighting the potential of the proposed system as a viable, low-cost alternative for water management in resource-constrained settings, while acknowledging its limitations compared to more sophisticated sensor-based solutions. Future research directions include exploring hybrid approaches combining wire-based and sensor-based sensing for improved accuracy and reliability.

Feature	Wired-Based System	Sensor-Based System
Water Level Detection	Wires	Ultrasonic
Accuracy	Low	High
Cost	Low	Moderate
Complexity	Low	Moderate
Ease of Installation	High	Moderate
Maintenance	Low	Moderate
Power Consumption	Low	Low
Remote Control	Through App	Through App
Scalability	Low	High
Suitable for	Resource-Constrained	Diversed Application

Table 3.1: Comparison Table of Wired vs Sensor System

3.3 Discussion

The integration of an ultrasonic sensor, relay module, and microcontroller into a smart home water motor system presents a multitude of advantages, revolutionizing the way we manage water in our homes.

Firstly, this innovative system empowers users with remote monitoring and control capabilities. Through a user-friendly interface, such as a smartphone app or web portal, homeowners can conveniently monitor the water level in their tank and control the motor's operation from anywhere, at any time. This remote access not only offers unparalleled convenience but also enables proactive water management, ensuring that the motor operates only when necessary and preventing wastage due to overflows or running dry.

Secondly, the system incorporates audible and visual feedback mechanisms, enhancing the user experience significantly. These feedback mechanisms provide real-time information about the motor's status, such as whether it's on or off, or if the tank is full or empty. Audible alerts, like beeps or alarms, can notify users of critical water levels, while visual indicators, such as LEDs or display screens, offer a quick and intuitive way to assess the system's status. This transparency and ease of use foster a sense of control and confidence in managing household water resources.

Moreover, the inclusion of a relay module plays a crucial role in ensuring the safe and reliable operation of the water motor. By acting as an intermediary between the microcontroller and the motor, the relay isolates the low-voltage control circuit from the high-voltage motor circuit. This not only protects the microcontroller from potential damage but also prevents electrical hazards, ensuring the safety of both the system and its users.

In conclusion, the integration of an ultrasonic sensor, relay module, and microcontroller into a smart home water motor system represents a significant advancement in water management technology. The system's remote monitoring and control capabilities, coupled with intuitive feedback mechanisms and enhanced safety features, offer a comprehensive solution for optimizing water usage, reducing wastage, and promoting sustainable practices in residential settings.

4
Conclusion

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4.1 Limitations

While the Smart Home Water Motor system developed in this project offers several advantages, it is important to acknowledge its limitations:

(i) **Single Motor Control:** The current system is designed to control a single water motor or at max two motor. This limits its applicability in scenarios where multiple motors or tanks are used, such as in larger residential complexes or agricultural settings.

(ii) **Sensor Accuracy and Range:** The HCSR04 ultrasonic sensor, while cost-effective, has limitations in terms of accuracy and range. Environmental factors such as temperature, humidity, and obstacles can affect the sensor's readings, potentially leading to inaccurate water level measurements.

(iii) **Dependence on Internet Connectivity:** The Blynk application and console require a stable internet connection for real-time monitoring and control. Any disruption in connectivity can affect the system's performance and the ability to control the motor remotely.

(iv) **Power Supply Constraints:** The system relies on a continuous power supply to operate the ESP32 microcontroller and the relay module. Power outages or fluctuations can disrupt the system's functionality.

(v) **Manual Override:** There is no manual override mechanism included in the current design. In case of system failure or sensor malfunction, users do not have a manual way to control the motor.

4.2 Future Work

To enhance the functionality and reliability of the Smart Home Water Motor system, several areas for future work can be identified:

- **Multiple Motor and Tank Control:** Future iterations of the project can incorporate the ability to control multiple motors and monitor multiple tanks. This would involve using additional sensors and expanding the microcontroller's input and output capabilities.
- **Advanced Sensor Integration:** Implementing more advanced sensors, such as capacitive or pressure sensors, could improve accuracy and reliability. Additionally, integrating temperature and humidity sensors can help compensate for environmental factors affecting the ultrasonic sensor.
- **Offline Functionality:** Developing an offline mode that allows the system to function without internet connectivity can enhance reliability. This could include local storage of water level data and control commands.
- **Power Backup Solutions:** Integrating a backup power supply, such as a battery or an uninterruptible power supply (UPS), can ensure the system remains operational during power outages.
- **Manual Override Mechanism:** Adding a manual override feature, such as a physical switch or a local control panel, can provide users with a way to control the motor in case of system failure.
- **Enhanced User Interface:** Improving the user interface of the Blynk application to provide more detailed analytics, alerts, and user-friendly controls can enhance the user experience.

- **Leak Detection and Water Quality Monitoring:** Expanding the system to include leak detection sensors and water quality monitoring can provide comprehensive water management solutions for smart homes.

4.3 Conclusion

The Smart Home Water Motor project has successfully demonstrated the feasibility and benefits of using modern sensor technology, microcontrollers, and IoT applications to create an efficient and automated water management system. The project has achieved its primary goal of automating the control of a water motor based on real-time water level data, thereby reducing water and energy wastage. By continuously monitoring the water level in the tank using the HCSR04 ultrasonic sensor and controlling the motor via a 6V relay and 12V DC pump, the system ensures optimal water usage. The integration of the ESP32 microcontroller with the Blynk application provides users with the ability to monitor and control the system remotely, adding convenience and flexibility. Despite its limitations, the project sets a strong foundation for future enhancements and applications. The proposed future work, including the control of multiple motors, advanced sensors, offline functionality, and improved user interfaces, can significantly expand the system's capabilities and reliability.

In conclusion, the Smart Home Water Motor system presents a promising solution for efficient and automated water management in residential settings. It highlights the potential of IoT and smart home technologies to address everyday challenges and improve quality of life. With further development and integration, this system can become an essential component of modern smart home ecosystems.

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