# MINI PROJECT REPORT

# SMART WASHING MACHINE SYSTEM

## MCTA 3203

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**Group : 10**

**Section : 1**



| NO. | NAME | MATRIC NO. |
|---|---|---|
| 1. | MUHAMMAD FAIZ BIN MD RIZAM | 2229695 |
| 2. | ISMA ASYRAF BIN MOHD HAFIDZ | 2210105 |
| 3. | MUHAMMAD ARIEF ZULKARNAIN BIN ABDUL RAHMAN | 2217275 |

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## Introduction

This project focuses on designing and developing a prototype for a smart washing machine that applies the usage of multiple sensors, actuators, and controllers to automate and improve conventional washing machine operations. It employs both Arduino Mega and Arduino Uno microcontrollers alongside additional hardware elements such as relays, motor drivers, ultrasonic sensors, and water level sensors.

The goal is to create a functional prototype that demonstrates the application of intelligent automation in daily home appliances. Focus is directed towards ease of use, integrated and advanced safety measures, and intelligent water usage management, thus improving overall effectiveness and functionality. The design also adds amazing features such as wireless connectivity, and fabric-specific laundering to replicate attributes of contemporary smart devices.

## Design problem and Objectives

Conventional washing machines frequently miss automation and user-oriented engagement, restricting both efficiency and convenience. This project tackles that gap by presenting the subsequent objectives:

1. Utilize relay-operated pumps to automate the intake and drainage of water.

2. Employ an ultrasonic sensor to sense human presence, activating the device solely when necessary.

3. Enhance user friendly interaction by monitoring clothings weight by using load cell that activates a buzzer when the maximum weight is achieved while in use.

4. Utilize a water level sensor to automatically halt water inflow once the desired level is attained.

5. Include a button and display interface for choosing water temperature and starting the wash cycle.

6. Facilitate communication between Arduino Mega and Uno to enhance task distribution.

7. Incorporate options for adjustable washing settings (e.g., Rapid Wash, Heavy Duty, Gentle).

9. These goals seek to integrate automation, safety, and intelligent control to create a smart washing machine tailored to upcoming technological requirements.

## **Materials and Equipment**

Our smart washing machine system consists of the following components:

1. Microcontrollers:Arduino Mega (main controller, sender).

○ Arduino Uno (receiver, integrated with Mega).

○ Two additional microcontrollers for demonstration purposes, are not integrated into the main system.

2. Sensors and Actuators:

○ Ultrasonic Sensor: Detects the presence of clothing in the washing machine.

○ Water Level Sensor (red): Measures the water level in the drum to stop the inflow pump automatically.

○ Relay Module (2-channel): Controls two pumps for water inflow and drainage.

○ Motor Driver (L9110): Drives a DC motor to rotate the drum.

○ Buzzer: Alerts the user if weight of the clothing exceeded the maximum weight.

○ Load cell (5kg) (HX711) : Detects if the weight of the load inside the machine machine exceeds the maximum load.

3. User Interface:

○ Push the buttons to start the washing process.

○ LCD to show washing status.

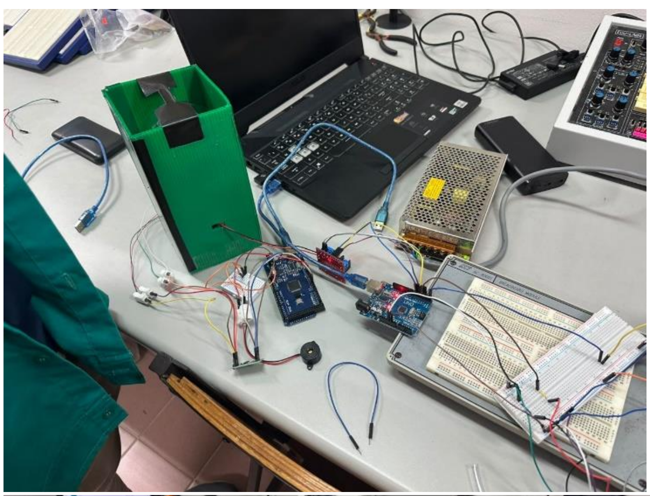
4. Communication:

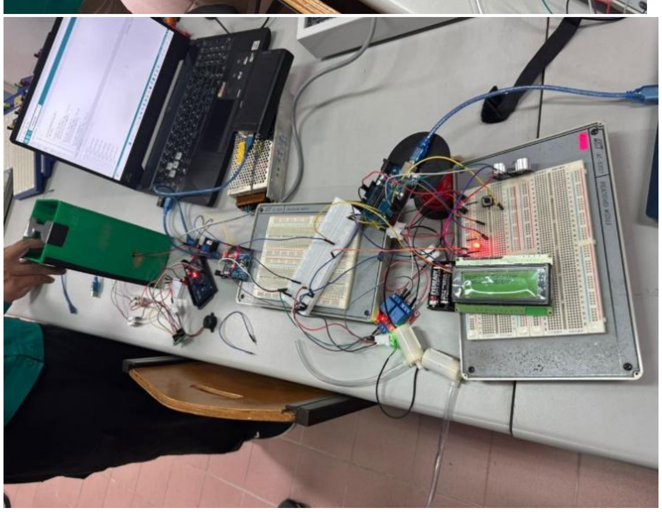
○ Arduino Mega acts as the master, while Arduino Uno acts as the slave.

5. Power Supply:

○ The components are powered using an external power source, a battery for the pump, and a relay connection. Proper grounding and connections were made to avoid malfunctions.

## Project Setup





## **Implementation of chapters**

1.Relay module to control two pumps:

one designated for drainage and another for water inflow. This setup was achieved by connecting the relay module to the Arduino Mega. Preliminary tests were conducted to verify that the relays could reliably activate and deactivate the pumps as required. Each pump was evaluated individually to confirm proper functionality; notably, the default system state upon startup is with both pumps turned off. The relays were programmed to respond to input from the water level sensor as well as user commands. This arrangement enabled automated management of water inflow and drainage, effectively eliminating the need for manual operation.

2. Rotation Control of the Washing Drum

In this setup, the L9110 motor driver was employed to manage the rotation of the washing drum. The Arduino Mega served as the control unit, regulating both the speed and direction of a connected DC motor. To accurately simulate the operational patterns of a typical washing machine, the system was programmed to alternate the motor's rotation between clockwise and counterclockwise directions. Thorough testing ensured that the motor driver could handle the required load and operate reliably without overheating. Additionally, rotation cycles were carefully synchronized with water inflow and drainage, thereby maintaining an effective and realistic washing process.

3. Laundry Detection with Ultrasonic Sensor

In this application, an ultrasonic sensor is integrated into the washing machine to detect the presence of laundry within the drum. The sensor emits ultrasonic pulses and measures the time taken for the echo to return, thereby determining the distance to any object inside. When clothing is present, the reflected signal returns sooner, allowing the system to identify that laundry has been loaded and initiate the washing cycle accordingly. If no items are detected, the machine remains inactive, thus conserving water and electricity. The sensor undergoes careful calibration to distinguish between actual garments and empty space, ensuring reliable operation and minimizing false detections. This not only enhances energy efficiency but also reduces unnecessary resource consumption.

4. LCD Display and Push Buttons

In this design, push buttons and an LCD display were incorporated to allow users to allow that when a user presses a button, the Arduino Mega processes the input and starts the washing process, starting from washing, rinsing, to spinning. The display also communicates the current stage of the washing cycle, such as “Filling Water,” “Washing,” or “Draining,” thereby providing clear feedback. This interface ensures straightforward and user-friendly interaction. Prior to implementation, both the LCD and push buttons were thoroughly tested to verify proper communication with the microcontroller.

5. Communication Between Uno and Arduino Mega

In this setup, the Arduino Uno serves as the slave, while the Arduino Mega acts as the master. They establish communication using serial protocols, allowing for the exchange of data and coordination of actions. Specifically, the Uno is responsible for managing components such as the LCD and push buttons, whereas the Mega oversees overall system operations. During testing, particular attention was given to ensuring reliable data transmission—verifying that information was accurately sent and received without interruptions or errors.

6. Integration and Assembling

Once individual components were tested, they were integrated to form a unified system. Wiring was carefully organized to ensure proper connections and avoid signal interference. The Arduino Mega functioned as the primary controller, coordinating all integrated elements. During assembly, issues with sensor readings, relay operation, or motor control were identified and resolved through debugging. Finally, comprehensive functionality tests were conducted on the complete assembly to confirm seamless interaction among all components.

## Discussion

The prototype demonstrated effective automation of essential washing machine operations through the integration of microcontroller-based control systems and sensor technology. The Arduino Mega, in tandem with a relay module, managed the processes of water intake and drainage using two pumps, guided by real-time water level data and user input.

Drum rotation was orchestrated via the L9110 motor driver, which capably replicated authentic washing cycles by alternating directions and synchronizing with corresponding water stages. Notably, the implementation of an ultrasonic sensor for laundry detection allowed the system to initiate cycles only when clothing was present, thereby improving both energy and water efficiency.

A user interface composed of an LCD display and push-buttons facilitated straightforward control and feedback. Serial communication between the Arduino Mega and Uno enabled consistent coordination between the core system logic and the interface. Final system integration resulted in cohesive interaction among all components, with successful troubleshooting of sensor and motor-related issues.

Collectively, these outcomes underscore the potential of low-cost microcontrollers to emulate intelligent appliance features. While advanced functionalities such as water heating and wireless connectivity are earmarked for future development, the prototype establishes a robust and scalable foundation for further smart home automation endeavors.

**Project successfulness**

Although the motor in our smart washing machine prototype did not operate as planned, the project can still be considered a success. The overall system achieved key objectives such as automated water inflow and drainage, laundry detection using an ultrasonic sensor, user interaction through push buttons and an LCD, and effective communication between the Arduino Mega and Uno. These core features functioned reliably, demonstrating our ability to design and integrate a complex embedded system. The motor issue, while significant, provided valuable learning opportunities in debugging, load handling, and power management—common challenges in real-world mechatronic applications. Importantly, we were able to identify the likely causes of the malfunction and understand how to address them in future iterations, such as by improving the power supply or refining motor control logic. From an engineering perspective, the ability to test, troubleshoot, and propose solutions reflects technical growth and project maturity. Therefore, despite the setback, the project successfully met its primary educational goals and laid a strong foundation for further development.

## Challenges and limitations

Throughout the process of developing the smart washing machine prototype, our team encountered significant obstacles that directly impacted the project's completion. Chief among these was persistent difficulty with the L9110 motor driver. Despite correctly following wiring and logic diagrams, the motor failed to activate as intended. This malfunction likely stemmed from insufficient power supply, issues with current delivery, or possibly a lack of synchronization between software commands and the hardware's response. As a result, we were unable to achieve a functional washing cycle, which severely limited the system's capabilities.

A secondary, yet equally critical, challenge involved integrating the Pixy camera. The initial plan was to use the camera for object or fabric detection, thereby enhancing the automation and intelligence of the washing process. Unfortunately, we ran into compatibility issues between the Pixy camera's communication protocols and the Arduino platform. Additionally, we faced physical connection difficulties and software library conflicts. Despite extensive troubleshooting, we were unable to establish reliable data transfer between the Pixy camera and the microcontroller, ultimately forcing us to exclude this feature from the final design.

These setbacks highlighted the complexities inherent in integrating advanced components within embedded systems. The experience underscored the necessity of thorough testing, careful power management, and ensuring compatibility between hardware and software elements.

## Performance Rating

The project ultimately received a score of 7.5 out of 10, which reflects the successful completion of core functionalities such as automated water inflow and drainage through the use of relays and pumps, the implementation of laundry detection using an ultrasonic sensor, and the development of an accessible user interface with push buttons and an LCD. Reliable communication between the Arduino Mega and Arduino Uno was also established, underscoring a competent grasp of embedded system integration. Some intended features, however, were not fully realized. The motor-driven drum rotation did not function as planned due to issues with the motor driver, which limited the prototype's ability to simulate actual washing cycles. Additionally, integration of the Pixy camera for object detection proved unfeasible, largely due to difficulties with communication protocols and hardware compatibility. Despite these setbacks, the project's primary components performed well and demonstrated considerable potential for future enhancements. The experience provided valuable insight into real-world prototyping challenges, such as power management, module compatibility, and the necessity of iterative testing. In summary, the project fulfilled its main objectives and served as a testament to the team's ability to design and construct a functional smart appliance prototype.

## Conclusion

In summary, the development of our smart washing machine prototype effectively showcased the integration of microcontroller-based systems with sensors, actuators, and user interfaces to automate routine household tasks. The process presented certain technical challenges, particularly in relation to motor control and the implementation of advanced components such as the Pixy camera. Nevertheless, the project achieved its primary objectives: automating water management, detecting laundry presence, ensuring operational safety, and providing a user-friendly control interface. The prototype's modular design and coordinated hardware-software functionality reflected the operational standards of contemporary household appliances. Importantly, this endeavor offered substantial hands-on experience in problem-solving, system integration, and embedded programming. With its robust foundation and thoughtfully designed architecture, the prototype demonstrates significant potential for future enhancements—including wireless control, fabric recognition, and automated water temperature regulation. Ultimately, the project not only satisfied academic requirements but also contributed meaningfully to our understanding of smart system design and real-world engineering practices.

## Recommendation

To significantly enhance the smart washing machine prototype, several key modifications should be considered. First, incorporating a genuine water heating mechanism equipped with a temperature sensor would provide authentic temperature control, allowing users to select wash settings that genuinely impact washing performance. Furthermore, upgrading the existing motor driver to a more robust solution—such as the L298N or a compatible motor shield—would address current limitations and ensure consistent drum rotation.

Integrating an ESP32 microcontroller would enable wireless connectivity, supporting remote monitoring and control via a mobile application, which aligns with modern smart appliance standards. Additionally, revisiting the camera integration—either by refining the Pixy camera setup or employing a Raspberry Pi for advanced image processing—could facilitate fabric or object detection, thereby enabling intelligent wash mode selection.

Finally, implementing preset wash modes, EEPROM-based data logging, and power-loss recovery would collectively contribute to improved user experience and system reliability. These enhancements would elevate the project from a basic prototype to a sophisticated, practical smart appliance with features expected in contemporary household technology.

## Acknowledgment

A special thank you to Dr. Wahju Sediono and Dr. Zulkifli Bin Zainal Abidin, my teaching assistant, and peers, for their outstanding assistance and support in completing this report. Their advice, input, and expertise have had a significant impact on the quality and comprehension of this work. Their time, patience, and dedication to my academic progress are deeply appreciated.

## Student’s Declaration

Certificate of Originality and Authenticity

This is to certify that we are responsible for the work submitted in this report, that the original work is our own except as specified in the references and acknowledgement, and that the original work contained herein have not been untaken or done by unspecified sources or persons.

We hereby certify that this report has not been done by only one individual and all of us have contributed to the report. The length of contribution to the reports by each individual is noted within this certificate.

We also hereby certify that we have read and understand the content of the total report and no further improvement on the reports is needed from any of the individual’s contributors to the report.

We therefore, agreed unanimously that this report shall be submitted for marking and this final printed report has been verified by us.

Name : Muhammad Faiz bin Md Rizam

Matric Numbers : 2229695

Signature :

| Read | Understand | Agree |
|---|---|---|
| / | / | / |

Name : Isma Asyraf bin Mohd Hafidz

Matric Numbers : 2210105

Signature :

| Read | Understand | Agree |
|---|---|---|
| / | / | / |

Name : Muhammad Arief Zulkarnain bin Abdul Rahman

Matric Numbers : 2217275

Signature :

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