INTERNATIONAL MULTI-AWARD WINNING INSTITUTION FOR SUSTAINABILITY

DEPARTMENT OF MECHATRONICS ENGINEERING

Mechatronics System Integration (MCTA3203)

Mini Project: Washing Machine

Section 1

(Group E)

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Abstract

As our group came to the end this course, this mini project was given us to implement everything we had learnt throughout the sem. This project focuses on integrating various elements in the realm of mechatronics such as control and automation. We wanted to showcase various elements in our project, mainly communication between microcontrollers, the ability to monitor inputs and outputs from sensors and actuators and the integration of Programmable Logic Controllers (PLC). To showcase the integration of these elements, we were assigned to make the system for a washing machine.

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1.1 Introduction

This project aims to demonstrate the integration of communication and monitoring abilities that can be achieved from PLC and ladder logic. We opted to use the Modbus communication protocol. Modbus serves as the linchpin for enabling seamless communication between devices within the same network, typically in a master-slave configuration. To program the washing machine system, we used ladder logic programming that was done on the OpenPLC software. The monitoring of inputs and outputs from sensors and actuators was done with the help of OpenPLC Runtime.

Objectives:

- To apply the knowledge gained by developing a washing machine system that incorporates various devices working together.
- To implement Modbus protocol to communicate with sensors and actuators.

1.2 Materials and Equipment

1. DC motor with fan
2. Arduino Uno
3. 9V battery to DC jack adapter
4. 9V battery
5. Micro limit switch
6. Water level sensor
7. 5V 1-channel relay module 10A
8. 5V 2-channel relay module 10A
9. 9V water pump
10. LED
11. Breadboard and jumper wires
12. Push button 12x12
13. 220Ω and 470Ω resistors
14. 16x2 I2C LCD
15. Mini strobe siren 12V
16.

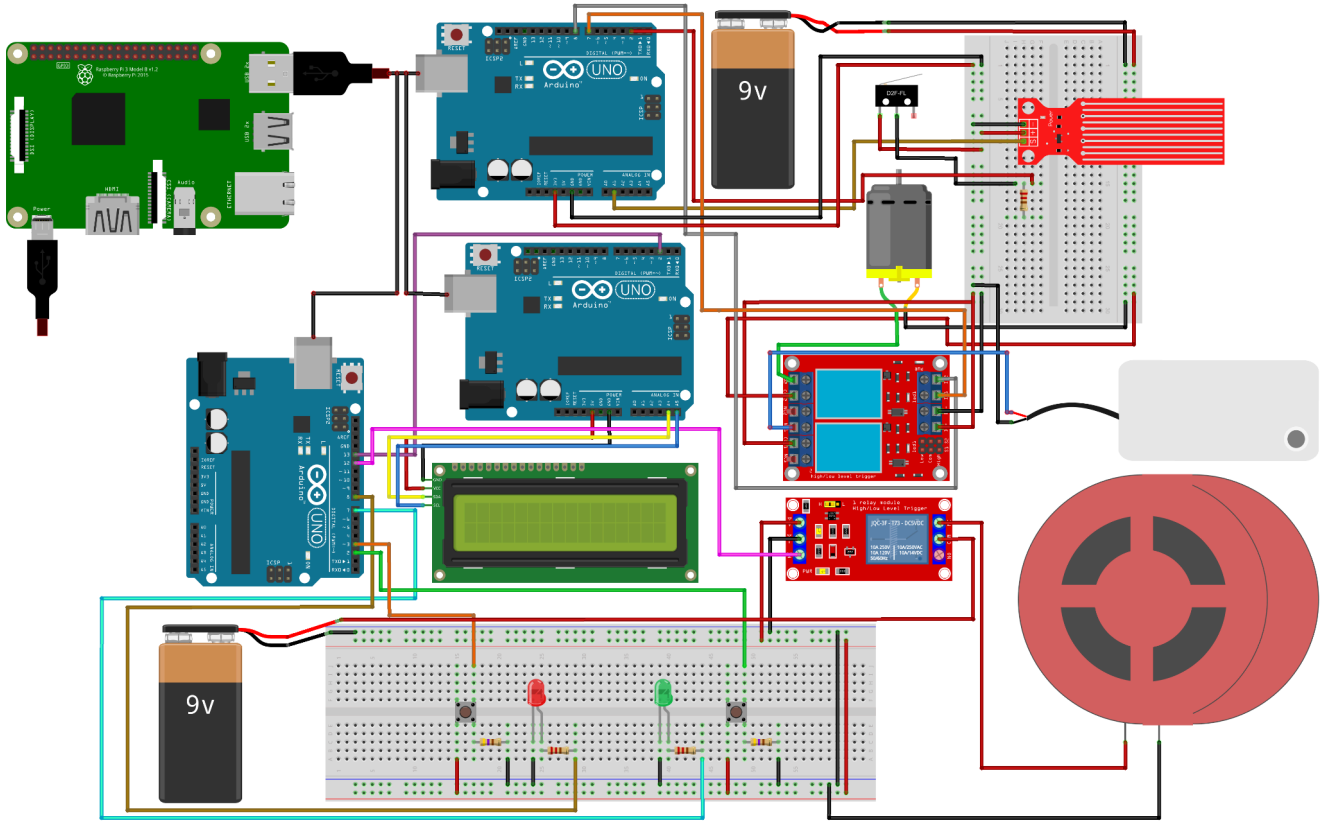
1.3 Experimental Setup

Hardware Setup

- Raspberry Pi
  - Configured as Modbus master.
  - Communicates with Arduino (Modbus slave) to read sensors' data.
- Arduino
  - Configured as slave.
  - Read data from sensors.

Software Setup

- Open PLC Editor
  - To create a ladder diagram
- Open PLC Runtime
  - Configured the slave devices.
  - Upload the ladder diagram to Raspberry Pi and execute the data.
  - Used to monitor the output based on the sensors' data received from Arduino.
- Radzio
  - Used to override the data address to control the system.

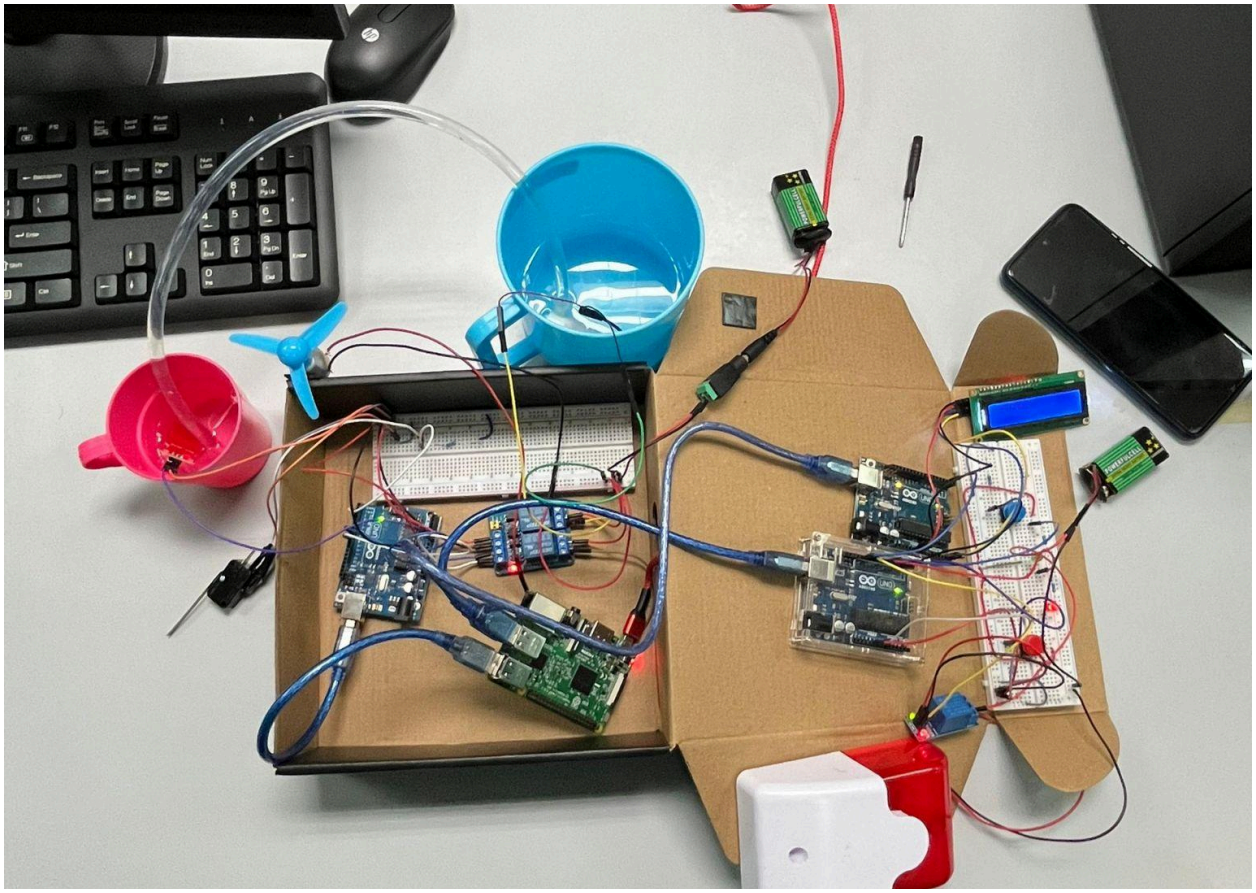


1.4 Methodology

1. Selected sensors were connected and chose Modbus for communication.
2. Sensors connected to Arduino and Arduino-Raspberry Pi serial communication is established.
3. Programmed Arduino to read sensor data and implemented Modbus communication for data transmission to Raspberry Pi.
4. Developed a ladder diagram using graphical symbols to depict logical control sequences for operating and managing the system components (sensors, Arduino, Raspberry Pi) based on input conditions and defined actions.
5. Installed the system in the lab, validated data accuracy, and confirmed real-time display using OpenPLC Runtime

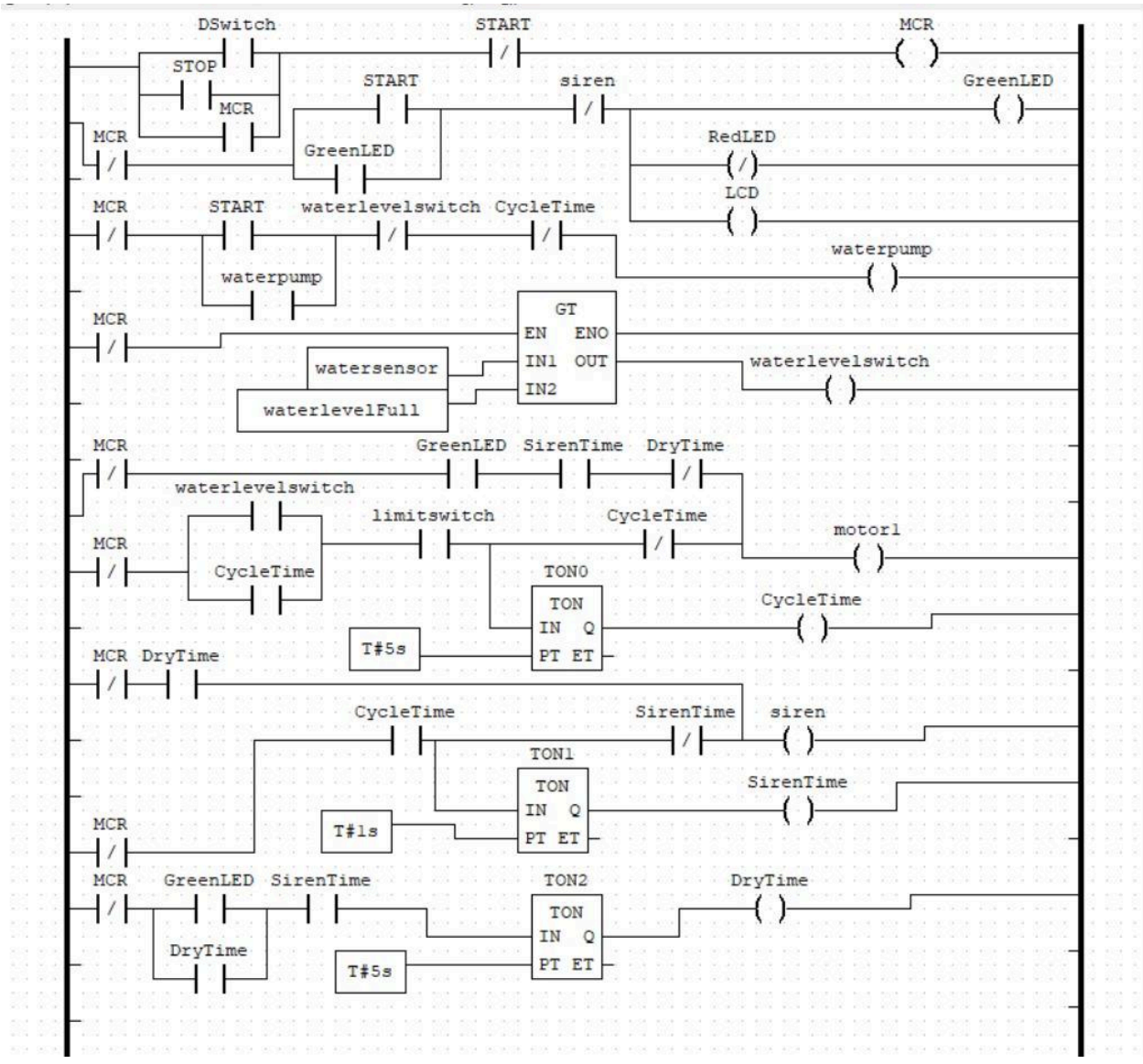
1.5 Result

We successfully developed a washing machine system with the addition of Modbus communication. The system outputs are a DC motor, a 9V water pump, LEDs, a 12V mini strobe siren and a 16x2 I2C LCD. System inputs include a water level sensor, a limit switch and buttons. The system has 4 microcontrollers, 3 Arduino Unos and 1 Raspberry Pi.



Hardware setup

The system was programmed using ladder logic in OpenPLC.



Ladder logic diagram

1.6 Discussion

1. The start button will start the system and also light up the green LED
2. The water pump will start pumping water into the washing drum until the water reaches a set level.
3. Then the DC motor will start, to start the washing phase, but only if the door is closed and the water reaches a set level.
4. The motor will run for 5 seconds.
5. After 5 seconds, a siren will sound for 1 second.
6. After the siren, the drying phase starts.
7. To stop the machine, a stop button must be pressed.

1.7 Conclusion

In conclusion, we learned the wide implications of the integration of technologies from communication, data monitoring and ladder logic. We also found out that the integration of the Modbus protocol is an essential component in putting the Industrial Internet of Things (IIoT) at the forefront of industrial plants. With this discovery, we could implement IIoT into our future projects to enhance efficiency, safety and productivity.

1.8 Recommendation

To enhance this washing machine system, a few features and capabilities can be added. Since there is already an IoT capability, an app for monitoring the washing machine can be made. Through this app, the user can monitor the time left before their washing machine is done with their laundry. Besides that, users could also remotely start and stop the washing machine, be alerted of any malfunctions and notify the user when the washing machine is done. This capability to remotely monitor and control the washing machine is ideal for self-laundry services such as mahallah self-laundries and also in other places. With the feature to monitor the time left before their washing machine is done with their laundry, the user no longer needs to waste their time waiting near their washing machine. This app could also avoid the inconvenience of taking other people’s clothes out because every user knows when their washing machine is done through the app.

1.9 Acknowledgements

We would like to acknowledge all of our instructors, Dr. Nadzril bin Sulaiman, Dr. Wahju Sediono and Dr. Zulkifli bin Zainal Abidin for the expert guidance, encouragement, and unwavering support throughout the project and also for the invaluable support and provision of resources crucial to the successful execution of the experiment on Systems integration (Microcontroller, PLC and Computer Systems). We hope to learn more from such talented instructors if the opportunity arises.

We would also like to thank Allah S.W.T. for guiding us in successfully demonstrating this experiment.

1.10 Student's Declaration
Declaration:

We certify that this project/assignment is entirely our own work, except where we have given fully documented references to the work of others, and that the material in this assignment has not previously been submitted for assessment in any formal course of study.

adam Date: 22/1/2024

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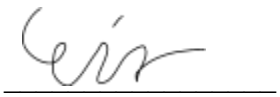

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