Faculty of Electronics & Computer Technology & Engineering

DEVELOPMENT OF IOT BASED WASHING MACHINE TRAINER FOR EDUCATIONAL PURPOSES

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Bachelor of Electronics Engineering Technology (Telecommunications) with Honors

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A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electronics Engineering Technology with Honours

Faculty of Electronics & Computer Technology Engineering

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2024

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FAKULTI TEKNOLOGI KEJUTERAAN ELEKTRONIK DAN KOMPUTER

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I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering Technology (Telecommunications) with Honours.

Signature	:	....
Supervisor Name	:	Ts. Eliyana Binti Ruslan
Date	:	15/1/2023

...

DEDICATION

To my esteemed mother Maryam Jameelah Binti Mohd Hashim, and Father Nizar Bin Misbah,

To my beloved family, esteemed lecturers, and cherished friends,

I extend my sincerest expressions of love, gratitude, and appreciation for your unwavering support throughout my academic journey. Your sacrifices, encouragement, and best wishes have been instrumental in my achievements.

I would also like to express my heartfelt thanks to my dedicated and respected supervisor, Ts. Eliyana Binti Ruslan, for the guidance and mentorship provided during this research endeavour.

With deepest regards,

Nur Nabila Binti Nizar

ABSTRACT

This project addresses the common struggle of higher education students in comprehending washing machine systems and maintenance. Recognizing the inefficiency of existing machines, the initiative focuses on enhancing teaching and learning processes, particularly for TVET students. The main objective is to develop an IoT-based washing machine trainer, offering practical training and effective learning tools. Specific objectives include simulating real washing machine functions, facilitating learning processes for instructors, analyzing understanding of washing machine systems, and integrating IoT for improved learning management. The project aims to benefit educational institutions, promote sustainable laundry practices, enhance accessibility, and improve hands-on learning. The development involves overcoming challenges, including errors in the trainer, such as water level sensors, door sensors, and drain valves. The IoT-based system, utilizing Arduino IoT Cloud, connects relays to monitor and control components, providing real-time communication and practical learning experiences. Future improvements could involve simulating various washing machine models, incorporating real-time data analytics, introducing virtual reality components, and implementing a user comments system for continuous enhancement.

ABSTRAK

Projek ini menangani perjuangan bersama pelajar pengajian tinggi dalam memahami sistem dan penyelenggaraan mesin basuh. Menyedari ketidakcekapan mesin sedia ada, inisiatif ini memberi tumpuan kepada meningkatkan proses pengajaran dan pembelajaran, khususnya untuk pelajar TVET. Objektif utama adalah untuk membangunkan jurulatih mesin basuh berasaskan IoT, menawarkan latihan praktikal dan alat pembelajaran yang berkesan. Objektif khusus termasuk mensimulasikan fungsi mesin basuh sebenar, memudahkan proses pembelajaran untuk pengajar, menganalisis pemahaman sistem mesin basuh dan menyepadukan IoT untuk pengurusan pembelajaran yang lebih baik. Projek ini bertujuan untuk memberi manfaat kepada institusi pendidikan, menggalakkan amalan dobi yang mampan, meningkatkan kebolehcapaian dan menambah baik pembelajaran secara langsung. Pembangunan melibatkan mengatasi cabaran, termasuk ralat dalam jurulatih, seperti penderia aras air, penderia pintu dan injap longkang. Sistem berasaskan IoT, menggunakan Arduino IoT Cloud, menghubungkan geganti untuk memantau dan mengawal komponen, menyediakan komunikasi masa nyata dan pengalaman pembelajaran praktikal. Penambahbaikan masa depan boleh melibatkan simulasi pelbagai model mesin basuh, menggabungkan analisis data masa nyata, memperkenalkan komponen realiti maya dan melaksanakan sistem ulasan pengguna untuk peningkatan berterusan.

ACKNOWLEDGEMENTS

First and foremost, I would like to express my gratitude to my supervisor, Ts. Eliyana Binti Ruslan for the precious guidance, words of wisdom and patient throughout this project.

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Finally, I would like to thank all the staffs at and fellow colleagues also classmates, as well as other individuals who are not listed here for being co-operative and helpful.

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V	-	Voltage
I	-	Current

CHAPTER 1

INTRODUCTION

1.1 Background

Various innovation products and technologies have been developed to fulfill the government's commitment to make Malaysia a sustainable and competitive nation globally. Not to mention the learning institutions where it emphasizes the development and advancement of technology in the study module. One of the main factors that lead to ineffective teaching and learning is lack of teaching aids and unsatisfactory learning management. A learning activity based on hands-on activities embedded with teaching aids should be influential for college students especially TVET student.

Most students face difficulties in understanding certain devices, for example the washing machine system and how to fix it. This problem is more worrying as it impedes the teaching and learning process itself. The issue occurred when the existing washing machine failed to detect an abnormality to the washing machine. It was found that 69% of the survey on washing machine consumers discarded the products because of a defect and the others were due to other factors.

The washing machine's interior design is complicated and challenging to investigate, resulting in difficulties for students and instructors to entirely carry out the learning process. "Development of IoT Based Washing Machine Trainer for Educational Purposes" project has been designed to be as an education trainer that can educate the student to especially TVET student to enhance their understanding. This project has introduced an alternative trainer for washing machines to replace the conventional trainer. Improvements have been made to some parts of the washing machine to detect abnormalities to the washing machine and notify by connecting to IoT device using IoT Cloud application. This project will show how to deal with the issues in the event of abnormality to the washing machine. The design of washing machine trainer will facilitate students and instructors in a more effective learning process.

1.2 Understanding Societal Issue

Washing machine trainers are limited in certain locations. Washing machines trainer may not be available in impoverished nations or underprivileged communities. This is because the washing machine trainers were designed for educational purposes. Trainer washing machine shortages may affect many parts of life. Laundry workers without training and experience may have fewer career prospects. Modern washing technology may be difficult for communities to embrace, resulting in inefficient laundry practices that wastewater and energy.

This worldwide problem necessitates actions to provide availability to inexpensive and dependable washing machines trainer. In underprivileged communities, vocational training programs and seminars may teach people how to use washing machines effectively and promote sustainable laundry practices.

1.3 Problem Statement

The majority of students in higher education struggle to comprehend the washing machine system and how to fix it. This problem is seen as more worrying as it impedes the teaching and learning process itself. The main factor leading to this problem is that the existing washing machines are less effective and interactive. This is because the washing machine's complex interior design, which necessitates a thorough learning process, makes it inefficient.

As a result, the project is made to help instructors to teach and learn more effectively while also improving student understanding, particularly for TVET students. The initiative is also thought to have the ability to get students interested in learning about washing machine systems and maintenance.

1.4 Project Objective

The main objective of a washing machine trainer is to provide a practical and effective training tool for individuals who want to learn about the mechanism and maintenance of a washing machine. Also, for design and facilitate the instructors' teaching and learning process, enhancing the students' understanding. The following specific objectives are:

a) To simulate the actual functioning of a washing machine that replicates the features and functions of a real washing machine, such as the water sensor and drain motor.
b) To develop facilitating effective learning processes for instructors
c) To improve learning management through IoT integration.

1.5 Scope of Project

Typically, the scope of a washing machine trainer project would include the design and development of an IoT-based training aid using IoT cloud that assists users in learning the operation and maintenance of a washing machine. The initiative consists of the following tasks:

a) The project focuses on benefiting educational institutions.
b) It aims to integrate IoT technology for detecting abnormalities in washing machines.
c) The goal is to promote sustainable laundry practices.
d) The project targets enhanced accessibility, especially in underprivileged communities.
e) It aims to improve hands-on learning and maintenance skills for students.

The overall objective of the project would be to develop a functional and user-friendly instrument for training individuals in the operation and maintenance of a washing machine.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Literature review is research that is conducted on studies done by others where this will be used to improve the system and to distinguish one another. All the comparison process during the literature review were made to complete the Development of Iot Based Washing Machine Trainer for Educational Purposes. This study is about the methods and technologies used as well as the processes used and the project management. In addition, there are additional things to consider including: -

- Reviewed previous projects for useful information in developing the proposed title.
- Review previous projects to find out the advantages and disadvantages of previous projects.
- Develop projects that can overcome previous projects.

2.2 Previous Research in Societal Issue

The ease of acquiring and maintaining a washing machine, as well as the cost of doing so, is one of the social challenges posed by washing machines and associated training. The expensive cost of modern washing machine trainers and teaching equipment could prevent individuals or educational institutions who have restricted budgets from accessing the significant learning possibilities that these products provide. Because of this limitation, individuals who are interested in the subject do not have equitable access to hands-on training, which holds back the development of critical abilities. To solve this problem, efforts might be made to reduce the costs of production and manufacturing, partnerships could be explored with manufacturers or industry experts for the purpose of discounted pricing or contributions, and more cheap alternatives could be developed without sacrificing the quality of the training experience. More individuals and institutions will be able to take benefit of through washing machine training if it is made more accessible and affordable. This will result in a more trained workforce and a better grasp of washing machine technology.

2.3 Detecting Sensor Faults, Anomalies and Outliers on the Internet of Things: A Survey on the Challenges and Solutions

In Industry 4.0, the Internet of Things (IoT) enables worldwide physical interactions. Smart sensors and enhanced communication technologies in IoT applications are changing work, education, creativity, and entertainment. Heterogeneous smart sensors in IoT contexts face sensor failure, malfunction, attrition, security concerns, theft, and manipulation. These situations may cause outlier readings.

In Wireless Sensor Networks (WSNs), sensor outlier and failure detection models have been studied, although IoT research is lacking. IoT applications need outlier and fault detection models since WSNs operate differently. IoT sensor data quality depends on sensor malfunction and outlier detection. Faulty or corrupted sensor data may negatively impact AI and ML models used in IoT applications, causing anomalous processes or outliers that depart dramatically from regular system behavior.

This study discusses Internet of Things sensor defect, anomaly, and outlier detection and its issues. It covers picking the right outlier detection model for IoT sensors in different scenarios. This study intends to help academics and practitioners choose effective methods for identifying and mitigating outliers and defects in IoT sensor data, assuring the reliability and accuracy of IoT system data. Addressing these difficulties may improve IoT application performance and trustworthiness across domains.

2.4 Washing Machine Trainer

Figure 2.1 Prototype of Washing Machine Trainer

Figure 2.1 is a prototype which a highly advanced and effective product that has created a distinct and prominent market area [1]. This semi-automatic trainer as per Figure 2.1 is designed particularly for laboratory experiments and provides an excellent learning platform for washing machine sequential control. The machine trainer is constructed with high-quality materials and cutting-edge technology to ensure its superior performance. To guarantee a faultless selection of products, it adheres to stringent quality standards and undertakes comprehensive inspection by seasoned quality controllers. Key specifications of the Washing Machine Trainer include its single-phase operation, semi-automatic automation grade, and a frequency of 50Hz. It operates on a 230V AC power supply, making it compatible with conventional electrical systems.

The Washing Machine Trainer includes several notable features [1]. It is precisely designed to produce precise and accurate results. The trainer is equipped with a motorized washing machine and dryer, allowing for practical demonstrations of washing machine functions. This function enables users to observe and comprehend the functioning principles and processes of a washing machine. In addition, the trainer provides a high level of functionality, thereby facilitating extensive learning opportunities. It features a user-friendly LCD display with function buttons, facilitating access to various controls and configurations. During experiments, the LCD monitor also displays pertinent information and data.

With its auto/manual selection mechanism, the Washing Machine Trainer allows users to choose between automatic and manual operation modes. In addition, the trainer includes switchable faults, allowing for the simulation of various fault scenarios for troubleshooting and diagnostic purposes. The trainer is designed to interface with most varieties of programmable logic controller (PLC), allowing for seamless integration into existing laboratory configurations. It also has analogue outputs and inputs, allowing for more advanced experimentation and analysis.

Overall, Washing Machine Trainer combines precision engineering, a motorized washing and dryer assembly, and high functionality to create an exceptional learning aid for laboratory experiments. It offers a comprehensive comprehension of sequential control and enables users to set initial process conditions, observe washing machine functions, and investigate various control options. With its sophisticated features and sturdy construction, this trainer establishes a new market standard and serves as a valuable resource for educational institutions and industry professionals [1].

2.5 Washing Machine Auto/Semi Auto

Figure 2.2: Prototype Washing Machine Auto/Semi Auto

In figure 2.2 is a prototype for washing machine auto/semi auto that is valuable instrument for vocational education students to learn about the repair and maintenance of washing machine circuits, as well as to become acquainted with common defects [2]. It is engraved with a block diagram that allows instructors to explain the various phases of washing machine circuits. Multiple evaluation locations on the trainer permit students to measure and evaluate signal shapes and values at various phases of the circuit. One of the main aspects of the Washing Machine Trainer is its ability to simulate defects. Students can activate these defects using basic switches, which can then be detected by measuring the signals at various test points and comparing them to the ideal signals specified in the manual. All stages of the washing machine's circuits are affected, including the motor, pump, door safety lock, heater, timer control signals, and water level switch.

The trainer is constructed as a freestanding metal workstation with four casters, making it simple to move around the laboratory. Multiple cut-away sections have been incorporated into the body of the washing machine, allowing pupils to observe the internal components. A valve is installed for safety purposes to prohibit the washing machine from operating if it is not correctly secured. The Washing Machine Trainer features a well-known brand design, a rust-resistant plastic body, a water valve selector for spin rinse cycles, and a particulate filter. It also offers at least three washing programs, including Normal, Gentle, and Soak.

The main unit for characteristic of the washing machine as per figure 2.2 is it has a plastic outer cabinet, a spin capacity of 5-15 kg, at least three wash programs, a rated wash power of 300-850W, a capacity of 5-7 kg, a rated voltage of 220-240V, a net weight of 15-30 kg, a fully auto (front loader) series, and a rated spin power of 100-500W. Next is secondary unit which has a plastic outer cabinet, a spin capacity of 5-7 kg, at least three wash programs, a rated wash power of 300-350W, a capacity of 5-7 kg, a rated voltage of 220-240V, a net weight of 15-20 kg, a semi auto series, and a rated spin power of 100-200W.

The Washing Machine Trainer provides a comprehensive illustration of washing machine circuits based on a familiar and simple domestic design. It provides multiple test locations for gauging signals throughout the washing machine's various phases. Students can test numerous components, such as the motor, pump, door safety lock, radiator, timer control signals, and water level switch. Simulated defects are incorporated to assess students' ability to diagnose and sustain the complete washing machine components. In addition, an English experiment manual with step-by-step laboratory procedures is included. AC/DC digital clamp meters and a digital insulation resistance tester toolbox set are included with the Washing Machine Trainer as installation and maintenance accessories [2].

2.6 Front Loading Washing Machine Maintenance and Assessment Trainer Didactic Equipment Electrical and Electronics Lab Equipment

Figure 2.3: Prototype Front Loading Washing Machine Maintenance and Assessment Trainer Didactic Equipment Electrical and Electronics Lab Equipment

Figure 2.3 is a prototype for front loading washing machine maintenance and assessment trainer didactic equipment electrical and electronics lab equipment that training device is a drum training module that very precisely imitates the operation of a real washing machine. It is designed to replicate a variety of problems that might occur in washing machines to fulfill a variety of experimental objectives. The fitness machine has a few important characteristics, which follows practical application in this context, "practical application" refers to the fact that the device has been developed expressly for the purpose of the practical application of washing machine control technology and that it may be used appropriately in accordance with training requirements. Next, a modular design that utilizes a standardized modular design, resulting in a product that is lightweight, simple in its operation, and resistant to error. Control that the gadget makes use of switches to control problems, therefore guaranteeing that its functioning is both secure and easy.

The following is an explanation of each of the training device's technical parameters is Weight of less than 150kg, dimensions of 1350 millimeters by 930 millimeters by 1700 millimeters, and working conditions at temperature range of -10 degrees Celsius to 40 degrees celsius with a relative humidity of less than 85 percent at 25 degrees Celsius.

The product is made up of three primary components, the first of which is the frame. It’s because the frame is created utilizing aluminum profiles, it can keep its strength while simultaneously lowering its weight, which enables it to be transported with ease. There are four cushions attached to the underside of the frame to provide support and stability. Second is the physical part, which is a component that simulates a genuine washing machine. This allows for more intuitive observation of experimental events as well as a better understanding of numerous faults that may occur in washing machines. Students will have a better understanding on the fundamentals of how a washing machine works because of the inclusion of a diagram of the washing machine's inner workings that is silk-screened onto the gadget.

In addition, there is a socket with six openings located on the side of the control area to deliver electrical power to the washing machine. Students are given the opportunity to obtain practical experience in identifying and resolving a variety of mechanical issues by using a device that provides a complete list of washing machine failure tests [3].

2.7 ZE3318 Ripple Washing Machine Maintenance and Assessment Trainer Educational Equipment Teaching Equipment

Figure 2.4: Prototype ZE3318 Ripple Washing Machine Maintenance and Assessment Trainer Educational Equipment Teaching Equipment

Figure 2.4 is a prototype of ZE3318 ripple washing machine maintenance and assessment trainer educational equipment that a pulsator training module replicates a washing machine's movements. It simulates washing machine issues and the training device's most essential feature is created to apply washing machine management technology in real-world situations and also may be used for several training objectives. Next, standardized Modular Design, which ensures the device is simple to install and portable, and Fault Control, which allows switches to handle faults for safe and comfortable operation. The training device's technical characteristics are 1800 millimeters by 800 millimeters by 0 millimeters, less than 50 kg, and 10°C to 40°C ambient temperature. At 25°C, the relative humidity is less than 85%.

It has three main parts which are aluminum frames that are used to balance strength and weight. The foundation has four lightweight, space-efficient cushions and is easy to relocate. This improves experimental observation and washing machine failure information. Switches allow the device to imitate several washing machine occurrences. The control component of the washing machine includes a plug with six apertures on the side to accept power. A thorough experiment list focused on washing machine failure testing by the gadget gives students hands-on experience in diagnosing and fixing various flaws.

In conclusion, the pulsator training module simulates a washing machine and a range of issues for experimentation. Its standardized modular design makes deployment and mobility easy and provides for realistic washing machine management technology teaching. Switches provide secure and simple fault control with the equipment. Electrical controller switches simulate washing machine occurrences. Schematic diagrams on the silk screen help explain these switches. For washing machine power, the control area features a six-hole plug. The device focuses on washing machine failure testing and offers several exercises for students to practice finding and resolving flaws. The pulsator training module is ideal for vocational education students who want to learn how to repair and maintain washing machines by doing [4].

2.8 Design Of a Fuzzy Logic Controller for Washing Machine

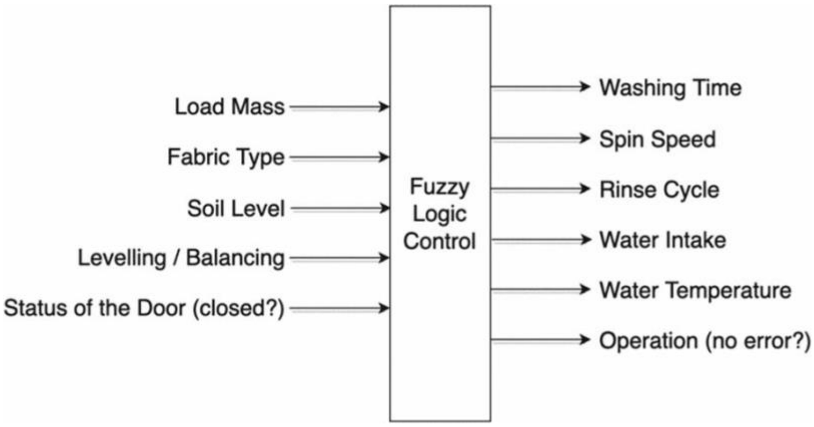

Figure 2.5: Design of A Fuzzy Logic Controller for Washing Machine

Figure 2.5 is a schematic diagram of fuzzy logic controller for washing machines. By using FisPro software, a washing machine's Fuzzy Logic Controller (FLC) was developed and simulated. The FLC handles fuzzy and Boolean inputs and outputs according to their properties. Based on human understanding and reasoning, 48 fuzzy rules captured the washing machine's complexity. These rules helped the FLC make smart judgments and regulate machine outputs. FLC system output was effective and realistic in simulations. By assessing load mass, fabric type, dirt level, levelling/balancing, and door state, the FLC controlled the washing machine's performance. Fuzzy logic regulated washing time, spinning speed, rinse cycle, water input, water temperature, and machine operation.

The washing machine's FLC showed how fuzzy logic can handle real-world uncertainties and errors. Fuzzy logic enhanced efficiency and resource allocation in the washing machine, creating efficient and customized cycles. This experiment shows that fuzzy logic controllers may improve washing machine operation and performance. The discoveries promote fuzzy logic applications and consumer electronics intelligent control systems [5].

2.9 Universal Motor with On-Off Controller for Washing Machine Application

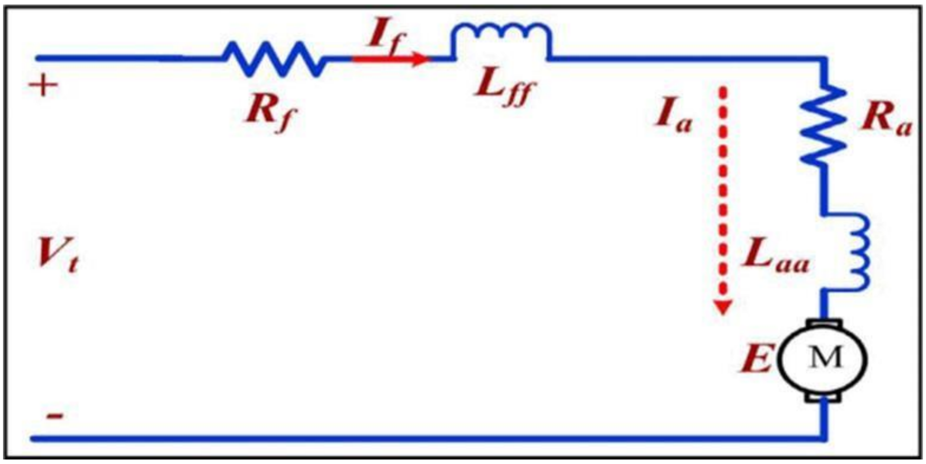

Figure 2.6: Equivalent circuit of the universal motor

Figure 2.6 is a circuit for universal on-off controller. It covers universal motors and its usage in washing machines, electric shavers, food mixers, vacuum cleaners, and boilers. These motors' voltage range, power rating, and speed demonstrate their versatility. Over 70% of houses worldwide have washing machines, demonstrating their relevance in daily life. This section covers washing machine program requirements. The spin mode requires 12000 rpm with a load and 18000 without a load. Due to decreasing torque, conventional motors cannot maintain a steady speed. The goal is to build a universal motor controller that can sustain 12,000 revolutions per minute using an IGBT (Insulated Gate Bipolar Transistor) connected in succession [6].

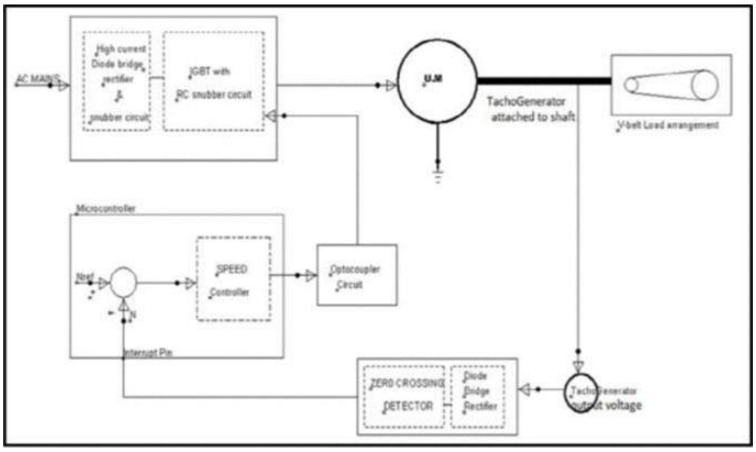

Figure 2.7: System Block Diagram

In Figure 2.7 is the system block diagram that show how to analyze the ways in which universal motors and DC series motors are comparable in terms of the sort of connection that exists between the armature winding and the field winding. Universal motors with laminated cores can reduce DC series motor difficulties such excessive inductive reactance and eddy losses when connected to AC. Universal motors employ compensatory windings to reduce armature response. The universal motors' low-speed torque and high horsepower-to-weight ratio are highlighted.

In addition, it gives a summary of existing research in this field and a foundation for the rest of the study. The major goal of this study is to design a controller board for common motor applications, with a focus on washing machine spin systems. Using a PWM grounded chopper, the goal is to keep the spin rate at 12,000 rpm while boosting system output. This research focuses on managing the motor's voltage to regulate speed. To increase torque and current ripple, harmonically orientated phase control is applied. Big filters were utilized on the system's input and output. Energy MOSFETs are hard to find due to semiconductor technology limits for high-voltage applications like 230V. Working with greater voltages is challenging due to these restrictions [6].

2.10 Washing Machine Trainer System Vocational Trainer Equipment

Figure 2.8: Washing Machine Trainer System Vocational Trainer Equipment

Figure 2.8 is an example prototype for the washing machine trainer system vocational trainer equipment. It provides a full range of functions and a detailed breakdown of its specs to facilitate efficient training and experimentation. The system consists of a printed circuit board (PCB) that lifts the lid on the various circuit boards of a washing machine. This enables users to troubleshoot the device and get a comprehensive understanding of the techniques for discovering faults. By using switches, it is possible to demonstrate more than ten different defects at the same time thanks to the availability of resources for the development of artificial faults. Users are provided with an opportunity for hands-on experience by the system makes the measurement of voltage and viewing of waveforms quite simple. In addition to that, it offers a reference for the normal voltages and waveforms. The accompanying training manual is comprehensive and skill-oriented, and it provides a detailed explanation of the underlying theory.

The system has 10 fault switches and 16 test points on-board, in addition to LED indications for fuzzy, cloth selection, wash, rinse, and spin. Users are better able to comprehend the logic of the system thanks to a block diagram printed on a glass epoxy printed circuit board (PCB). The dark maroon colored metal body of the washing machine has an intake for cold water and an inside tub made of polypropylene (PP). It provides adaptability by having a variety of program settings, such as normal, strong, saree, wool, wash, rinse, and spin so that it may accommodate a variety of washing requirements.

To ensure the PCB unit's long-term reliability and safety, it is housed inside of a powder-coated metal shell. The objective of the experiments that were carried out with the washing machine trainer system was to investigate the fully automatic washing machine, investigate its various sections, and identify various faults in components such as the buzzer, pressure sensor, drain actuator, feed valve safety lid sensor, motor clockwise, and motor anticlockwise. Users may also learn about the capabilities of the keypad, which include power on start/hold, process, program, and water level. In general, this system provides a learning experience that is both in-depth and practical in washing machine technology as well as the diagnosis and repair of common issues [7].

2.11 Monitoring The Status of Self-Operated Community Laundry Machines Using Iot Integration

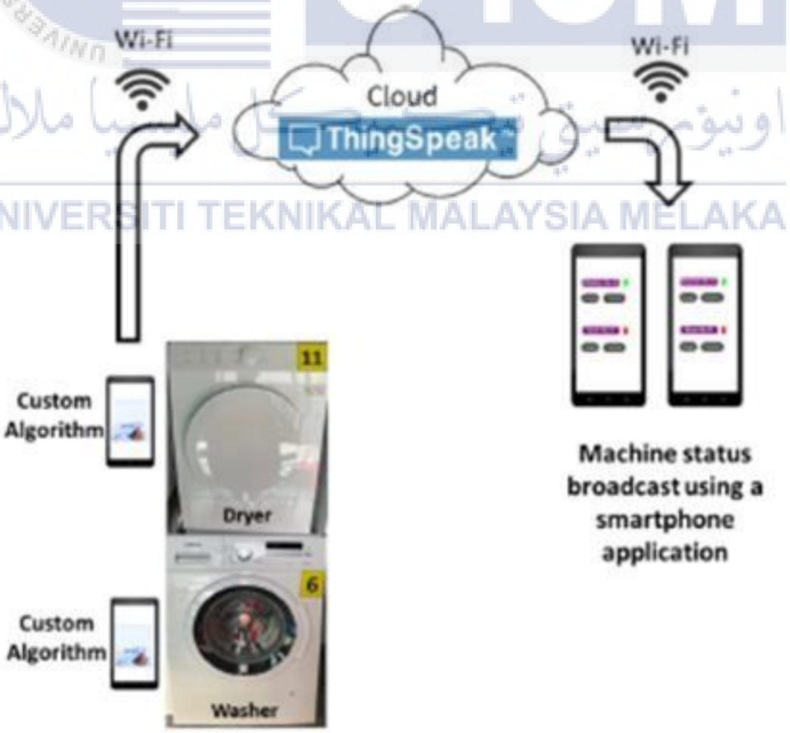

Figure 2.9: Schematic of a cloud-based remote monitoring and reporting platform for self-operated community washing machines.

Figure 2.9 is schematic of cloud-based remote monitoring and reporting platform for self-operated community washing machines that show how smartphones and magnetometer sensors were used to create a system that monitors washing machines in self-service laundry facilities. It needs actual time machine availability information to reduce peak-hour wait times. External monitors have been employed. These devices may need invasive installation and challenging operation. In situations with many pieces of equipment, vibration sensors attached to microcomputers were useless. Cellphones with magnetometers are suitable for this purpose.

The device uses smartphone magnetometer sensors to measure the washing machine's back panel magnetic field strength. This approach is non-intrusive and sensor safe. Simulink and MATLAB are used to represent magnetic field data and machine status. It contains sensor and computer components. The model is installed on Android devices as a stand-alone application, and Thingspeak syncs its status to the cloud so many people may utilize it. A mobile app for iOS and Android will make monitoring data easy to access. This system uses smartphones, magnetometer sensors, and cloud connection to monitor washing machines in self-service laundry facilities in a practical and unobtrusive way [8].

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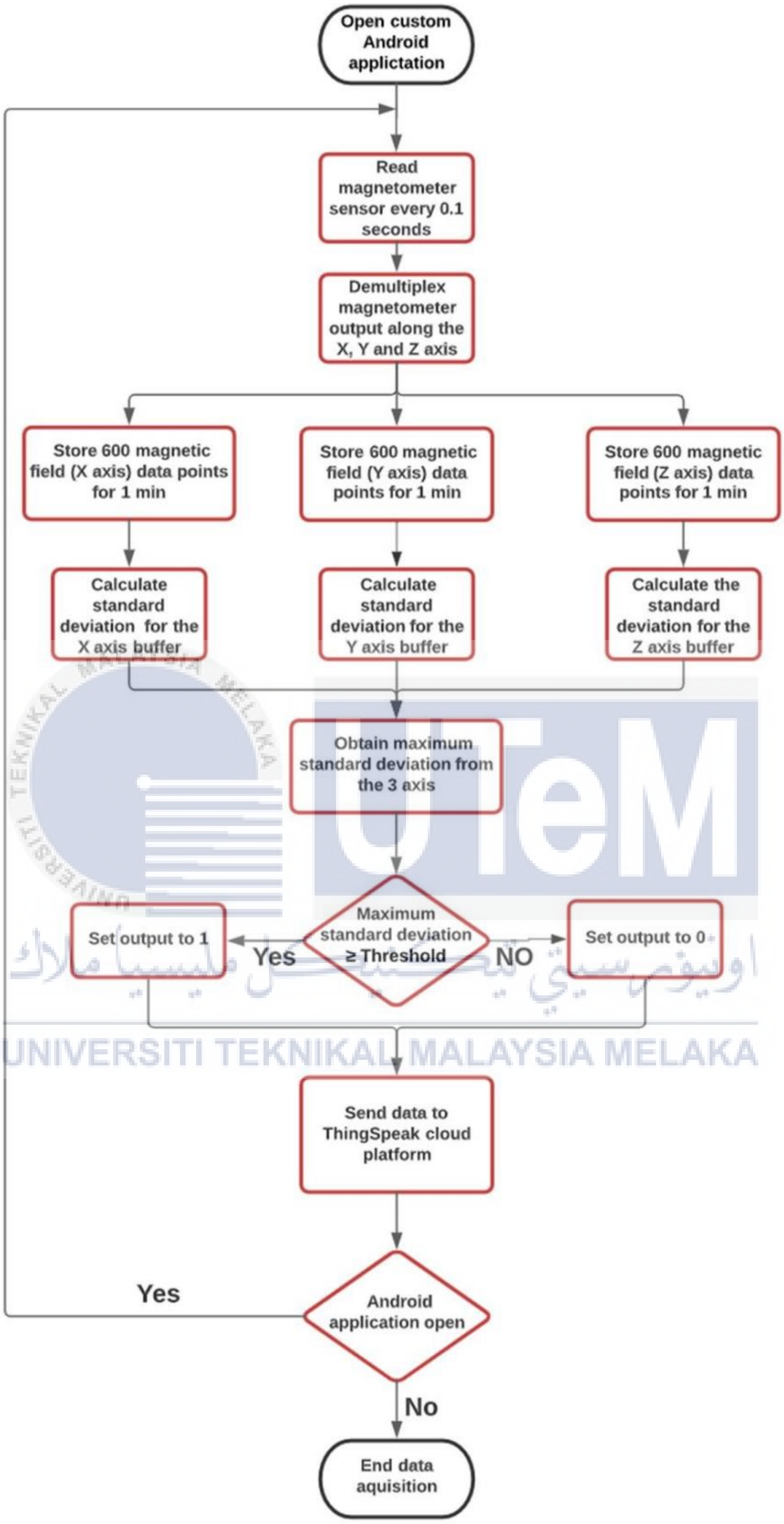


Figure 2.10: Flow chart of the sequence of steps in the algorithm to determine the ON/OFF state of a laundry machine.

In figure 2.10 is a flow chart that sequence of step in algorithm. The creation of a dependable monitoring system that makes use of non-intrusive sensing techniques and IoT technology has led to the development of a novel solution for monitoring washing machines. The device properly forecasts the status of the machine and shows this information on a specialized mobile application by attaching a smartphone to the rear panel of each washer and dryer. This strategy ensures that consumers will have low wait periods and will make optimum use of the machine; as a result, the decision-making tool that it provides is very beneficial. This technology has the possibility of significantly enhancing the user experience in coin-operated laundry rooms by having the capability to be installed in big facilities with hundreds of machines [8].

2.12 HANDYMANN: An App Based Smart Troubleshooting Assistant for A Deluge Valve Maintenance Problem

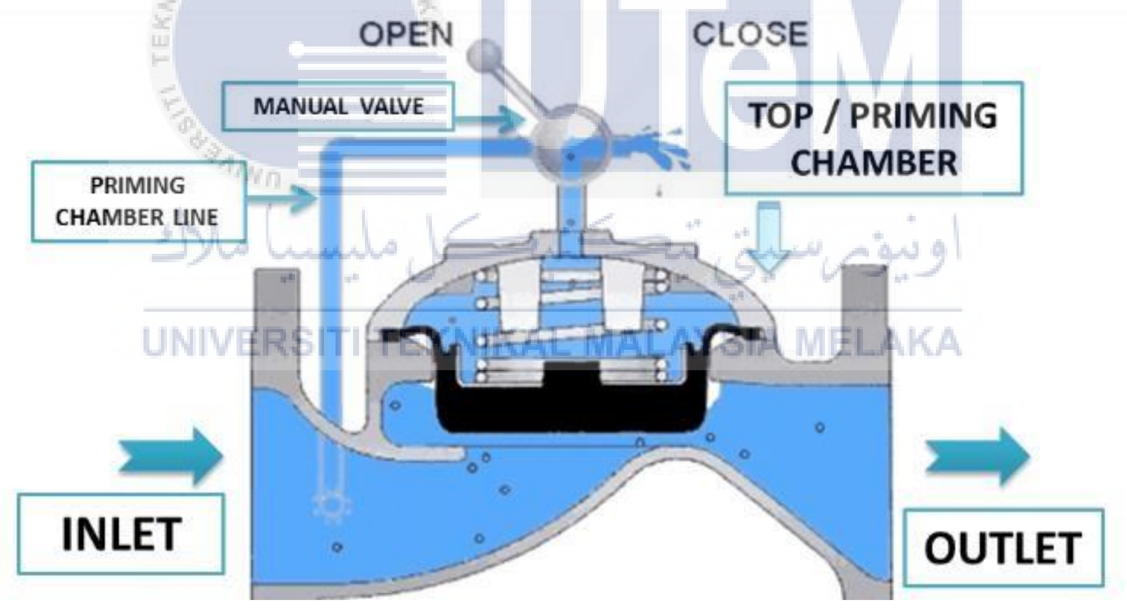


Figure 2.11: Industrial deluge valve system and Cross-sectional view

Figure 2.11 is an overview for industrial deluge valve system and cross-sectional. This project is a deluge valve safety system that was causing false positive alarm triggers, switching on the fire hydrant system and diesel generator, and wasting almost 140 liters of diesel each weekend and 30 liters of water per trigger fault was diagnosed and fixed using the android app "Handy Mann".

This emphasis is on tackling a particular issue that arises in an industrial context, more especially one that is associated with the storage and protection of flammable liquids. In the event of a fire or an increase in temperature, fire hydrant systems equipped with smoke and heat detectors are installed in the storage yards that hold high-speed diesel (HSD) and liquid petroleum gas (LPG). These systems cause the deluge valve to open and activate water sprinklers. However, a problem was found because of pressure imbalances between the hydrostatic and pneumatic lines. This led to a lack of compressed air pressure in the pneumatic line, which indicated that there was a deficit in the pneumatic line.

The article suggests the creation of a user-friendly, real-time Android application as a solution to the difficulties that arise while troubleshooting and reaching project deadlines respectively. This application's purpose is to help engineers in the process of creating comprehensive technical data sheets by taking into consideration various industry standards and requirements. Installation may be performed in either the "Company Confidential Set Mode" (CCS) or the "User Override Reset Mode" (UOR), both of which are available to choose from. While following organizational rules helps keep information secure in the CCS mode, the UOR mode enables engineers to explore innovative solutions and adapt to the specific needs of individual projects.

The application for smart troubleshooting produces a new set of values for use in project proposals and tenders, which cuts the amount of time needed for manually performed calculations by a substantial amount. In general, this cutting-edge Android application offers engineers a strong tool that may improve the efficiency of project proposals and tenders, assure compliance with industry standards, and speed troubleshooting procedures.[9].

2.13 Improving Temperature Sensor Accuracy in The Iot Trainer Kit by Linear Regression Method

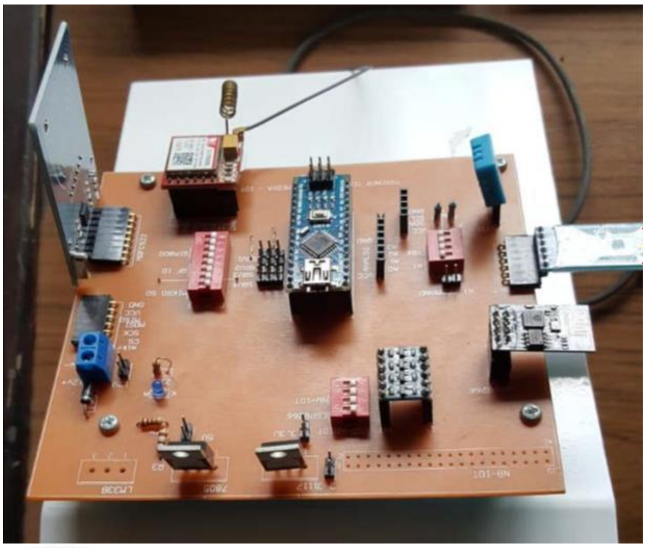


Figure 2.12: The IoT trainer kit prototype.

Figure 2.12 is a prototype of IoT trainer kit that high-quality education to prepare students for industrial revolution 4.0's rapid development. Implementing a well-structured trainer kit and practicum modules may improve students' understanding and abilities in these areas. For example, postgraduate students have employed FPGA/embedded system training kits for brief industrial-level training, and VR training kits for robotic surgical instruction. Power electronics, FPGA learning, audio processing, and Arduino trainer kits have been evaluated for their instructional value.

However, none of the evaluated articles have stressed the significance of checking the correctness of learning tools. These tools must be accurate to help students comprehend and produce accurate experimental findings. Without appropriate tools, students may misunderstand how microcontroller devices receive input. Polytechnics and the industrial revolution 4.0 need high-quality education. This revolution is projected to be led by the Electrical Engineering Department's Telecommunications Study Program. To achieve these requirements, a well-structured curriculum and well-equipped laboratory including trainer kits and practical modules are needed. To improve students' knowledge and provide correct experimental results, learning tools must be verified for accuracy.

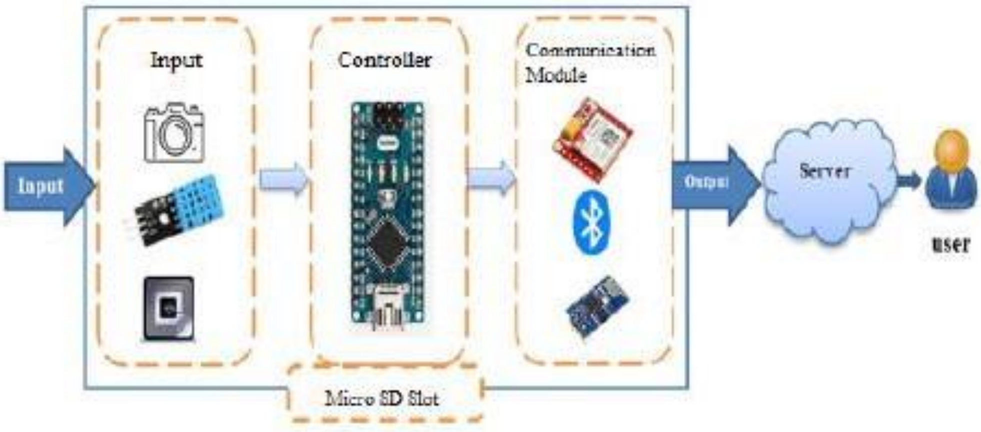


Figure 2.13: Trainer Kit Block Diagram

Figure 2.13 shows the block diagram of the reduction in error indicates that the sensor's measurements are now closer to the true values, leading to more precise temperature readings. Overall, the improvements in both the error rate and standard deviation demonstrate an increased accuracy of the temperature sensor after implementing the revision in the Arduino program. These enhancements are essential for ensuring reliable and trustworthy temperature measurements, enabling better monitoring and control in various applications [10].

2.14 Comparison Of Past Related Paper

Table 2.1: Comparison previous research

No	Name	Summary	Advantage	Disadvantage	Improvement
1	Washing machine trainer[1]	The Washing Machine Trainer is a high-tech lab tool for studying washing machine control. It has an LCD display, a motorised washer and dryer, and automatic or manual operation. Using programmable logic controllers, the trainer simulates faults. Education and industry benefit from it.	• It teaches washing machine sequential control. Demonstrations explain how washing machines work. • Functionality extends learning. LCD monitor and function buttons simplify controls and setup. • Switchable faults let trainers imitate many fault scenarios. This functionality teaches troubleshooting and diagnosis.	• The washing machine trainer may cost extra due to its many features and high-quality development. Exclude low-income persons. • The trainer cycles washers. Not all washing machine operating and maintenance issues are covered. • Additional capabilities and integration may require PLC programming or technical knowledge.	• Lowering production and manufacturing expenses could make the trainer more affordable for educational institutions and professionals. • Maintenance, energy efficiency, and other washing machine system courses could increase training. • Improve the LCD display and control buttons to make learning easier.
2	Washing machine auto/semi auto [2]	The Washing Machine Trainer teaches circuits. An adjustable metal desktop, cut-away plastic body, and genuine faults are included. Students can measure signals with test points and block diagrams. Trainers test the engine, pump, safety	• It teaches students how to understand and fix washing machine circuits. • The trainer's simulated faults allow pupils to practise troubleshooting and problem-solving. • It covers motor, pump, safety lock, heater, timer	• The trainer's domestic washing machine model may limit exposure to real-world designs and settings. • The course replicates faults, but it may not reflect the complexity and real-time obstacles professionals experience	• Residential and commercial washing machine trainers will help students comprehend different circuit designs in real-world circumstances. • Enhanced Fault Simulation: Complex, realistic fault simulations challenge students and teach advanced

		lock, heater, timer, and water level switch.	control signals, and water level switch stages of washing machine circuits.	when repairing washing machines. • Some educational settings cannot afford the Washing Machine Trainer and its peripherals.	troubleshooting and problem-solving. • Virtual or augmented reality washing machine circuit control makes training fun.
3	Front loading washing machine maintenance and assessment trainer didactic equipment electrical and electronics lab equipment [3]	This project will build an electrical and electronics lab and front-loading washer maintenance training centre. Diagnostics, test units, spare parts, fault simulation devices, training, and washing machine repair safety equipment are offered. Oscilloscopes, multimeters, power supplies, function generators, circuit simulators, and breadboards are needed in electrical and electronics labs. The project emphasises safety and hands-on learning.	• The initiative gives front-loading washing machine maintenance and electrical/electronic trainees real-world experience. • Diagnostic tools, simulated defects, and practical exercises help trainees detect and fix problems. • Training materials, test units, and circuit modelling software enhance washing machine maintenance and electrical/electronic knowledge.	• The training setup, including equipment, replacement parts, and diagnostic tools, might be costly. Limited-budget organisations may struggle. • The project needs room for training and lab equipment. The project may be delayed if space is restricted. • Maintaining and updating equipment and training materials ensures their efficacy and relevance. Maintenance might take time and resources.	• Front-loading washers and electronics require updated equipment and training. Trainees learn the newest field technology and practises. • Add online courses or simulations to hands-on training. Remote training increases project reach and participation. • Learn from manufacturers, industry experts, or service centres. Case studies, practical demonstrations, and guest lectures enhance learning.
4	Ze3318 ripple washing machine maintenance	Pulsator training teaches washing machine control and is portable. Students	• Modularity simplifies deployment and mobility. Its portability and setup improve vocational training.	• It may not address all student washing machine issues.	• Add sensors and actuators for a more realistic simulation.

	and assessment trainer educational equipment teaching equipment [4]	can simulate obstacles using a washing machine. Its aluminium frame, modular design, and realistic physical and electrical components make it straightforward to use. Fault control switches and hands-on tests are included. The curriculum teaches washing machine repair.	• Fault control switches improve safety and operability. Students can safely simulate washer breakdowns. • All Experiments: Washing machine failure testing abound. This lets students exercise problem-solving.	• The module's simulation may not give adequate tactile interaction with real machines to increase motor skills and knowledge. • Low-budget schools may have trouble investing and maintaining.	• Simulate a wider spectrum of complicated defects to better identify potential difficulties. • Use touch screens or tactile controls for hands-on learning.
5	Design of a fuzzy logic controller for washing machine [5]	This project develops a Fuzzy Logic Controller (FLC) for washing machines that considers load mass, fabric type, soil level, levelling/balancing, door status, fuzzy logic, and outputs like washing time, spinning speed, water intake, water temperature, rinse cycle, and operation status to improve efficiency and effectiveness.	• Increased washing machine efficiency • Optimises outputs such washing duration, spinning speed, water intake, water temperature, rinse cycle, and operation status. • Increases washing machine efficiency and effectiveness.	• Complexity in developing and implementing the Fuzzy Logic Controller, requiring expertise in fuzzy logic and system design. • Time-consuming process of constructing an effective rule base for the controller. • Potential need for additional computational resources and processing power.	• Reduced water and energy waste through resource optimisation. • Customised washing cycles for different laundry kinds improve cleaning and fabric care. • Intelligent decision-making using fuzzy logic to handle uncertainties and imprecise input values.

6	Universal motor with on-off controller for washing machine application [6]	This research presents an on-off controller for washing machine universal motors to sustain 12,000 rpm during spin cycle. A tacho-generator, microprocessor, PWM chopper circuit, and IGBT control voltage and speed. The cost-effective washing machine controller boosts system performance.	• The project achieves accurate and continuous speed control of 12,000 rpm during washing machine spin cycles. • The proposed controller provides a cost-efficient solution for regulating speed in universal motors. • The PWM-based control circuit effectively reduces unwanted harmonics, current ripple, and torque ripple, ensuring smoother motor operation.	• Limited to universal motor applications, not applicable to other motor types. • Requires additional components and circuitry for closed-loop speed regulation. • Complexity in designing and implementing the PWM chopper circuit. • Potential challenges in calibrating and fine-tuning the controller for optimal performance.	• Enhanced speed accuracy and stability during the spin cycle. • Reduction of harmonics, current ripple, and torque ripple for smoother motor operation. • Cost-effectiveness using a PWM chopper circuit and IGBT. • Integration of closed-loop speed regulation for improved control.
7	Washing machine trainer system vocational trainer equipment [7]	The Washing Machine Trainer System simplifies washer technology and issues. The circuit board and LEDs help users troubleshoot washing machines. A detailed manual covers voltage measuring, waveform interpretation, and failure modelling. The Washing Machine Trainer System simplifies washer diagnosis and repair.	• Users can control the washing machine's circuits. Experience improves problem-solving. • Circuit boards and system specs explain washing machine technology. They can locate machine logic, parts, and sections. • Fault switches simulate malfunctions in real time. This feature teaches common issues.	• Before applying, train and experiment. Washer repairs are rare. • System fault switches simplify simulation. These simulated defects may impair the system's washing machine failure preparation. • Users complete training. Reliance may hinder independent problem-solving and adaptability.	• Simulate more washer difficulties. This would give users more realistic and varied training scenarios. • Fuzzy logic with machine learning or conventional control. Users would learn complex washing machine controls. • Real-time troubleshooting. This would accelerate learning and reduce errors.

8	Monitoring the status of self-operated community laundry machines using iot integration [8]	This paper introduces an IoT automation system for monitoring self-operated community laundry machines. By utilizing smartphones and a custom algorithm, the system accurately determines the ON/OFF state of each machine and provides real-time updates to users through mobile applications. This improves the user experience by reducing wait times and optimizing machine usage.	• Real-time laundry machine monitoring reduces wait times and increases efficiency. • Knowing machine availability helps consumers organise their laundry schedule, improving their experience. • Smartphones and magnetic field monitoring replace intrusive installations and equipment.	• The system uses smartphones for monitoring, which may limit accessibility for users who don't have appropriate devices or don't like using cell phones for such tasks.	• Mobile apps let users track and plan laundry remotely. • Users may make quick selections and avoid wait periods with rapid notifications and updates on laundry machine availability. • Real-time information helps users maximise laundry machine use and reduce idle time.
9	Handymann: an app based smart troubleshooting assistant for a deluge valve maintenance problem [9]	HandyMann is an Android app for smart industrial maintenance troubleshooting. It addresses deluge valve safety system difficulties, creates technical data sheets, and saves time and money. The app is discreet, accurate, and battery efficient.	• Complex problem-solving takes less time with the HandyMann software. • The project saves firms money by avoiding technical problem-solving outsourcing. • During troubleshooting and maintenance, the app's Confidential Set mode protects company data.	• The HandyMann app is Android-only, which may limit its utility to Android users. • The project's operation and performance depend on the app, rendering it vulnerable to technological faults and bugs. • New users, especially those unfamiliar with mobile apps and	• Compatibility with iOS would extend the app's reach. • Regular updates and bug fixes would improve app performance and user experience. • Making the app's UI more intuitive and user-friendly would improve usability and lessen the learning curve for new users.

				technology, may need time to master the app's functions.	
10	Improving temperature sensor accuracy in the iot trainer kit by linear regression method [10]	This study employs linear regression to improve IoT Trainer Kit temperature sensor accuracy. The Arduino programme implemented a regression equation by analysing thermometer and sensor information. The study reduced error rate and standard deviation, improving the temperature sensor in the IoT Trainer Kit.	• The project improves the temperature sensor in the IoT Trainer Kit, assuring more accurate temperature. • Reduced sensor error rate and standard deviation improve IoT data analysis and decision-making. • The IoT Trainer Kit gives students more accurate and trustworthy sensor data, improving their IoT technology education.	• The project only improves the IoT Trainer Kit's temperature sensor accuracy, ignoring other concerns. • The DHT11 temperature sensor is handled, ignoring other kit components that may be inaccurate. • Linear regression can enhance accuracy, however some sensors and applications require alternate methods or advanced methodologies.	• Upgrade to DHT22 temperature sensors for greater accuracy and stability. Upgrades may be needed. • Sensor Fusion: Combine temperature and humidity sensors to overcome sensor restrictions and improve results. • Ongoing Maintenance: Monitor sensor performance. Preventative maintenance and calibration are possible.

2.15 Summary

At the end of this chapter, various project advantages and disadvantages are discussed. Furthermore, the disadvantages have been minimized to the greatest extent feasible. Table 2.2 compares washing machine technology initiatives by approach, convenience, efficiency, and accessibility. "Washing Machine Trainer" and "Monitoring the Status of Self-operated Community Laundry Machines Using IoT Integration" are user-friendly, efficient, and accessible.

Table 2.2: Summary of Past Related Paper

Reference	Method used	Characteristic			
		Convenient	Efficient	Accessible	Inaccessible
1	Programmable Logic Controllers, LCD display, Switchable faults	✓	✓	✓	
2	Adjustable metal desktop, Genuine faults, Test points and block diagrams	✓	✓	✓	
3	Diagnostic tools, Test units, Simulated defects	✓	✓		✓
4	Aluminum frame, Modular design, Fault control switches	✓	✓	✓	
5	Fuzzy Logic Controller, Load mass,	✓	✓		✓
6	Tacho-generator, Microprocessor, PWM chopper circuit	✓	✓		✓
7	Circuit board, LEDs, Fault switches	✓	✓	✓	
8	IoT Automation system, Custom algorithm, Mobile applications	✓	✓	✓	
9	Android app, Deluge valve safety system, Confidential Set mode	✓	✓	✓	
10	Linear regression, Arduino programme, DHT11 temperature sensor	✓	✓	✓	

CHAPTER 3

METHODOLOGY

3.1 Introduction

In this chapter, the methods used to develop the proposed IoT Based Washing Machine Trainer for Educational Purposes are presented. This includes the explanation of the process flow of developing the system, the selection of the hardware and software, and the working flow of the proposed system.

3.2 IoT Based Washing Machine Trainer in Societal Issue

A lack of practical training opportunities in technical fields is one societal issue that can be addressed by developing the IoT-based washing machine trainer proposed for educational purposes. Many educational institutions struggle to provide students with hands-on experience and practical skill development, especially in fields that require specific equipment or resources. This limit may impact the overall competence and preparation of individuals entering the workforce.

The proposed washing machine trainer provides an innovative use of IoT technology and addresses this gap in teaching. incorporating IoT technology into the training procedure. It allows students to engage in interactive and realistic training scenarios in which they can manipulate and observe the operation of a washing machine in a controlled environment. This hands-on experience enables students to develop practical skills, diagnose problems, and comprehend the interior workings of the machine.

Moreover, the accessibility of the instructor through connected devices and applications increases the flexibility and convenience of learning. Students have remote access and interact with instructors, allowing them to practice and acquire knowledge at their own convenience and comfort. This aspect addresses the issue of limited access to specialized training facilities, especially in areas with resource constraints or geographic limitations.

By addressing the societal issue of insufficient practical training, the proposed IoT-based washing machine trainer contributes to the enhancement of technical education. It equips individuals with the necessary skills and competencies to meet industry demands and encourages a more competent and qualified workforce in the washing machine operations field.

3.3 Methodology

The process of the nation becoming more sophisticated and advanced involves the use of a variety of instruments that simplify and accelerate different aspects of the activity. The idea is an innovation that is being pushed with the goal of easing the learning process. This procedure is difficult for everyone involved, including the instructors and the students. There're a few errors in the washing machine trainer that has been created. For example, the water level sensor that regulates water intake, preventing overflow or underfill. It adapts to load sizes, optimizing water usage for efficiency. Second, the washing machine's door sensor is to make sure the cycle only starts when the door is closed and keeps things safe. Next, the drain valve acts like a smart gate that opens to let used water out after washing and closing to get ready for the next cycle. It ensures clothes get rinsed properly, keeping the laundry process smooth and efficient. Furthermore, the motor in a washing machine makes everything spin. It powers the drum to move clothes around, helping water and detergent clean them up. Although, Figure 3.1 shows the flowchart of this project.

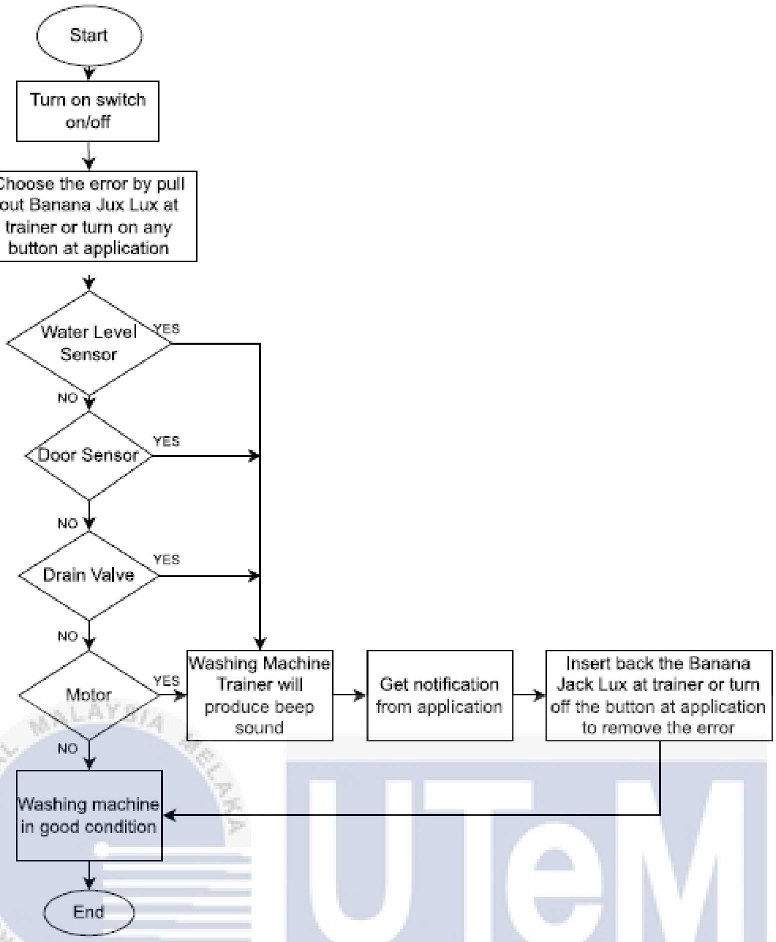


Figure 3.1: Flowchart of Iot Based Washing Machine Trainer For Educational Purposes

As showed in Figure 3.1, most important is turn on the on/off button to activate the operation. Than, choose the fault by pulling out the banana jack lux at trainer or turn on button at application to create the error. As follow next, the error will appear by produce “beep” sound at washing machine and notification will send to application to tell the user. To get rid of the error, insert back the banana jack lux into the trainer or turn off the button at applicattion and it will notify the washing machine is in good condition.

3.3.1 Experimental setup

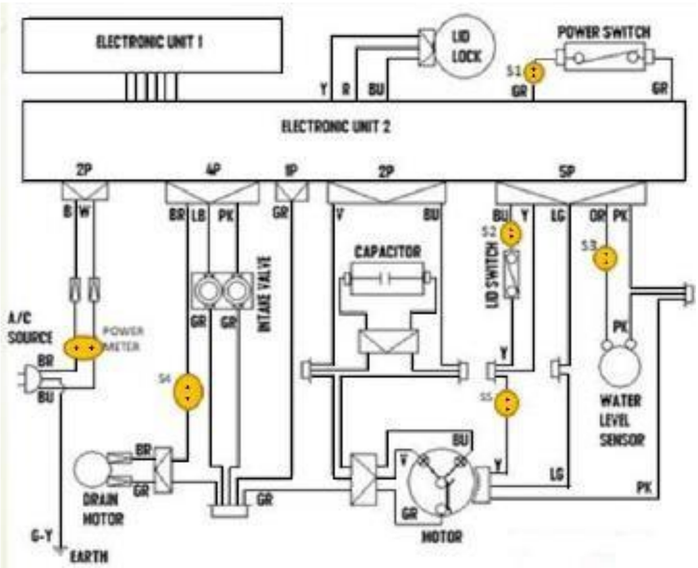


Figure 3.2: Schematic Circuit

Figure 3.2 is a schematic circuit for washing machine Haier modal HWM60-M1101 with 6kg load. The yellow highlight in circuit is the error that was created to make a fault in washing machine. Added banana jack lux will get the washing machine in good condition. Also, adding voltmeter and ammeter to know the voltage and current.

3.3.1.1 Parameters

Using the application to notice the error that users create by pulling out or removing the banana jack lux will also give users more information about voltage and current at the washing machine. It will be easier for users to teach others at learning institutions or at industry.

3.3.1.2 Equipment

To ensure that hardware functions properly and to guarantee that the hardware is capable of performing its duties, there are a few components that must be present.

3.3.1.2.1 Voltmeter

Figure 3.2: Example of Digital Voltmeter

Figure 3.2 shows a digital voltmeter (DVM) is an electrical instrument used to measure voltage in an electrical circuit. It provides a numerical display of the measured voltage, making it easier to read and more precise compared to analog voltmeters. DVMs use analog-to-digital converters (ADCs) to convert the analog voltage into a digital value, which is then displayed on a numeric LCD or LED screen. They offer features such as auto-ranging, peak voltage measurement, and data logging capabilities. Digital voltmeters come in various voltage ranges to accommodate different measurement needs and are commonly used by electrical engineers, technicians, and hobbyists for circuit analysis, troubleshooting, and system maintenance.

3.3.1.2.2 Ammeter

Figure 3.3: Example of Ammeter

An ammeter is an electrical instrument used to measure electric current flowing through a circuit. As per Figure 3.3, it provides a quantitative measurement of the current in amperes (A). Ammeters are typically connected in series within the circuit, allowing the current to flow through the instrument. They have a calibrated scale or a digital display that shows the current reading. Ammeters come in different types, including analog ammeters with a moving needle and digital ammeters with numeric displays. It's important to select an ammeter with an appropriate current range for accurate measurements. Ammeters are widely used in various applications, including electrical testing, circuit analysis, and monitoring electrical systems. Proper safety precautions should be followed while using ammeters to avoid electric shock or damage to the instrument. The measuring device is used for the quantity of electricity flowing through an electric conductor

3.3.1.2.3 Banana Jack Lux / U Jumper

Figure 3.4: Example of Banana Jack Lux or U Jumper

A banana jack lux as per Figure 3.4 is a common type of connector used in electronics to establish secure and reliable electrical connections. It consists of a cylindrical metal pin with a spring-loaded collar and a plastic or rubber insulating sleeve. The Jack Lux is typically inserted into a corresponding socket to establish an electrical connection.

3.3.1.2.4 Switch On / Off

Figure 3.5: Example of Switch On/Off

A switch is a device that allows for the control of electrical circuits by turning them on or off. As per Figure 3.5, it allows electrical current to flow through the circuit when the switch is in the "on" position, enabling the connected device or system to operate. Conversely, when the switch is in the "off" position, it interrupts the flow of electrical current, effectively shutting down the circuit and preventing the device or system from functioning. Switches are fundamental components in electrical systems, providing a simple and efficient means of controlling the flow of electricity to various devices and appliances.

3.3.1.2.5 Arduino Uno

Figure 3.6: Example of Arduino Uno

In electronics applications and prototyping, the Arduino Uno is a popular choice of microcontroller board because of its input/output ports, USB connection, and compatibility with the Arduino Integrated Development Environment (IDE).

3.4 Limitation of proposed methodology

These limitations include the potential high costs involved in developing a realistic trainer, the challenge of accurately simulating real-world washing machine operations, the requirement for adaptability to evolving technology, the need to ensure accessibility for users with varying levels of technical knowledge, considerations for scalability and customization, and the need for regular maintenance and repairs. The suggested technique may be enhanced to give learners more useful and relevant training experience by addressing these constraints. This can be accomplished using cost-effective solutions, user-friendly interfaces, and design flexibility among other things.

3.5 Expected Result

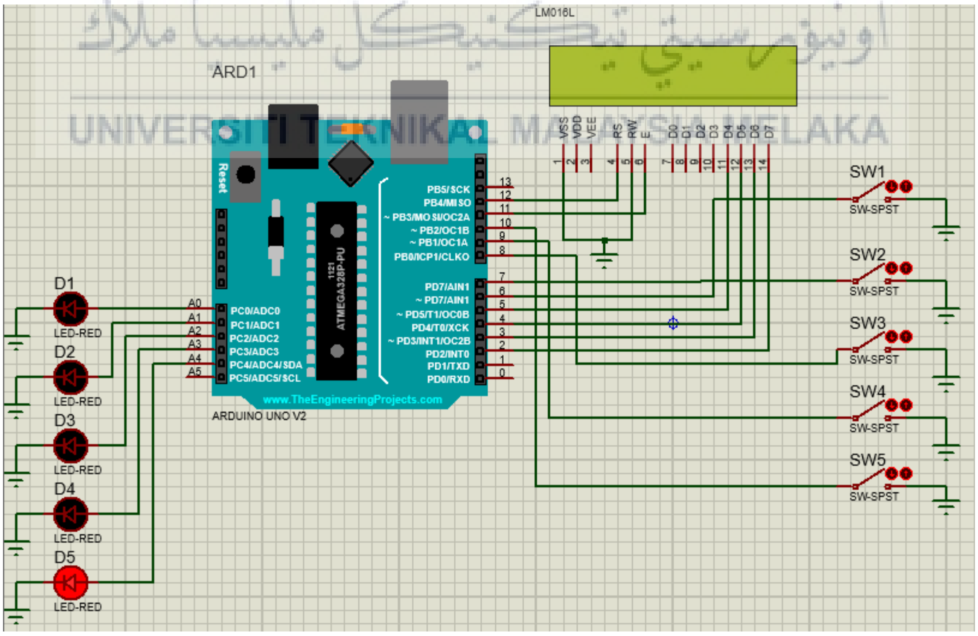


Figure 3.7: Simulation circuit in proteus

In Figure 3.7, the connection of LED, LCD, and the switch can be illustrated to enhance the functionality of the washing machine trainer. The switch is utilized to deliberately create errors or faults in the washing machine by toggling it on or off. Acting as a replacement for an application, the LCD display functions to showcase the detected faults or errors. Additionally, LEDs are employed to indicate specific faults on the trainer washing machine. Each switch is assigned to a corresponding LED, where Switch 1 is connected to LED 1 (power button), Switch 2 to LED 2 (water level), Switch 3 to LED 3 (door sensor), Switch 4 to LED 4 (motor), and Switch 5 to LED 5 (water pump). This configuration enables a comprehensive understanding of fault detection and facilitates effective troubleshooting in the educational setting.

3.6 Summary

This chapter is to be proposed for the washing machine trainer to utilize IoT (Internet of Things) technology to enhance the training experience. By incorporating IoT capabilities, the trainer can offer advanced features which is display the error at application. Learners can access the trainer's functions through connected devices, allowing for convenient and flexible learning. However, it's important to consider limitations such as the cost of implementing IoT infrastructure and the need for reliable internet connectivity. By addressing these challenges and leveraging the benefits of IoT, the proposed methodology can provide an innovative and immersive training experience for learners in the field of washing machine operations.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the results and analysis on the Development of IoT Based Washing Machine Trainer for Educational Purposes. The stage for the Arduino IoT Cloud-based system is designed for monitoring and controlling a set of relays in response to specific error conditions. This innovative code facilitates real-time communication between the physical system and the cloud, allowing for dynamic control and monitoring. The relays are strategically linked to components associated with potential issues, such as water levels, door sensors, drain valves, and motors. Through this interconnected setup, the system can promptly respond to changes in the IoT Cloud variables, taking predefined actions and generating status messages. This introduction encapsulates the essence of an intelligent and responsive system that leverages the capabilities of Arduino IoT Cloud for efficient control and monitoring of error conditions.

4.1.1 IoT Remote Application

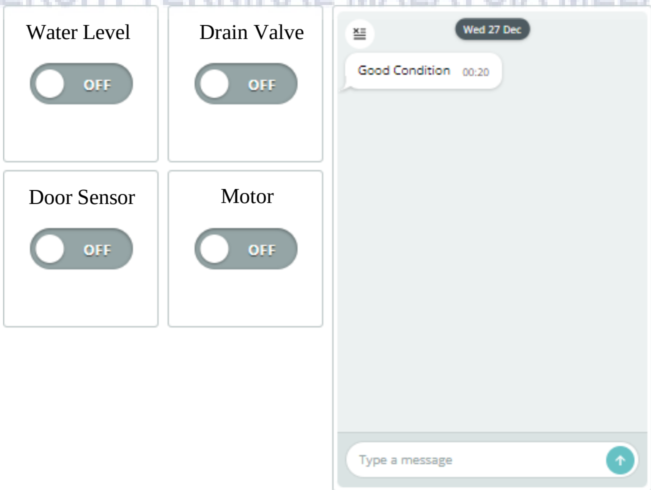
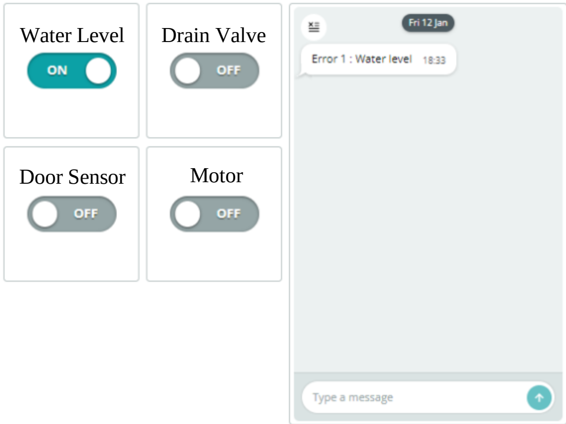
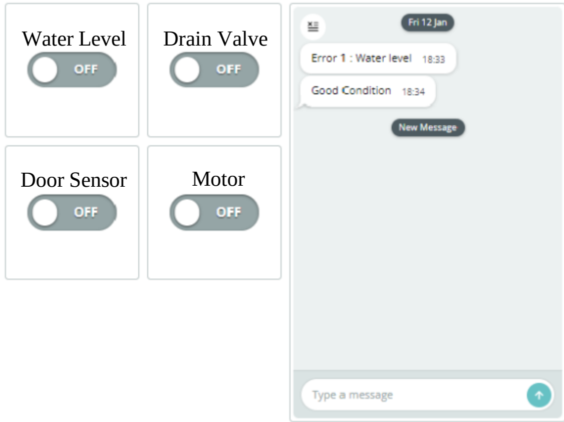
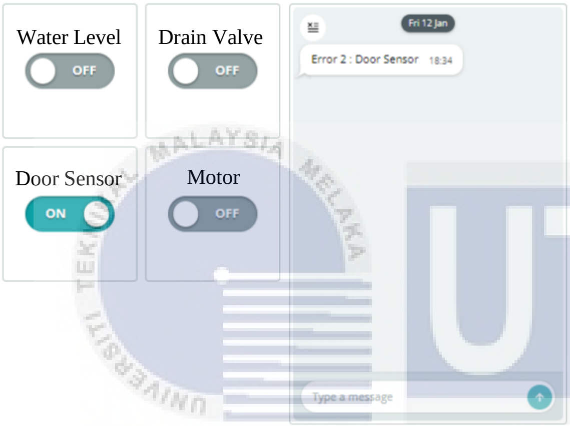
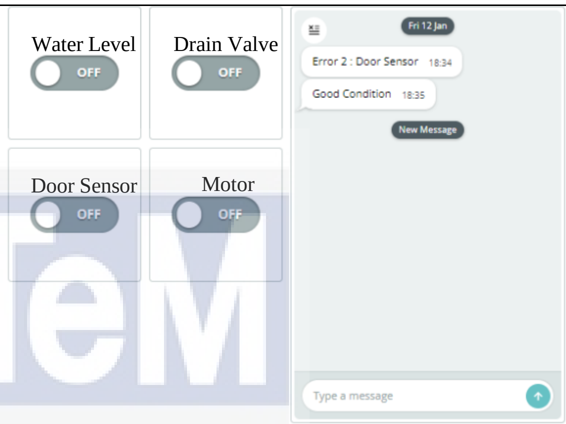
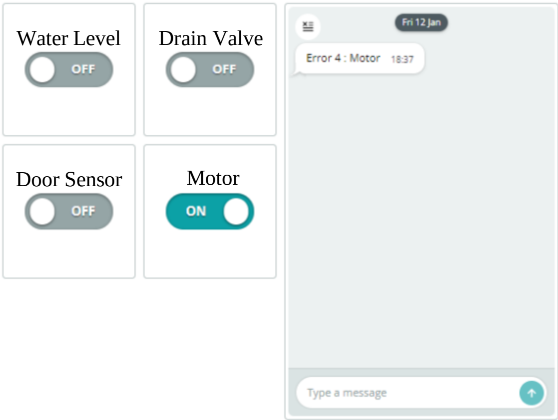
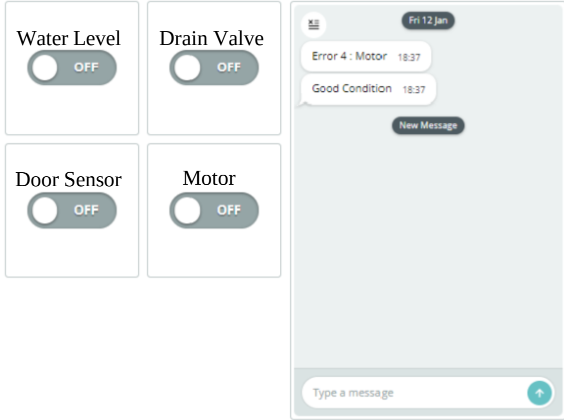
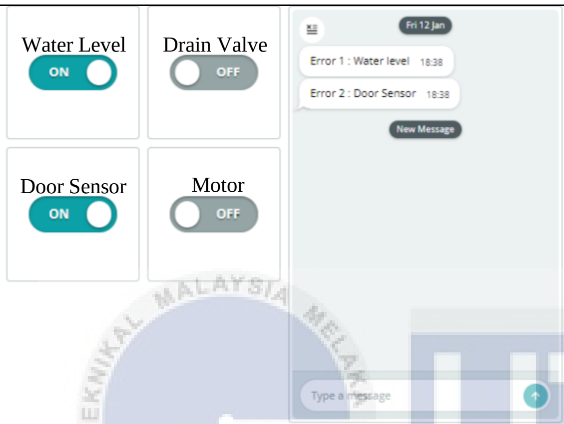
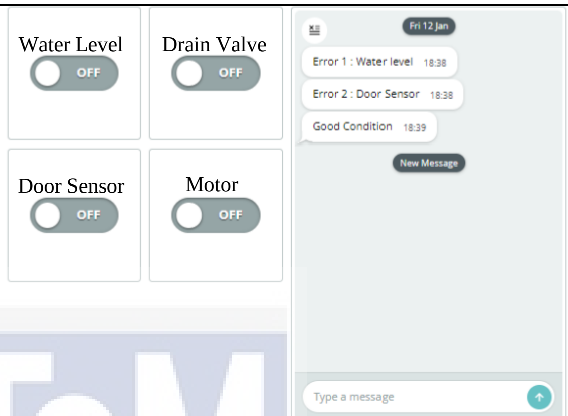
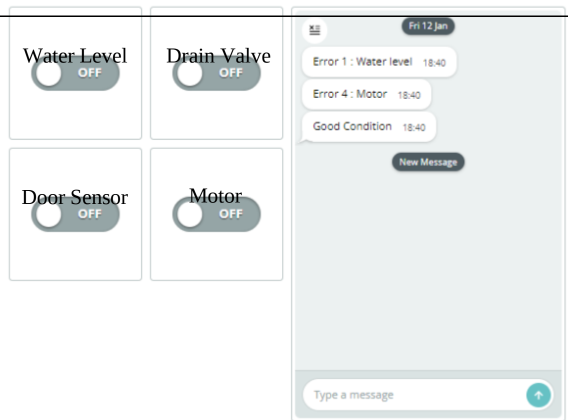
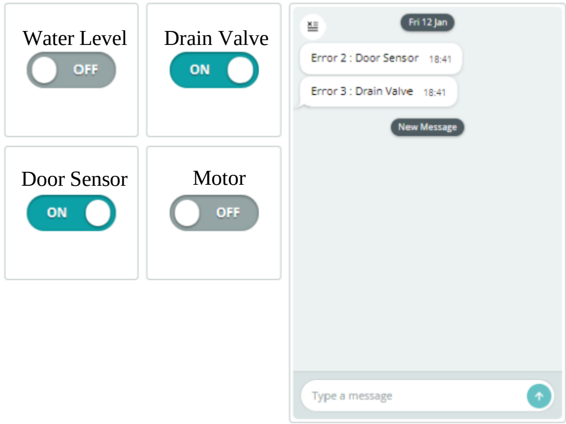
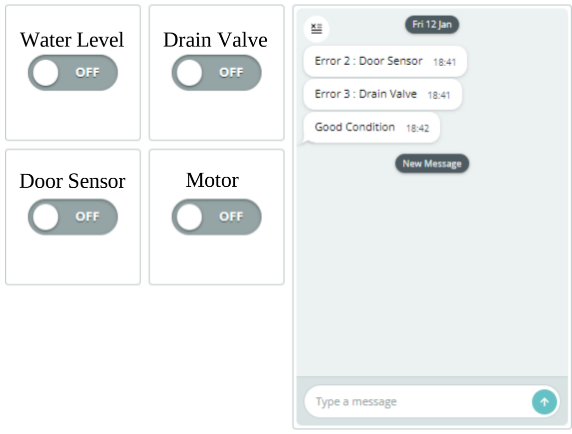
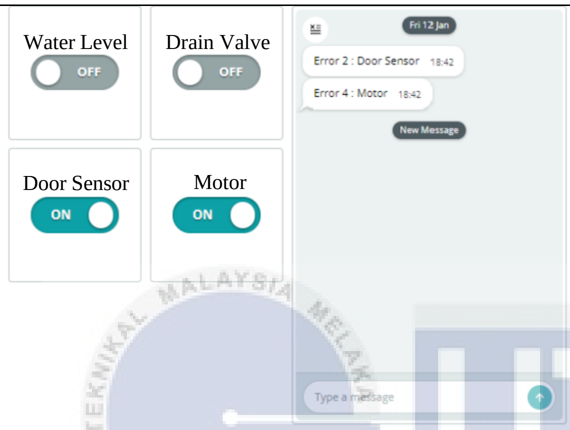
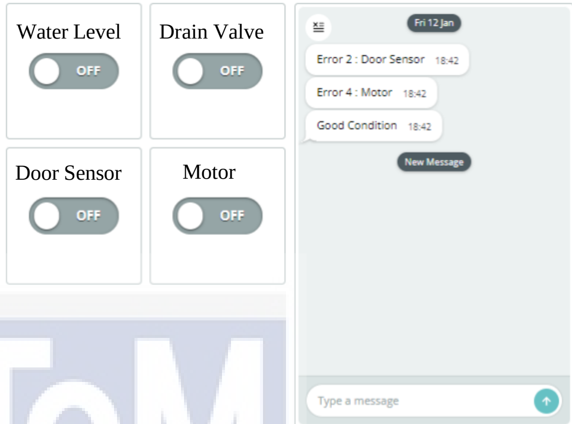
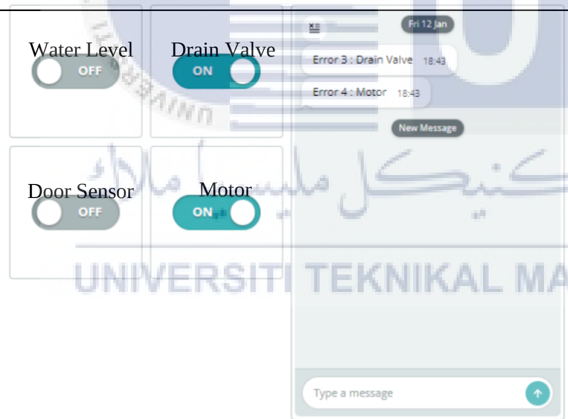
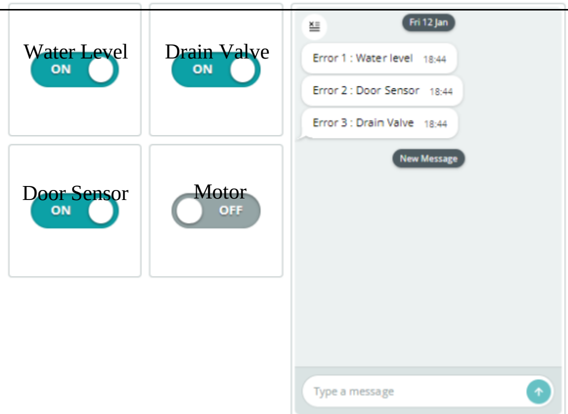
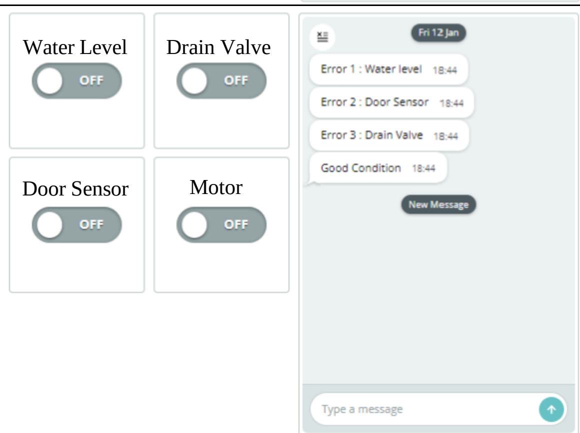


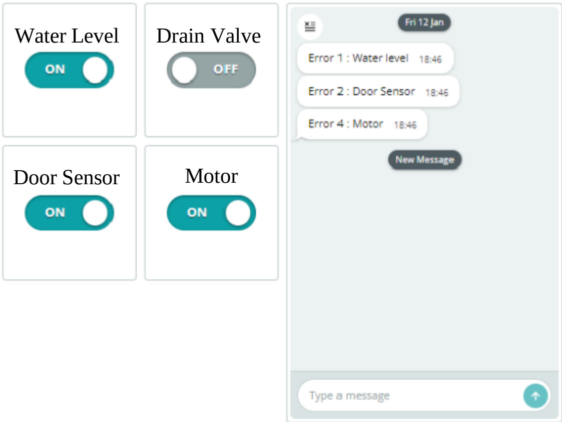
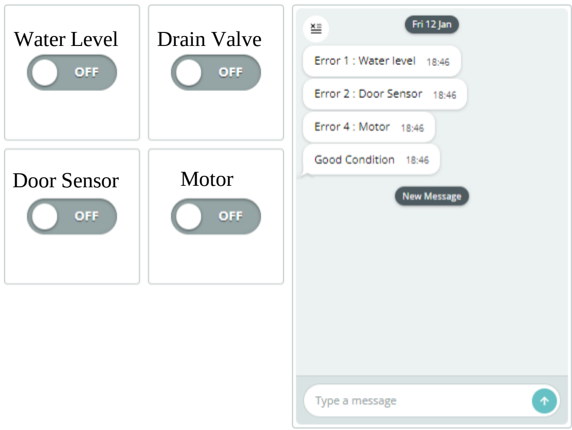
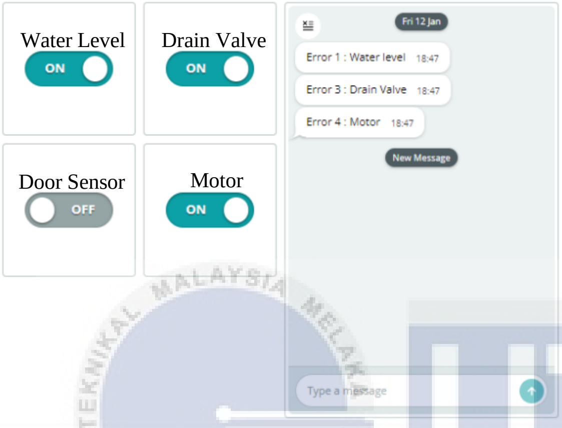
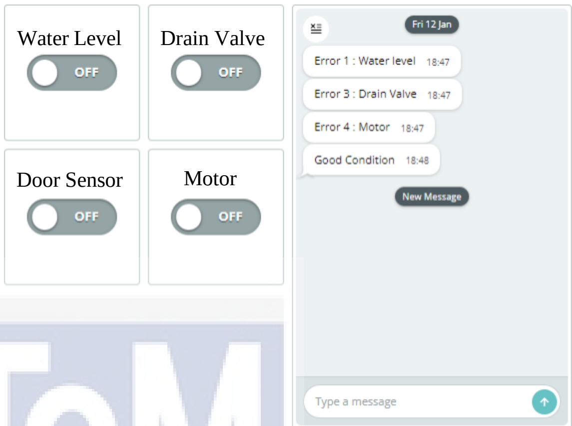
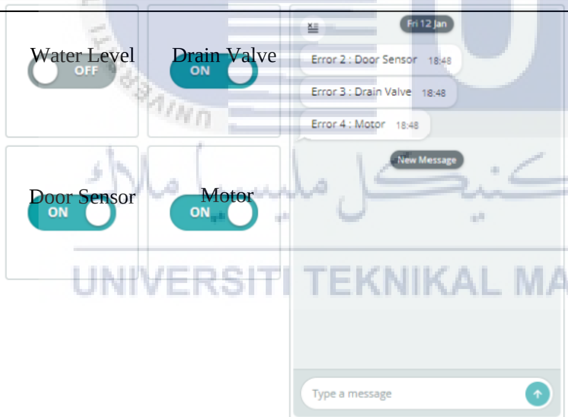
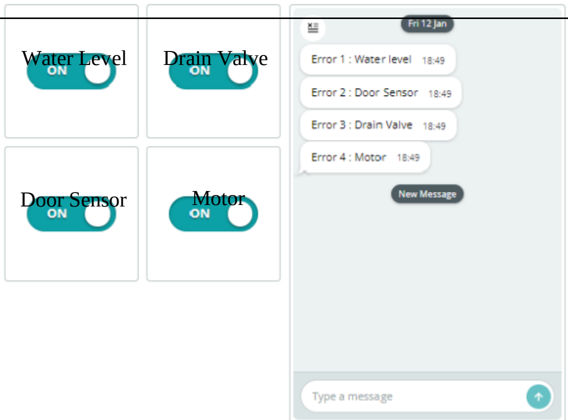
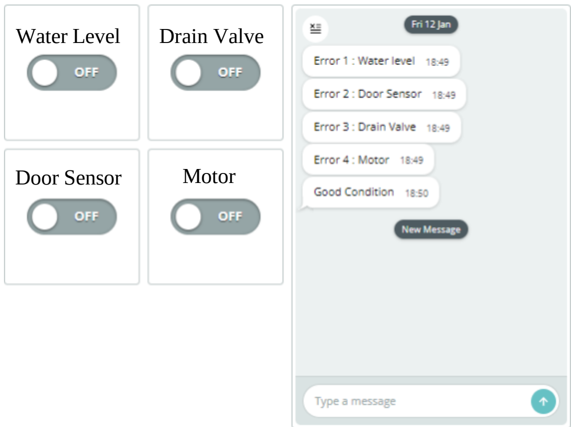
Figure 4.1: Notification from application that display good condition represent no error in wasing machine

Table 4.1 : Analysis data collection

Feature	Error Display	Good Condition Display
Water Level		
Door Sensor		
Drain Valve		

Motor		
Water Level and Door Sensor		
Water Level and Drain Valve		
Water Level and Motor		

Door Sensor and Drain Valve		
Door Sensor and Motor		
Drain Valve and Motor		
Water Level, Door Sensor and Drain Valve		

Water Level, Door Sensor and Motor		
Water Level, Drain Valve and Motor		
Door Sensor, Drain Valve and Motor		
Water Level, Door Sensor Drain Valve and Motor		

The washing machine trainer incorporates several key features to enhance learning, including the Water Level sensor, which regulates water intake to prevent overflow. The Door Sensor ensures that the washing cycle initiates only when the door is securely closed. Another essential component is the Drain Valve, functioning as a smart gate that opens after washing to release used water, optimizing the rinsing process. The Motor, a crucial element, powers the drum's rotation, facilitating the washing process. Table 4.1 presents data collected from application, detailing error displays triggered by actions such as pulling out the banana jack lux or using the application's button to simulate errors. The error display prompts notifications and beeps on the washing machine. The condition column indicates whether the washing machine is in good condition or not. Achieving a good condition involves placing the banana jack lux back in the trainer or using the application's button to turn off errors, ensuring a smooth washing machine operation with no detected issues.

4.1.2 Washing Machine Trainer

The washing machine trainer model is HWM60-M1101 that offers a comprehensive learning experience for understanding electrical components in a practical setting. Equipped with essential tools such as a voltmeter for measuring electrical potential, an ammeter to gauge electricity flow, and a power monitor for tracking power processes, this trainer facilitates hands-on exploration. Additionally, safety features like the Miniature Circuit Breaker (MCB) and the Molded Case Circuit Breaker (MCCB) ensure protection against excessive electric currents. The trainer includes a switch for convenient on/off control. In terms of the washing machine models (HWM60-P1201 and HWM60-M1201), they operate at a rated voltage of 220V-240V~/50Hz, with a washing/spinning capacity of 6.0 kg load. The IPX4 water-proof design ensures safety, and the machine's dimensions make it suitable for effective learning and teaching scenarios. This setup provides a practical and illustrative approach to understanding electrical components within the context of a washing machine.

Figure 4.2: The Trainer for Washing Machine

4.1.3 Connect Washing Mashine Trainer with ESP32

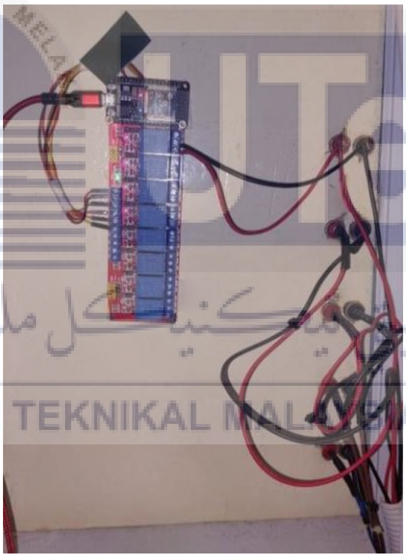


Figure 4.3: ESP32 with relay 8 channel

As shown in Figure 4.18, it is wirelessly controlling electrical circuits. With its built-in Wi-Fi, it allows to turn devices on/off remotely. making it a managing and automating various for the trainer.

Figure 4.4: Full Hardware of Washing Machine Trainer

Following the success in both hardware and software implementation, the process of connecting the ESP32 to the washing machine trainer becomes a straightforward task that significantly enhances the overall functionality of the setup. This involves establishing a secure connection between the ESP32 module and the electrical components of the washing machine as shown in Figure 4.20. Through this connection, users gain the capability to collect real-time data and exercise control over various parameters. Furthermore, this integration seamlessly interfaces with the Arduino IoT Cloud application, presenting users with a user-friendly platform for monitoring and managing the washing machine. With the IoT Cloud application, users can remotely access crucial information, including voltage, current, and power consumption, facilitating efficient monitoring and control. This integrated approach not only introduces a layer of convenience but also explores possibilities for automation and the implementation of smart functionalities within the washing machine trainer setup.

4.2 Summary

This chapter presented case studies to demonstrate applicability of the results and analysis of the IoT-based Washing Machine Trainer for educational purposes are presented. The Arduino IoT Cloud-based system, designed to monitor and control relays in response to specific error conditions, enables real-time communication between the physical system and the cloud. The relays are strategically linked to components like water levels, door sensors, drain valves, and motors. The associated Arduino IoT Cloud code dynamically responds to changes in variables, executing predefined actions and generating status messages. The Washing Machine Trainer, equipped with essential tools and safety features, offers a practical learning experience. Following hardware and software success, connecting the ESP32 to the trainer enhances functionality, allowing real-time data collection and control. Integrated with the Arduino IoT Cloud application, users can remotely access vital information, fostering efficient monitoring and control, and exploring possibilities for automation within the setup.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In summary, the "Development of IoT Based Washing Machine Trainer for Educational Purposes" project addresses a pressing issue in technical education, focusing on the challenges faced by students, especially in TVET programs, in comprehending and maintaining washing machine systems. The initiative introduces an innovative IoT-based trainer that simulates real-world washing machine functionalities, detects abnormalities, and integrates with IoT Cloud applications for enhanced learning management. By providing hands-on and interactive training scenarios, the project not only improves student's practical skills but also addresses the societal issue of limited access to specialized training facilities, particularly in underprivileged communities.

The methodology of the project encompasses a systematic process flow, including the development of the IoT-based trainer, experimental setups, and coding for Arduino IoT Cloud. The successful implementation of the Arduino IoT Cloud-based system is highlighted in the results and analysis chapter, showcasing its ability to monitor and control relays in response to specific error conditions. The case studies presented further validate the project's results, emphasizing the practical learning experience and the potential for automation within the setup. Overall, this initiative contributes to advancing technical education, aligning with the government's commitment to making Malaysia a sustainable and globally competitive nation. The integration of IoT technology not only improves training accessibility but also promotes sustainable practices and career prospects for individuals entering the workforce.

5.2 Future Works

For future improvements, accuracy of the Development of IoT Based Washing Machine Trainer for Educational Purposes results could be enhanced as follows:

i. Expand the trainer to simulate many washing machine models with varied features to expose students to different technology.

ii. Integrate real-time data analytics for students to review throughout training to understand performance metrics and mistake patterns.

iii. For an immersive learning experience, include a virtual reality component that lets students interact with washing machine components.

iv. User comments System which collects student and teacher comments to enhance the trainer's design and effectiveness.

REFERENCES

[1] Vinamra, “Washing Machine Trainer,” 2019.

[2] cassandra, “WASHING MACHINE AUTO/SEMI AUTO,” 2021.

[3] Jennie, “ZE3319 Front Loading Washing Machine Maintenance and Assessment Trainer Teaching Equipment,” 2019.

[4] CHIN JIA, “ZE3318 Ripple Washing Machine Maintenance and Assessment Trainer Educational Equipment Teaching Equipment,” 2022.

[5] C. J. Zheng, C. J. Jing, and L. H. Yew, “Design of a Fuzzy Logic Controller for Washing Machine,” in *2022 3rd International Conference on Artificial Intelligence and Data Sciences: Championing Innovations in Artificial Intelligence and Data Sciences for Sustainable Future, AiDAS 2022 - Proceedings*, Institute of Electrical and Electronics Engineers Inc., 2022, pp. 45–48. doi: 10.1109/AiDAS56890.2022.9918719.

[6] S. Natarajan, K. Balasubramanian, P. R. Satpathy, and T. S. Babu, “Universal Motor with On-Off Controller for Washing Machine Application,” in *2021 International Conference in Advances in Power, Signal, and Information Technology, APSIT 2021*, Institute of Electrical and Electronics Engineers Inc., 2021. doi: 10.1109/APSIT52773.2021.9641321.

[7] B Damodaran Shaji, “Washing Machine Trainer System Vocational Trainer Equipment,” 2005.

[8] A. Menachery and C. Johnson, “Monitoring the Status of Self-Operated Community Laundry Machines using IoT integration,” in *Proceedings of the 3rd IEEE Eurasia Conference on IOT, Communication and Engineering 2021,*

ECICE 2021, Institute of Electrical and Electronics Engineers Inc., 2021, pp. 83–85. doi: 10.1109/ECICE52819.2021.9645688.

[9] Massachusetts Institute of Technology and Institute of Electrical and Electronics Engineers, *2018 IEEE MIT Undergraduate Research Technology Conference (URTC) : October 5, 2018, Cambridge, MA, USA.*

[10] IEEE Staff, *2019 International Conference on Mechatronics, Robotics and Systems Engineering (MoRSE)*. IEEE, 2019.

APPENDICES

Appendix A Gant Chart

No	PSM 2 Project Activity	Expected	Week													
		Actual	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Registration for PSM 2	Expected														
		Actual														
2	PSM 2 briefing	Expected														
		Actual														
3	Complete Hardware	Expected														
		Actual														
4	Study for coding	Expected														
		Actual														
5	Create a coding using Arduino IoT Cloud	Expected														
		Actual														
6	Testing the coding	Expected														
		Actual														
7	Progress Update to superviso	Expected														
		Actual														
8	onnect hardware and softwar	Expected														
		Actual														
9	Testing the project	Expected														
		Actual														
10	eview project with superviso	Expected														
		Actual														
11	Complete chapter 4 and 5	Expected														
		Actual														
12	Review report with superviso	Expected														
		Actual														
13	Submit report	Expected														
		Actual														
14	PSM 2 presentation	Expected														
		Actual														