Faculty of Electronic and Computer Engineering and Technology

DEVELOPMENT OF GENERAL WASTE INTELLIGENCE SORTING SYSTEM WITH GSM

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours

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DEVELOPMENT OF GENERAL WASTE INTELLIGENCE SORTING SYSTEM WITH GSM

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

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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FAKULTI TEKNOLOGI KEJUTERAAN ELEKTRIK DAN ELEKTRONIK

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APPROVAL

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 Electronics Engineering Technology (Industrial Electronics) with Honours.

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Co-Supervisor :

Name (if any)

Date :

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DEDICATION

To my beloved mother, Azyliana Binti Harun, and father, Zamri Bin Abu Bakar,

To my Supervisor,

To my supportive friends,

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ABSTRACT

Waste sorting systems have become increasingly important as a means of reducing environmental pollution and promoting sustainable development .The increasing of waste can lead to air pollution and water pollution .The gas that come out from decompose waste is dangerous for human to breath which can lead to many diseases. This system involves the separation of waste materials into different categories based on their composition, with the aim of facilitating recycling, composting, and disposal. The objective of waste sorting system is to design a system that can sort the waste base on their type such as wet waste , dry waste and metal waste . Then the project also will be implemented with GSM that develop a system which can monitor the condition of the waste in the bin . After that, the system will be analyse to determine it weaknesses in sorting the waste .This system has been developed by many user before which the previous project will be study and compared .The comparison of previous will help the system to achieve it objective and make an improvement than previous system .The system will be using various component such as Microcontroller and proximity sensor .The microcontroller act as the brain for the system while proximity sensor is use to detect the waste . The project will be summarized and will achieve the objective of the system to sort the waste.

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ABSTRAK

Sistem pengisihan sisa telah menjadi semakin penting sebagai cara mengurangkan pencemaran alam sekitar dan menggalakkan pembangunan mampan. Peningkatan sisa boleh menyebabkan pencemaran udara dan pencemaran air. Gas yang keluar dari sisa reput berbahaya bagi manusia untuk bernafas yang boleh membawa kepada banyak penyakit. Sistem ini melibatkan pemisahan bahan buangan ke dalam kategori yang berbeza berdasarkan komposisi mereka, dengan tujuan untuk memudahkan kitar semula, pengkomposan, dan pelupusan. Objektif sistem pengasingan sisa adalah untuk mereka bentuk sistem yang boleh menyusun asas sisa pada jenis mereka seperti sisa basah, sisa kering dan sisa logam. Kemudian projek ini juga akan dilaksanakan dengan GSM yang membangunkan satu sistem yang boleh memantau keadaan sisa di dalam tong. Selepas itu, sistem akan dianalisis untuk menentukan kelemahannya dalam menyusun sisa . Sistem ini telah dibangunkan oleh ramai pengguna sebelum ini yang mana projek sebelumnya akan dikaji dan dibandingkan . Perbandingan sebelumnya akan membantu sistem untuk mencapai objektifnya dan membuat peningkatan daripada sistem sebelumnya . Sistem ini akan menggunakan pelbagai komponen seperti Microcontroller dan sensor kehampiran. Microcontroller bertindak sebagai otak untuk sistem manakala sensor kehampiran digunakan untuk mengesan sisa . Projek ini akan diringkaskan dan akan mencapai objektif sistem untuk menyusun sisa.

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All praises are to Allah S.W.T, Lord of the Universe, the most Merciful, the most Gracious and Beneficent to Prophet Muhammad S.A.W, His Companion and the people who follow His path. First and foremost, a lot of thanks to Almighty Allah for giving me strength and patience in completing Final Year Project 1 for this semester.

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Besides, my appreciation also goes to my family who always gives moral support to keep me motivated and never gives up. Their prayers for my success inspire me to give my best in completing this project. Their love and support are helpful to ease my pressure. My sincere appreciation also extends to all my colleagues and others who have helped at various occasions. I hope those people who helped me will have a beautiful life.

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CHAPTER 1

INTRODUCTION

1.1 Background

The issue of waste management has become a major challenge in many parts of the world due to the increasing amount of waste generated by human activities. Improper disposal of waste can lead to environmental pollution, health hazards, and depletion of natural resources. To address this challenge, waste sorting systems have been developed to facilitate the separation of waste materials for recycling, composting, and safe disposal.

1.2 Addressing Waste Management through waste sorting system

Waste sorting systems can be used in a variety of settings, including the home, the workplace, and public areas like parks and streets. A garbage sorting system's number of waste categories can also change based on its level of sophistication and the waste management regulations in the area. For instance, some systems would merely call for the sorting of recyclables like paper, plastic, and glass, while others might include call for hazardous and organic trash.[2]

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Advancements in technology have also played a significant role in improving the efficiency and accuracy of waste sorting systems. Automated sorting systems that employ sensors, artificial intelligence, and robotics have been developed to enhance the speed and precision of waste sorting processes. [3]

The success of waste sorting systems depends on the cooperation and collaboration of the various stakeholders, including government agencies, waste management companies, and the general public. Education and awareness campaigns are also important to encourage public participation and compliance with waste sorting policies. [4]

1.3 Problem Statement

Ineffective waste management techniques endanger public health and greatly contribute to environmental deterioration. The efficient separation of recyclable and non-recyclable materials at the source is hampered by the existing lack of an automated and intelligent trash sorting system, which increases landfill consumption and misses recycling chances.

As a result, pollution rises, natural resource depletion occurs, and greenhouse gas emissions rise. The creation of a strong waste sorting system that makes use of cutting-edge technologies, like robotics, computer vision, and artificial intelligence, is required to address this urgent problem and improve the precision and effectiveness of waste sorting procedures. To provide continuous monitoring of garbage bins, provide real-time status updates, and optimise waste collection routes, this system should include advanced sensors, IoT technologies, and GSM.

By guaranteeing the correct separation of waste streams, this system should easily integrate into the current waste management infrastructure and support sustainable practices, helping to improve resource efficiency and the environment.

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1.4 Project Objective

The major objectives are.

1. To design a system that can automatically sort a waste base on their type dry , wet and metal.

2.To develop a system which will then alert a user that the waste inside the bin is full to avoid overflow by using GSM.

3.To analyse the efficiency of the system

1.5 Scope of Project

An Arduino microcontroller and a GSM with a proximity sensor as the output will be used in this project. Using this approach, the project will separate the waste into dry, metal, and wet categories while keeping an eye on the amount of waste in each container to prevent overflow and notify the local authorities to handle waste cleanup. The project is primarily concerned with locations like restaurants, grocery stores, offices, and homes where trash disposal is dependent on kind.

a)

b)

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

As societies all around the world continue to struggle with the problems of waste management, garbage sorting systems have become more and more crucial. For the sake of the environment, reducing hazards to the public's health, and supporting the sustainable use of resources, waste disposal and sorting must be done properly. [8]

In recent years, there has been growing interest in developing effective garbage sorting systems that can efficiently sort different types of waste materials, including plastics, paper, metals, and organic waste. The development of advanced technologies such as artificial intelligence, machine learning, and robotics has provided new opportunities for creating innovative garbage sorting systems that can improve waste management practices. [9]

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This literature review will explore the current state of research on garbage sorting systems, with a focus on the latest technologies, methodologies, and approaches that have been used to develop and implement effective waste management strategies. It will also examine the challenges and opportunities associated with garbage sorting systems, as well as the potential implications of these systems for the environment, public health, and sustainable development.

2.2 Existing Study

Intelligent Waste Separator (IWS) can replace the traditional way of dealing with waste; The prototype automatically places garbage into the basins and accepts wastes by using a multimedia embedded processor, image processing specifically using the image recognition algorithm, and machine learning in order to select and separate waste. It developed prototype consists of a shared trash can, with supplementary basins in it, using multimedia technology. [10]

Spot Garbage is a smartphone-based application. It detects a pile of garbage and identifies the location where the garbage is present by using the location access of smartphones. The app uses the convolutional neural networks architecture for identifying wastes in images. [11], [12].

IoT based Waste Collection System using Infrared Sensors Convolutional Neural Networks, a cutting-edge classification technique, are used by a robotic garbage segregator to divide the waste into different groups. Better recycling and reuse techniques are made possible by this approach, which aids in effective waste management. The project aims to build and construct a system that may be successfully used to segregate waste by utilising the ideas of Artificial Neural Networks and Image Analysis, notably the image recognition method. [13]

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Adaptive and Interactive Modelling System (AIMS)that uses induction algorithm to interpret sensor data streams and produce an efficient description of object characteristics which will define material separation strategies. [14]

Automatic Waste Segregator and Monitoring System is a system in which it sorts wastes into three different categories, namely metal, plastic, and the wet (organic) waste. Other wastes are categorized as wet waste, which signifies organic waste which classifies as left-over and vegetable peels. [15]

2.3 Analysis On Previous Studies

Studies Presented	**Method Used**	Strength	Weaknesses	Segregated Wastes	Findings
Intelligent Waste Separator (IWS)	Machine Learning	Due to IWS detect the anatomy, waste separation do not depend on people. Hence, it will avoiding mixing waste in bins has a fewer ratio of error	The capacities of waste separator do not allow in obtaining information and response is slow.	aluminum cans, plastic cutlery, and plastic bottle	The result shows that it has the possibility to a positioned independent object in classification algorithm that was based with only two out of seven in differentiating and classifying wastes

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Spot Garbage	Deep learning	A model that can describe the garbage from others. It is 11 times faster than naïve window sliding and can perform prediction. It also uses an Android App	Garbage detection fails in an insufficiently available image. If there is similar garbage object the system fail to classify the object.	Plastic Bottles, tin cans, paper, metals some decayed objects	There are outperforms approach with the use of deep learning method, image trusting on image processing increased by 7% for accuracy and specificity was 11%
IoT based Waste Collection System using Infrared Sensor	Azure Machine Learning System	This project will send the information to the agency and help the agency schedule for pickup.	Required in real time generated data and collection of waste.	No specified waste segregated	It uses IR sensors to notified the server if the bin is full and schedule for collection.
Adaptive and Interactive Modelling System (AIMS)	Artificial Intelligence and Induction Algorithm	Using an artificial intelligence to learn algorithm of the waste that can effectively sort the waste.	Require a long time to learn a which waste to be sort because the characteristic of the waste may be differ.	glass, metal, and plastic	They use machine learning techniques that can be effectively applied to container sorting

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Waste Segregation System Using Artificial Neural Networks	Classification using Convolutional Neural Networks	Convolution Neural Networks were created and implemented using one of the machine learning technologies. It is designed to separate waste, minimising the need for human interaction in the handling of waste materials.	No physical mechanical device to categorize wastes into different bins. Accuracy rate should be added to train the data set.	Bottles, cans, milk covers, paper bags, and boxes. Spoons, papers, straws, and plastic bags	By using CNN's, the trash objects are classified with a current accuracy rate of 70%. The database's enlargement for waste categories aids in improving accuracy while training the network for categorization purposes.
Automatic Waste Segregator and Monitoring System	An algorithm was not specified except it used ultrasonic sensor and induction sorting	Sorting of waste at the primary stage will make waste management more effective and fruitful.	It is very costly, Waste separation is time-consuming.	Metallic wastes (paper clip, battery, safety pin), organic waste (leftover foods) and dry waste (paper, small bottle,	The proposed be able to monitor the waste collection process and management of the overall collection process.

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				cartons, tetra pack)	

The table clearly illustrates the many systematic reviews of the literature as well as a few studies that demonstrate the advantages, disadvantages, and conclusions of the various studies discovered. Additionally, the application to which it was used and the conclusion, in which the study's results were further addressed, were stated. Some of the drawbacks of the various studies were addressed as well, which aided the proponent in determining the right algorithm and application to utilise and the rationale behind its selection. The development of this system will be focused on Automatic Waste segregator and monitoring system. The design will be improve and will be implemented with current technology to make it better.

2.3.1 Implementation of Arduino and GSM

This study's implementation involves managing the system that sorts the objects .This study's methodology is exploratory .The core component of the system, which can read data from proximity sensors, is an Arduino .The GSM module will use the sensor data to communicate with Arduino .This module functions as a notice, informing a user of things like the trash can's level .It will instantly inform the organisation of the trash can's existing situation .We can draw the conclusion that the experiment worked as expected because the data could be saved in a database and the system maintained accuracy of 100% without any sensor interruption.

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2.3.2 The benefit of using GSM module as notified system in measure the content of trash bins.

GSM technology has been developed for a while, GSM mobile phones and modems are readily available around the world and it offers relatively affordable goods and solutions.

Since GSM-based networks (i.e., base stations) are established all over the world, the same mobile phone functions anywhere. This makes use of cost advantages and offers smooth wireless communication. Users will be able to use phone and data services uninterrupted by this. Therefore, travelling abroad poses no threat.

Because there are many economical network engineers available, it is simple to maintain GSM networks. The telecom providers' income will rise as a result of this . Since the phone relies on a SIM card to function, users may easily switch between several phone models.

Inside the walls of the house and workplace, the GSM signal remains unaffected .With other wireless technology-based devices, such as CDMA, LTE, etc., GSM may be easily integrated. [16]

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2.3.3 Experimental Modelling

This subtopic shown an example of previous project.The project use Arduino and GSM. [17]

No	Diagram
1	

Figure 1: Side View

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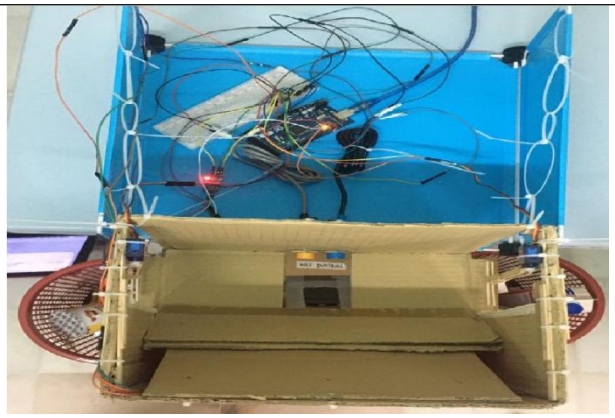
2	 ***Figure 2: Top view***
3	 ***Figure 3: front view***

Table 1: Model of Waste Sorting System

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Type of waste	Diagram
Paper waste	 ***Figure 4: Paper Waste***
Wet Waste	 ***Figure 5: Wet Waste***

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Table 2: Material use in the process

Level of waste	18 cm – 28 cm	13 cm – 17 cm	0 cm – 12 cm
LED light responses	 ***Figure 6: Red LED***	 ***Figure 7: Yellow***	 ***Figure 8: Green LED***

		LED	

Table 3: Indicator of trash can level

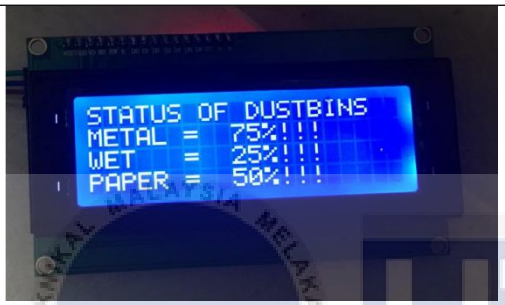

Figure 9: LCD Display Status of dustbins

Figure 10: LCD Display status of dustbins when it full

Table 4: LCD Display the status of trash can

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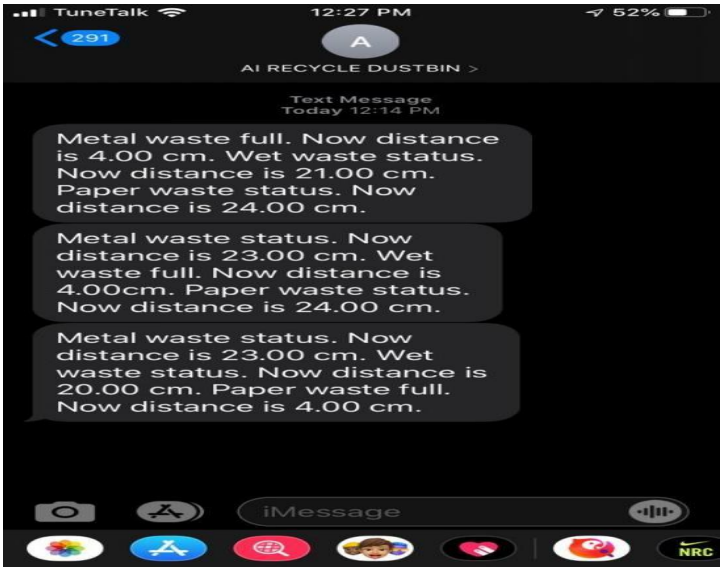

Figure 11: Alerting Message to User's Phone

2.4 Conclusion

In this chapter,we have cover the method use in previous study and shortly brief about the system that will be use in our project.We also provided the example of previous study that use the method that is related to our system and we also give an explanation of implementation of Arduino and GSM and the benefit of using this system.This study is based on existing study that we have research through internet and related with our current project.

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CHAPTER 3

METHODOLOGY

3.1 Proposed System

The development of General Waste Intelligence Sorting System With GSM is divided into four compartmetns.Each compartments has their own function, the first compartments consists of Moisture sensor for detecting wet waste and second compartments is Inductive sensor to detect metal waste.Next, third compartments is ultrasonic sensor which is to measure the level of waste inside bin.The last compartments is GSM system which will send the data.

Waste respectively. The whole system is controlled byMicro controller. Each and every component is interfaced to the microcontroller board.The necessary code for controlling the sensors and the motors is coded using arduino, in which the inputs and the output ports can be defined easily. To provide details of every decision we have used a Liquid Crystal Display device to display the decisions made by the arduino processor.

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3.2 Consideration for Social Sustainability

The decision of making process for designing the project will be considerate social impact. For example, building a project that can help people sort the waste without need to open each bin to throw their waste . The project will ensure safety and avoid unwanted accident that will happen in future . Finally, the project not only display it by using only SMS but it will also show on LCD . This is because of the using of SMS might affected some people who live in rural area might not get a good signal from their communication provider.

3.2 Consideration for Social Sustainability

The decision of making process for designing the project will be considerate social impact. For example, building a project that can help people sort the waste without need to open each bin to throw their waste . The project will ensure safety and avoid unwanted accident that will happen in future . Finally, the project not only display it by using only SMS but it will also show on LCD . This is because of the using of SMS might affected some people who live in rural area might not get a good signal from their communication provider.

3.3 Societal and Global Issue

Ineffective trash sorting systems are a serious social and environmental concern with far-reaching effects on resource management, the environment, and public health. garbage sorting is essential for efficient garbage management, recycling, and reducing the environmental impact of waste . Sorting the waste properly can impact the health and safety risk and reduce the incoming disease in the future . As the country begin to develop from time to time the resource will be more limited . This is one of main reason why sort waste can be useful to recycle the material such as plastic, metal and paper.

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3.4 Components

Mechanical

1. Servo Motor
2. DC Motor

3. Conveyor Belt

4. Ply wood

Electrical

1. GSM

2. Moisture sensor

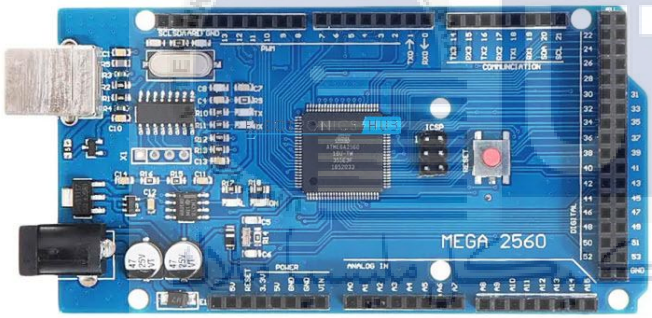
3. Arduino Atmega

4. Inductive sensor

5. Ultrasonic sensor

6. Power Supply

7. Motor Driver

Component	Unit	Description
Arduino Atmega  *Figure 12: Arduino Atmega*	1	• Atmega2560 • Operating Voltage:5V • Input voltage:7-12V • Input Voltage(limit):6-20V • Digital I/O pins: 54(15 PWM output) • Analog Input pins: 16 • DC current per I/O pin:20mA • DC current for 3.3V pin:50mA • Flash memory: 256kb • SRAM: 8kb • EEPROM: 4kb • Clock Speed: 16Mhz • LED_BUILTIN:13

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Servo Motor
 
Figure 13: Servo Motor
	2	• Plastics gears
		• Operating Voltage: 4.8 - 5VDC
		• Speed at 4.80V(no load): 0.12 s/60°
		• Torque at 4.80V : 1.8 kg.cm (~0.1765 N.m)
		• Rotation angle: 180 degree
		• Size: 23.0 x12.2 x 29.0mm
		• Weight: 9.0g
		• Wiring:
		  ○ Brown = GND
		  ○ RED = 5V
		  ○ Orange = Signal

DC Motor  *Figure 14: DC motor*	2	• Rated voltage: 12VDC. • No load current: < 100mA • No load speed: 150 ± 15 RPM • Rated load torque: 177mN.m(1.8kgf.cm) • Rated current: < 600mA. • Rated load speed: 112 ± 11 RPM. • Weight: 160g • Gear ratio: 30:1 • Shaft: 6mm diameter x 15.5mm length
Conveyor Belt	2	

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 ***Figure 15: Conveyor Belt***		
Ply Wood  ***Figure 16: Ply Wood***	1	
GSM 	1	• Onboard two set power supply interface VCC5 5V power supply, VCC4 interface, 3.5v-4.5V power supply, optional power on self starting (default) and control start. • Onboard SMA (default) and IPXmini antenna interface, SIM900A interface reserved reset.

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Figure 17: GSM		• Support 2, mobile phone 3,4G card • Low power consumption: 1.0 mA (sleep mode) • Serial port circuit: support for 3.3V single chip microcomputer • TTL serial port: support 3.3 and 5V single chip microcomputer. • Antenna interface circuit(SMA bend female port)
Moisture Sensor  *Figure 18: Moisture Sensor*	1	• Input Voltage: 5V • Input Current :<20m • Output Voltage: 0 to 4.2V • Size : 63x60x8 mm • Weight: 3gm • Depth of detection : 37mm
Inductive Sensor	1	• Output Type: NPN, PNP • Output Status: Normally Open

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 ***Figure 19: Inductive Sensor***		• Detecting Object: Metal (Conductive) • Supply Voltage: DC 6-36V • Current Output: 300mA • Response Frequency: 100Hz • Operating Temperature: -25°C to +65°C (Non-freezing Condition) • Cable Length: 120cm/47" • External Material: Plastic, Alloy • Weight: 85g
Ultrasonic Sensor  ***Figure 20: Ultrasonic Sensor***	3	• Operating voltage: +5V • Theoretical Measuring Distance: 2cm to 450cm • Practical Measuring Distance: 2cm to 80cm • Accuracy: 3mm • Measuring angle covered: <15° • Operating Current: <15mA • Operating Frequency: 40Hz
Power supply	3	• Input Voltage: 110-120V AC 200 - 240V AC • Input Frequency: 50/60Hz • Inrush Current: Max. • 30A cold start at 240Vac

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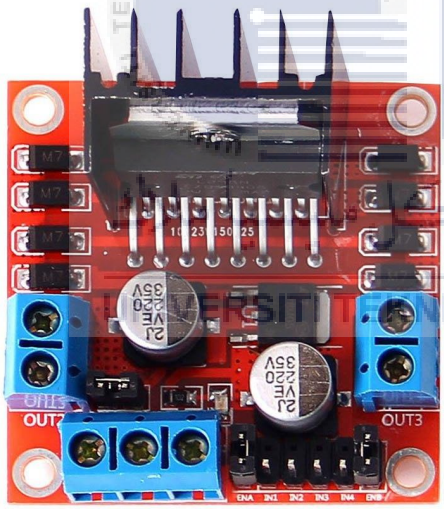
 ***Figure 21: Power Supply***		input, with rated load and 25 deg C ambient • AC Leakage Current: • Rated Output Current: 10A • Current Range: 0-12A • Output Power: 120W • Line Regulation: +/- 5% • Load Regulation:+/- 5%
Motor Driver  ***Figure 22: Motor Driver***	1	• Driver Model: L298N 2A • Driver Chip: Double H Bridge L298N • Motor Supply Voltage (Maximum): 46V • Motor Supply Current (Maximum): 2A • Logic Voltage: 5V • Driver Voltage: 5-35V • Driver Current:2A • Logical Current:0-36mA • Maximum Power (W): 25W • Current Sense for each motor • Heatsink for better performance • Power-On LED

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		indicator
LCD I2C  ***Figure 23: LCD I2C***	1	• Easy to use. Less I/O ports are occupied, only four - VCC, GND, SDA (serial data line), SCL (serial clock line). • Support IIC protocol. The I2C LCD1602 library is provided, so you can call it directly. • With a potentiometer used to adjust backlight and contrast. • Power supply: +5V • Address of the module: 20 x 04.

Table 5: List of Component

1. Atmega 2560

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560 chip. It is part of the Arduino family of open-source hardware and software platforms designed for prototyping and building interactive electronic projects.

The ATmega2560 microcontroller is the heart of the Arduino Mega 2560. It is a powerful 8-bit microcontroller with 256KB of flash memory for storing the program code, 8KB of SRAM for data storage, and 4KB of EEPROM for non-volatile data storage. The ATmega2560 operates at a clock speed of 16 MHz and has 54 digital input/output pins, 16 analog inputs, and 15 PWM (Pulse Width Modulation) outputs.[18]

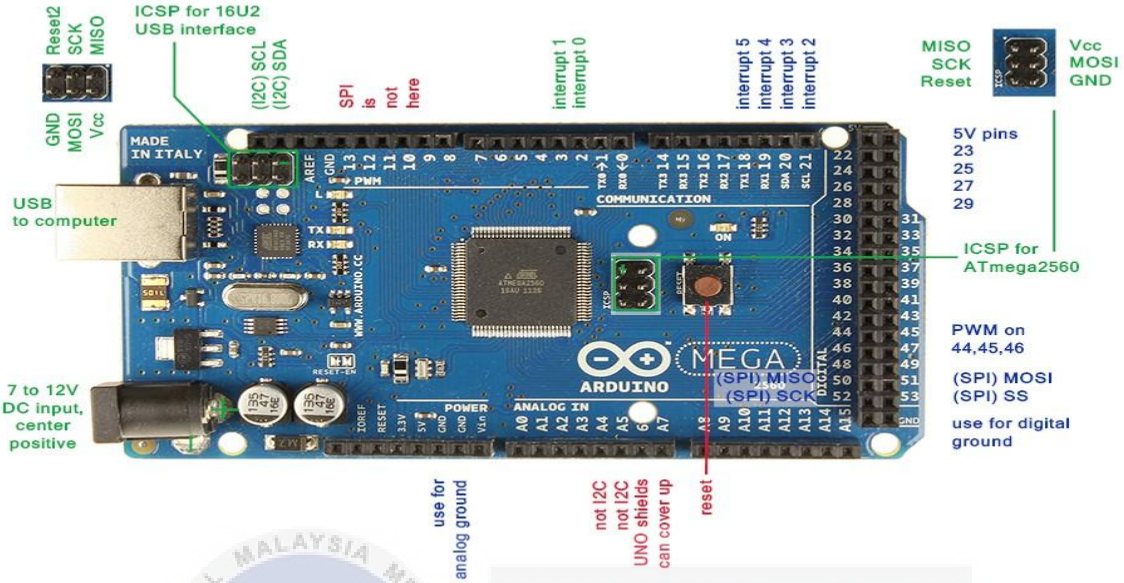

Figure 24: Arduino Atmega

The control board for general waste sorting system is Arduino atmega 2560.All parts needed is present in figure 7 will help to guide when doing hardware .The pins for the motor and sensors are attached to digital pins and PWM pins .The microcontroller act as the main controller in this project .It will read the data received from proximity sensor .Then Arduino will send the signal to the motor and GSM .Motor and GSM will receive the signal and do their functions as intended .

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2. GSM

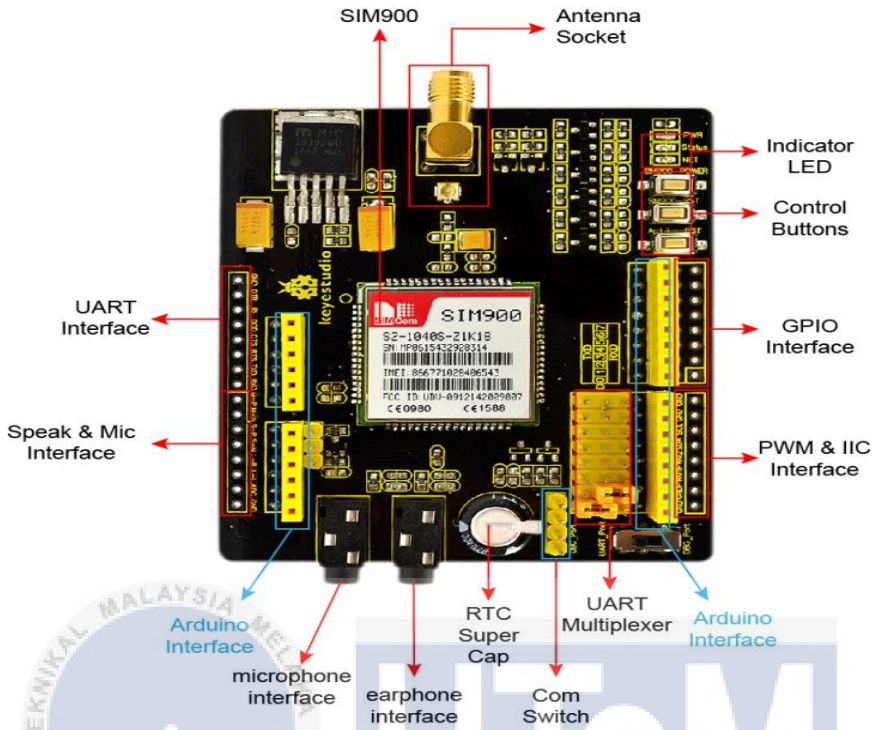

Figure 25: GSM

GSM 900, also known as Global System for Mobile Communications 900 MHz, is a widely used mobile communication standard for cellular networks. It operates in the frequency range of 900 MHz, which is one of the frequency bands allocated for GSM services.

GSM 900 is part of the second-generation (2G) cellular network technologies and is still used in many parts of the world, although it has been largely surpassed by newer generations such as 3G, 4G, and 5G. However, GSM 900 continues to be used due to its wide coverage, compatibility with older devices, and cost-effectiveness for certain applications.[19]

GSM will be use in this project to send the data of the bin to the user.It will work with ultrasonic sensor.The message will be send to indicate the level of waste inside the bins.When the bins are 50% full the GSM system will send the information the user using

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SMS.The message that will be receive by user is “Bins is moderate condition”.If the bins is full the message will be send “Bins is full”.The model that is use in this project is GSM 900 which have antenna function that can a signal to the user without problem.

3.Moisture Sensor

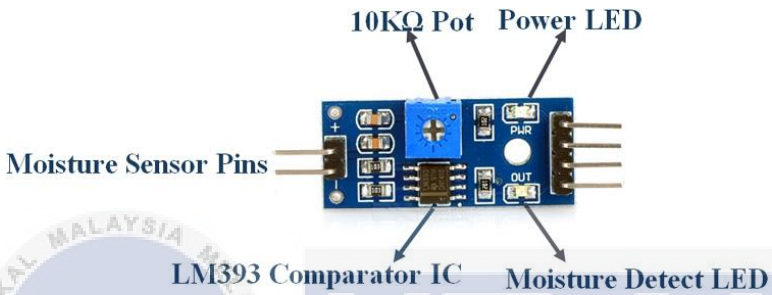

Figure 26: Moisture Sensor

A moisture sensor, also known as a soil moisture sensor or hygrometer, is a device designed to measure the moisture content or humidity level in soil, air, or other substances. It is commonly used in gardening, agriculture, and environmental monitoring applications to determine the water content of the soil or to monitor humidity levels in the air. Moisture sensors are often integrated into electronic systems or microcontroller-based platforms like Arduino to provide real-time readings and enable automated irrigation systems. These sensors can be connected to analog or digital inputs of a microcontroller, which can then process the data and trigger actions based on the moisture readings.

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4.Inductive Sensor

Figure 27: Inductive Sensor

An inductive sensor, also known as an inductive proximity sensor or proximity switch, is a type of sensor used to detect the presence or proximity of metallic objects without physical contact. It operates based on the principle of electromagnetic induction. It's important to note that inductive sensors can only detect metallic objects and are not suitable for detecting non-metallic materials like plastic, wood, or liquids. Additionally, the sensing range and performance of the sensor may vary depending on the specific application and environmental conditions, so it's essential to select the appropriate sensor model for the desired application.

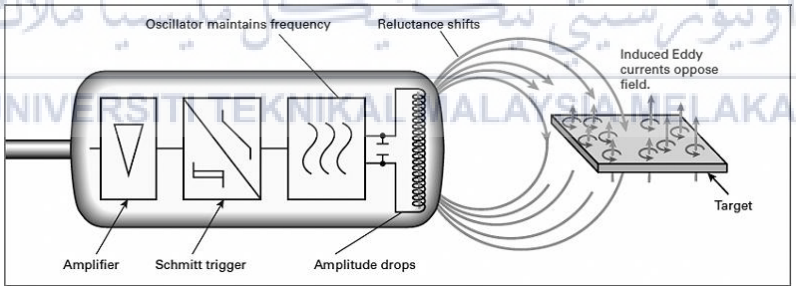

Figure 28: Inductive Sensor Working Diagram

Inductive sensor will be use in this project to detect the presence of metal waste.When the sensor detect metal it will produce an output signal that can be read by Arduino.This information can be used to trigger specific actions such as trigger servo motor to push the waste inside the bins.Inductive sensor produce electromagnetic field,when the metal waste enter it sensing range it will interact with electromagnetic field.This is why the inductive is choose in this project.

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5. Ultrasonic Sensor

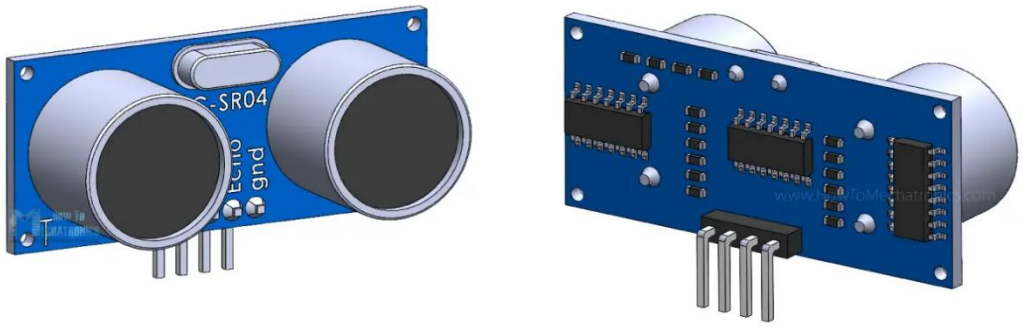

Figure 29: Ultrasonic Sensor

A gadget called an ultrasonic sensor employs sound waves at a frequency higher than the range of human hearing to locate and gauge the distance to objects. Similar to how bats and dolphins navigate and find items in their surroundings, it uses the echolocation concept. The performance of ultrasonic sensors can be impacted by a number of variables, including temperature, humidity, and auditory interference. Additionally, depending on the particular model and environmental factors, the detecting range and accuracy may differ, making it crucial to select the right sensor for the desired application.

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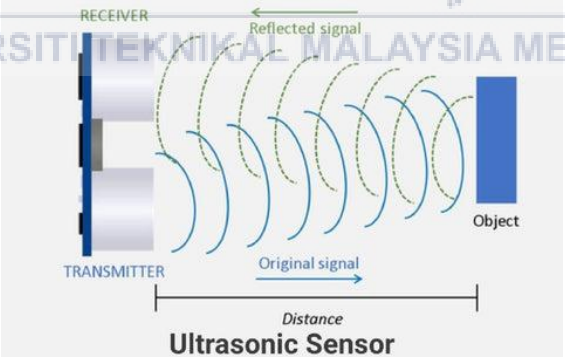

Figure 30: Ultrasonic Sensor Working Principle

Ultrasonic is use to measure the level of waste inside the bins . The sensor will integrate with GSM . Ultrasonic sensor will send a sound wave to the surface of the waste . Then it will produce echo which will be send back to the receiver . The sensor then converts the

signal into electrical signals that can be processed by Arduino . Arduino then will measure the duration of the wave travel between waste and receiver .

6. Power Supply 12V

Figure 31: DC Power Supply

Rechargeable lithium-ion batteries are frequently found in portable electronic devices including power banks, computers, cameras, and cell phone . Their high energy density, lengthy cycle life, and low self-discharge rate make them desirable. It's important to keep in mind that there will be some power loss while changing the voltage from a lithium-ion battery. How well the energy from the battery is used will depend on how well the voltage converter circuitry performs .The battery is use as power supply that connect to Arduino .

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7. DC motor

Figure 32: DC motor

An electrical device known as a DC (Direct Current) motor transforms electrical energy into mechanical rotating motion. Due to its simplicity, convenience of use, and variety of applications, it is one of the most widely used types of motors. They have benefits including great torque at low speeds, ease of control, and dependability. To guarantee appropriate functioning and safety, they can need extra parts like motor drivers or speed controls .DC motor will be use to move the conveyor belt.

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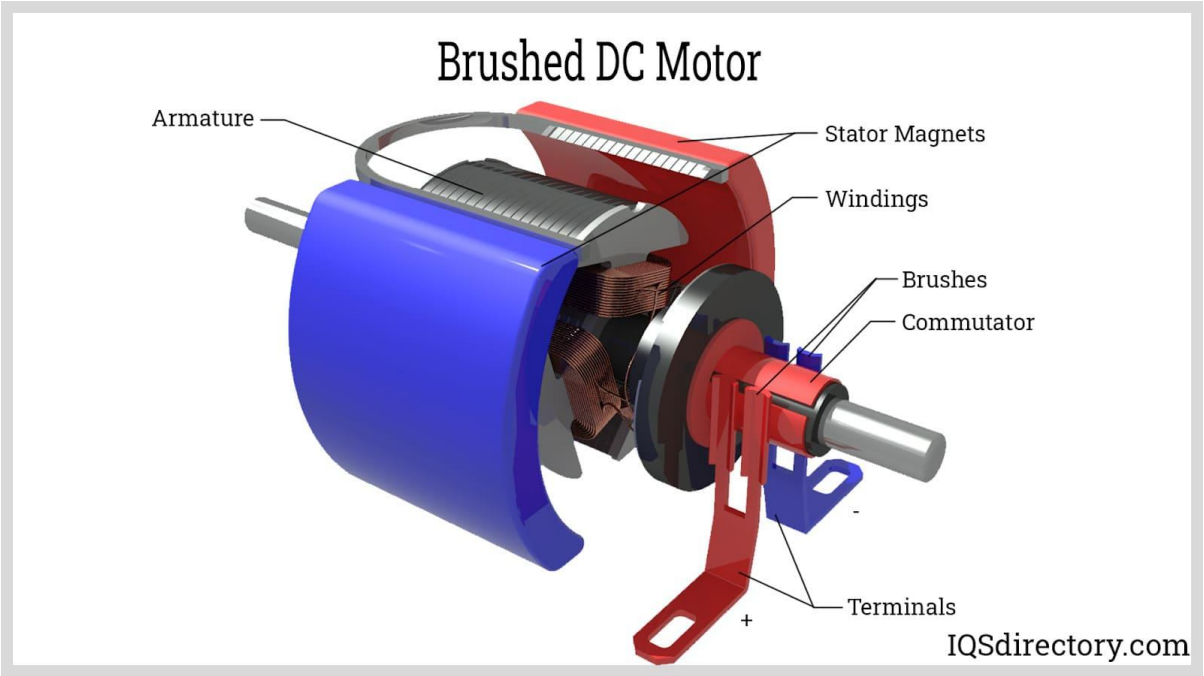

Figure 33: DC motor Working Principle

8. Servo Motor

Figure 34: Servo Motor

In many applications where precise control of angular position, velocity, and acceleration is necessary, servo motors are a typical type of motor. It is frequently utilised in robotics, automation, RC cars, and other systems that need for precise and regulated motion .Servo motors are appropriate for applications that need precise motion control because they

provide exact positioning and control. Robotic arms, remote-controlled cars, automated machinery, cameras, and other devices that need controlled motion frequently employ them. The right servo motor must be chosen for your application based on the necessary torque, speed, and range of motion. Servo motor is use to move the waste inside the bins . The waste segregating system may include different compartments or bins for various types of waste, such as wet waste, dry waste, or metal waste. Sensors, such as proximity sensors or optical sensors, can be used to detect waste items and trigger the servo motor's movement.

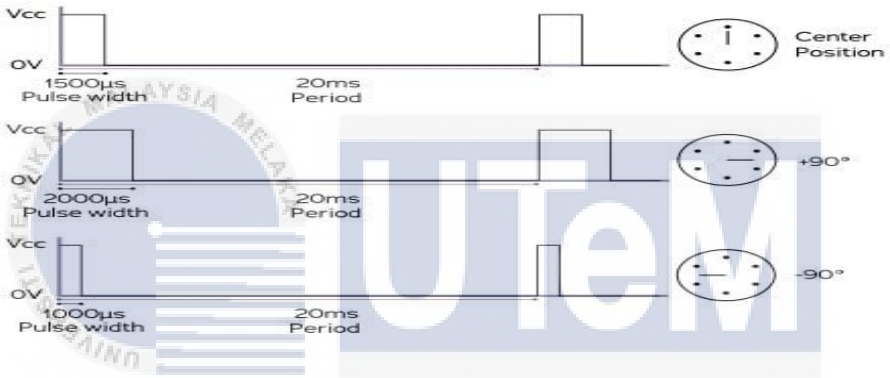

Figure 35: PWM of Servo Motor

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9. Motor Driver

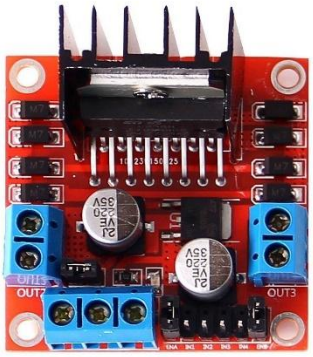

Figure 36: Motor Driver

An electric motor is powered and controlled by a motor driver, an electrical component or circuit. The motor's speed, direction, and other operational parameters are driven and controlled by it by providing the required voltage, current, and control signals. The choice of a motor driver is influenced by various elements, including the type of motor, the required voltage and current, compatibility with the control interface, and the features required for the particular application. The exact control, safety, and effective functioning of electric motors are made possible by the use of motor drivers, allowing them to be incorporated into a variety of electronic devices and equipment. Motor drivers is use to provide necessary power and control signals to drive the motors. It will ensure the DC motor to receive appropriate voltage and current levels , preventing damage due to overvoltage or excessive current draw . It can control the direction and speed of the motor which is essential for the system to reduce error the reading of proximity sensor.

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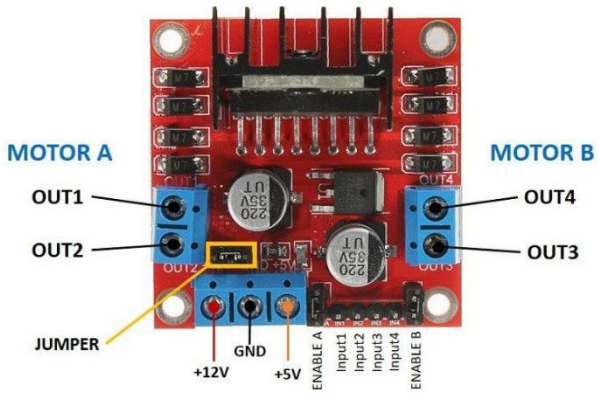

Figure 37: Motor Driver Pinout

10. LCD I2C

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Figure 38: LCD I2C

An LCD is a flat-panel display that is frequently seen in consumer gadgets, including calculators, digital timepieces, and watches. It is made up of a grid of minuscule pixels, each of which contains a liquid crystal that can be programmed to display text or pictures. Due to its low power requirements, small size, and simplicity of integration into many electrical systems, LCDs are frequently employed.

The serial communication protocol I2C, on the other hand, permits communication between integrated circuits. A clock line (SCL) and a data line (SDA) make up the two-

wire interface. The I2C protocol enables the connection of several devices to a single bus, and each device is given a distinct address.

Combining LCD with I2C indicates that an I2C interface is already present in the LCD module. As a result, the LCD no longer needs the numerous separate cables that would normally be needed to connect and control it. Instead, a tiny I2C module or backpack is attached to the LCD to manage connection with the microcontroller.[20]

LCD I2C were use to display the information about the bins . When the ultrasonic sensor send the information to the Arduino microcontroller . The microcontroller will do the calculation from signal receive from the sensor. LCD will display the information if bins is 50% height it will display “Condition : Moderate Level : 50%” if it full then it will display “Condition : Full Level : 100%”.

3.5 Software Used

1. Proteus Software

Proteus is a widely used software suite for electronic design automation (EDA). It is primarily used for designing, simulating, and testing electronic circuits and systems. Proteus offers a comprehensive set of tools that enable engineers, designers, and hobbyists to create and validate electronic designs efficiently. Proteus is widely used in various industries, including electronics, telecommunications, robotics, and automation. It is suitable for both educational purposes and professional projects, offering a comprehensive set of tools for electronic design and simulation. [21]

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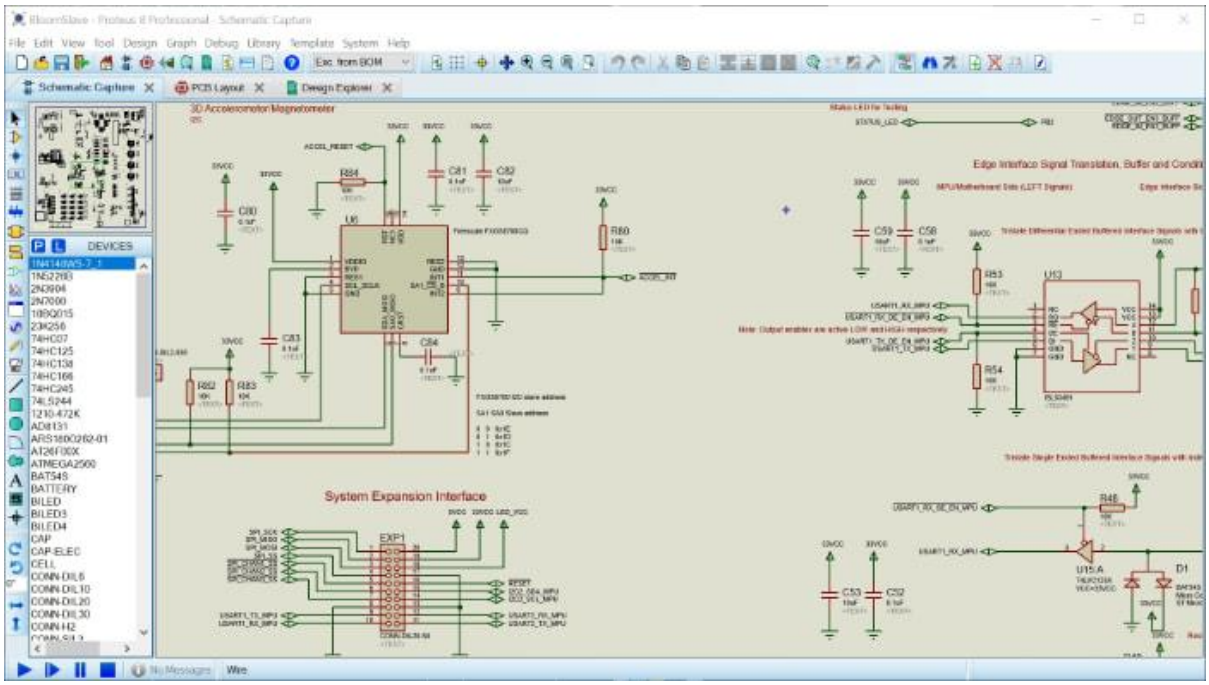

Figure 39: An example of schematic diagram using Proteus

2. Arduine IDE(Integrated Development Environment)

An open-source software environment called the Arduino Integrated Development Environment (IDE) is used to programme Arduino microcontrollers. It offers a simple user interface that makes creating, compiling, and uploading code to Arduino boards easier. The Arduino IDE offers sophisticated functionality for more seasoned users while yet being user-friendly for newbies. Open-source software for Windows, macOS, and Linux operating systems is the Arduino IDE. Due to its simplicity, adaptability, and broad community support, it is widely utilised by professionals, students, and enthusiasts in the field of electronics and robotics.[22]

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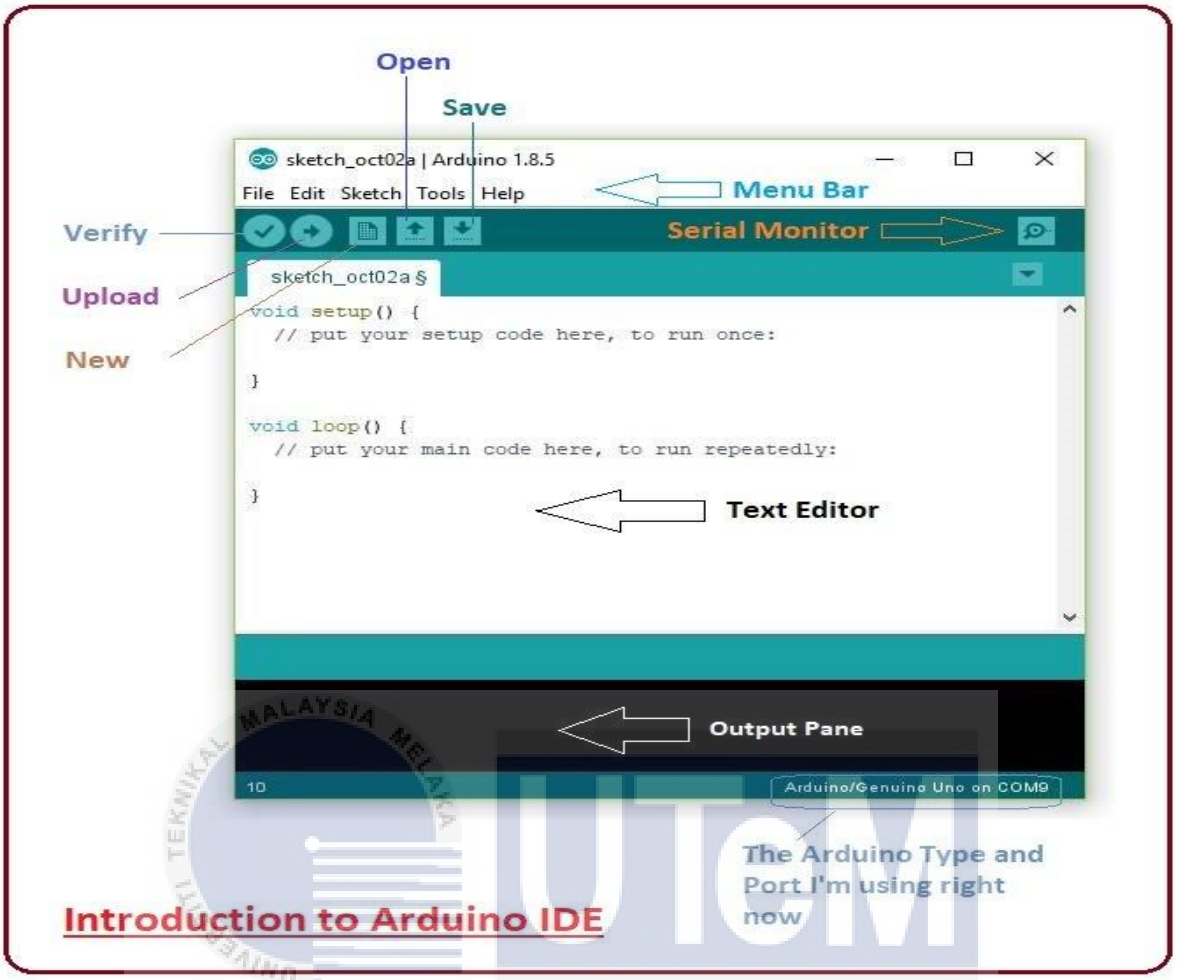

Figure 40: Example of Arduino IDE software

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3.6 Project Flow

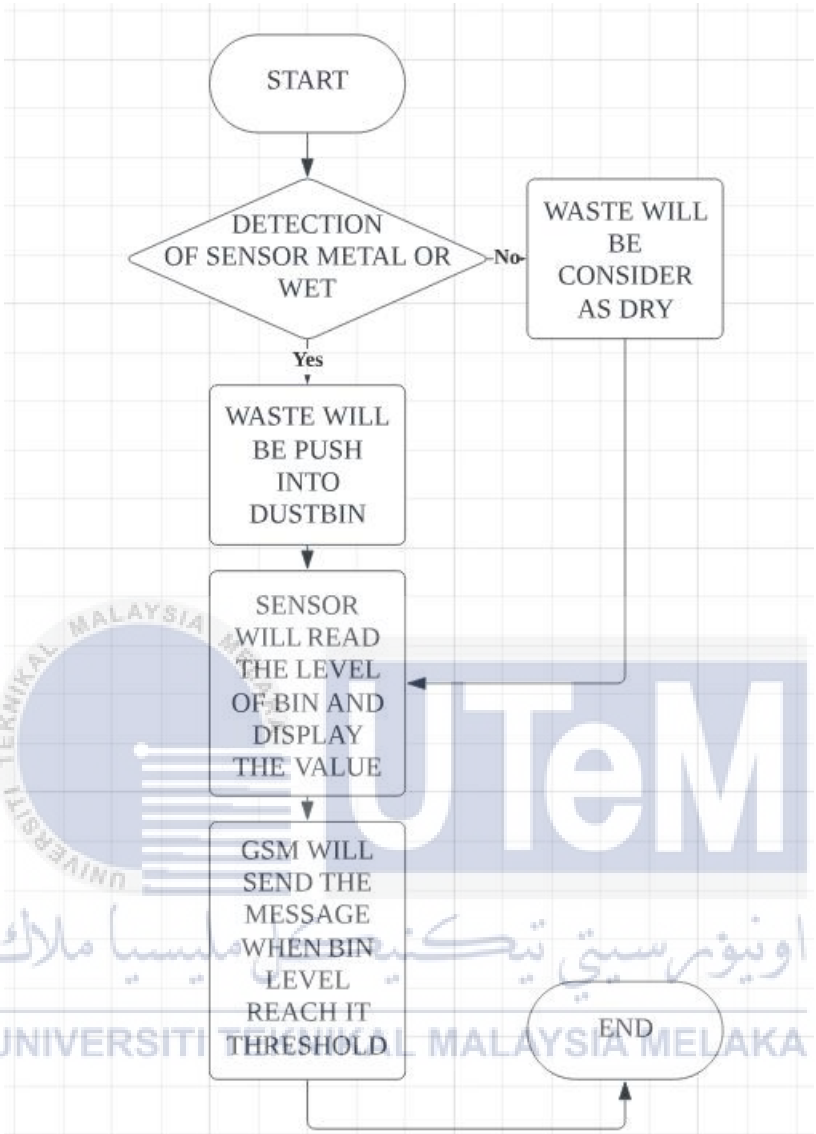

Figure 41: Project flowchart for general system

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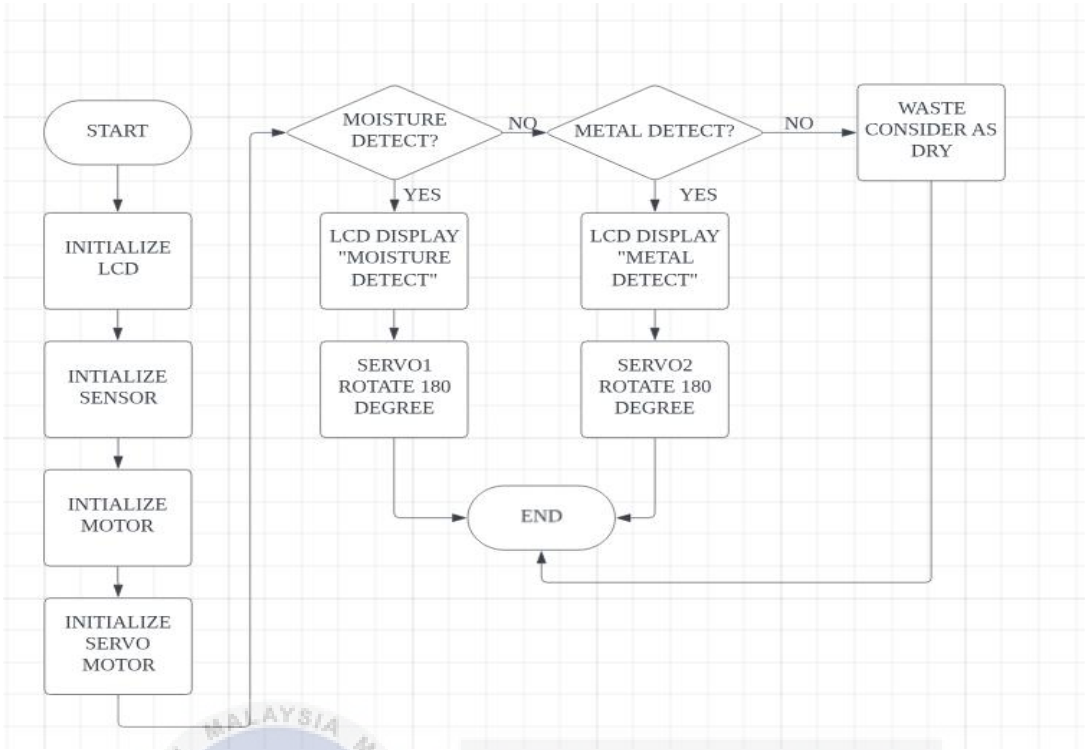

Figure 42: Sorting System flowchart

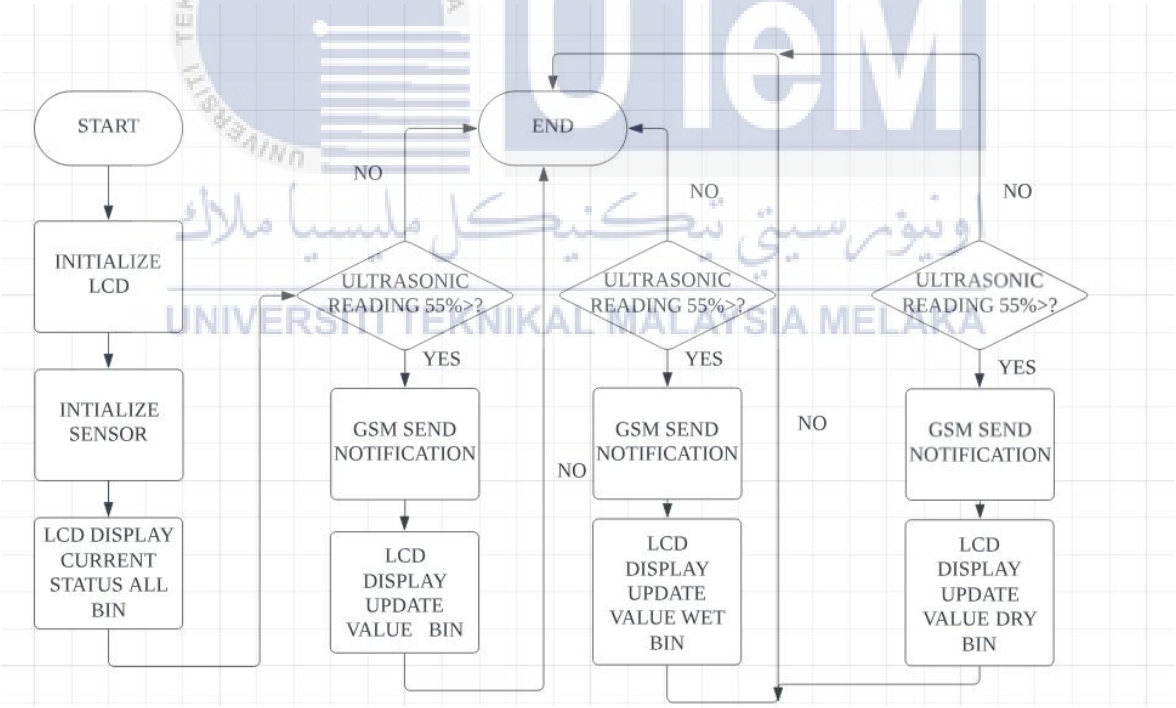

Figure 43: Monitoring system flowchart

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3.7 Block Diagram

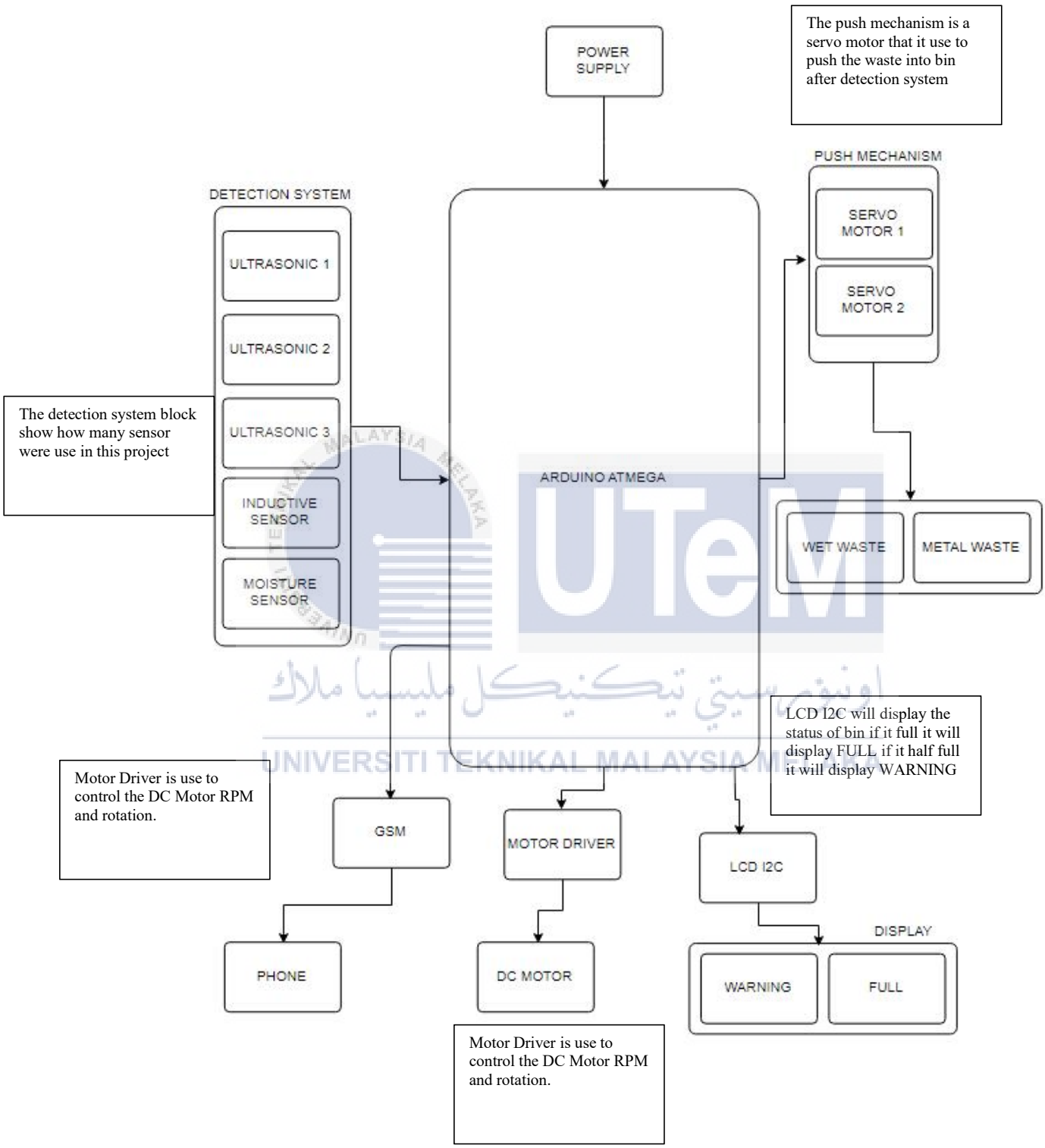

Figure 44: Block diagram of the project

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3.8 Schematic Diagram

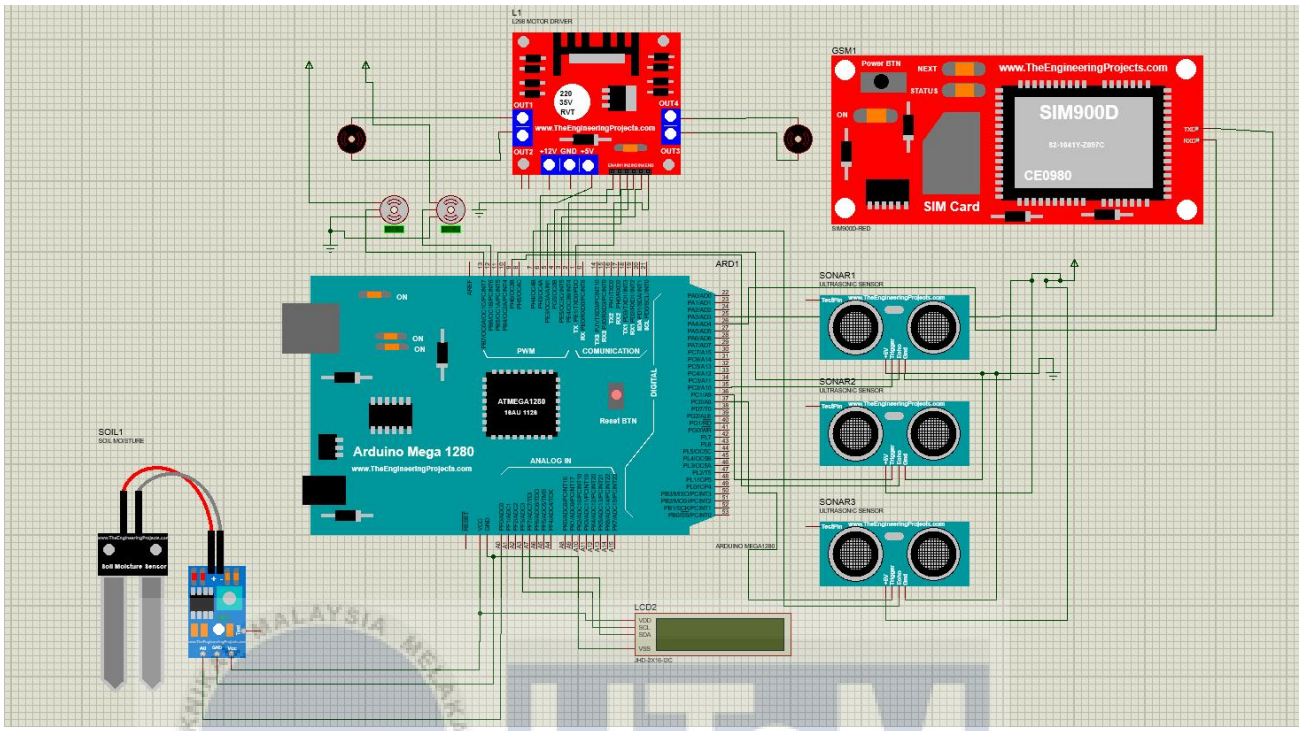

Figure 45: Image of schematic diagram of the project.

3.9 Experimental Setup

The Experiment setup is a step to prove the concept can be done to sort the waste based on it type.

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Figure 46: Working Protoype and IR sensor

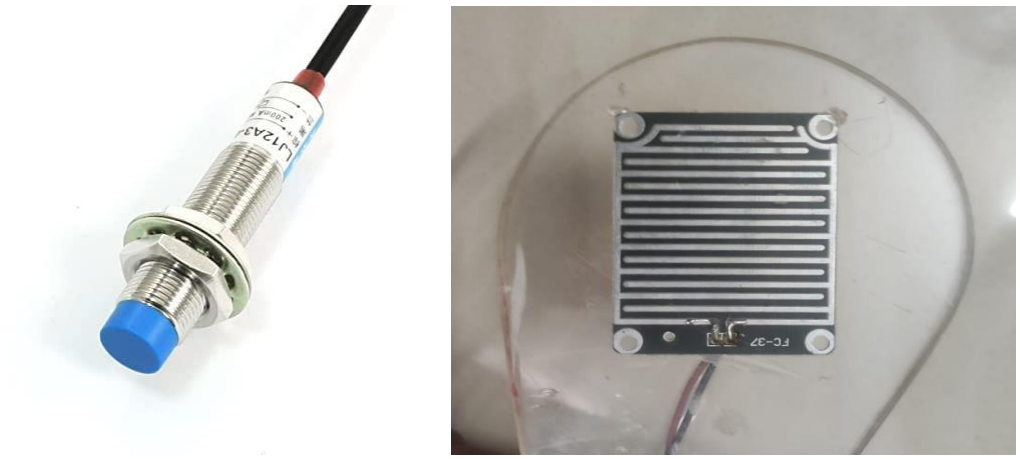

Figure 47: Inductive sensor and Moisture Sensor

As shown in Figure 3.7-1 and Figure 3.7-2, the system will detect three types of waste that is Wet, Metal and Plastic. The sensor will be utilized to detect the object based on their type. If the sensor detects the object, it will display it type on the LCD, then the waste will fall to the container provided. [23]

Table 1: Result of Metallic Waste Separation.

Sl. No.	Type of Metal Waste	Discarded or Not
1	Safety pin	Yes
2	Paper clip	Yes
3	Battery	Yes
4	Nail	Yes

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Table 2: Result of Organic Waste Separation.

Sl. No.	Types of Organic Waste	Discarded or Not
1	Kitchen waste	Yes
2	Leftover food	Yes
3	Vegetable peel/Fruit peel	Yes
4	Rotten fruits and Vegetables	Yes

Table 3: Result of Dry Waste Separation.

Sl. No.	Type of Dry Waste	Discarded or Not
1	Paper	Yes
2	Small bottles	Yes
3	Heavy cartons	No
4	Milk cover	Yes
5	Dry leaves	Yes
6	Clothes	Yes
7	Tetra pack	No

Figure 48: Experimental Table

Based on Experimental table **Figure 48: Experimental Table** it shown the efficiency of the system in sorting the waste based on it type. [23]

3.9.1 Summary

In this chapter, we have cover all the component that are use in our project.A proximity sensor is use to detect a type of waste which is necessary for the project to achieve it objective.The complete schematic diagram shown the connection of the circuit before we start to developed our project.Flow chart help to understand better about the flow of this project which can be our guideline.All of this system is control by microcontroller name Arduino which is the best for it variety of library that can give a satisfy output in the end.

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CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This section provides the findings and analysis of the development of a general intelligence waste sorting system with GSM based on how successfully the system uses an Arduino microcontroller to sort waste according to its type. The suggested system is concentrated on areas where people walk, like homes, offices, supermarkets, and other similar places. To identify the kind of waste that needs to be sorted, this system used proximity sensors. The user will then receive a notification via GSM regarding the status of the trash can, alerting the local authorities to pick up the rubbish when it reaches a predetermined level. The findings and debates from the creation, testing, and design of the General Intelligence Waste Sorting System with GSM are presented in this section. This study offers insightful information about how cutting-edge waste sorting technologies may revolutionise environmentally friendly waste management techniques.

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4.2 Results and Analysis

4.2.1 Preliminary Result

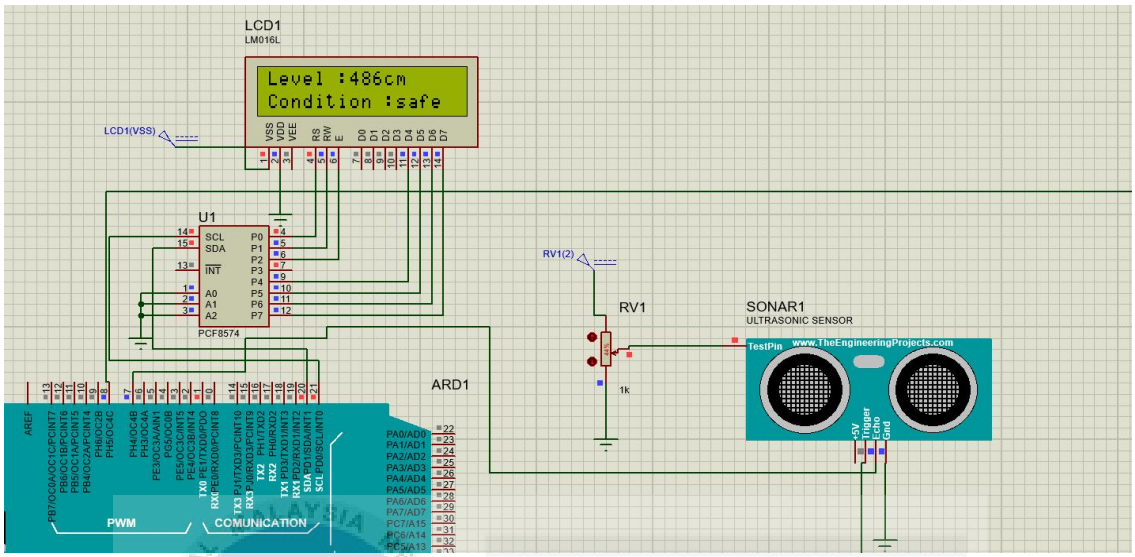

Figure 49: shown condition display "SAFE" on 40% Potentiometer

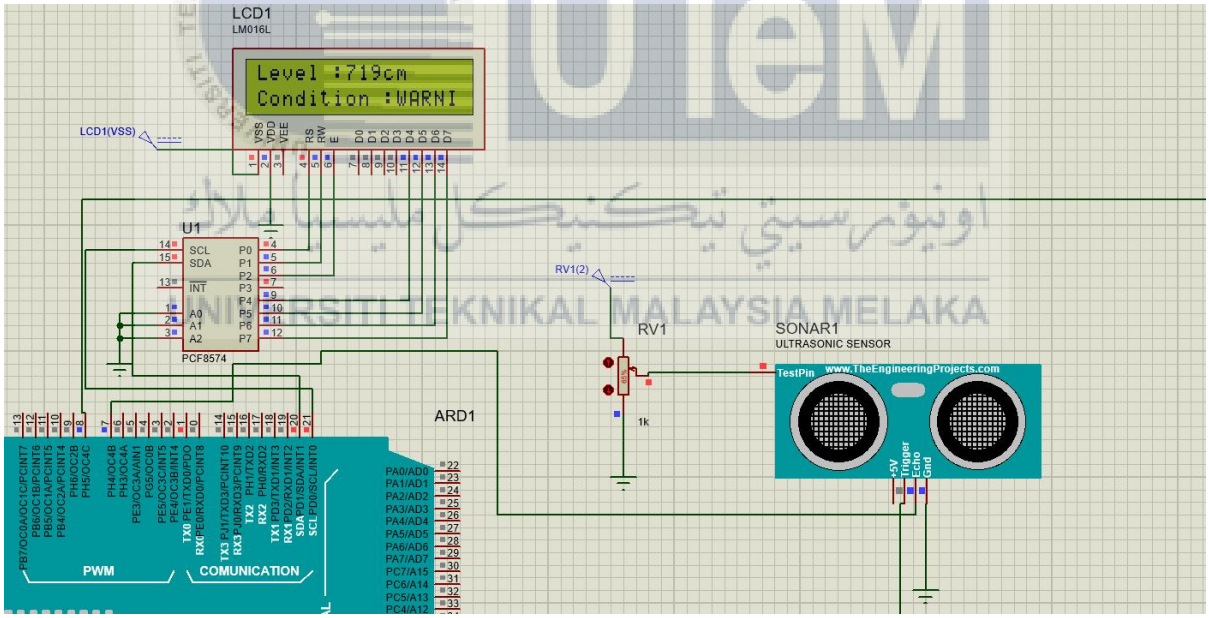

Figure 50: shown condition display "WARNING" on 60% Potentiometer

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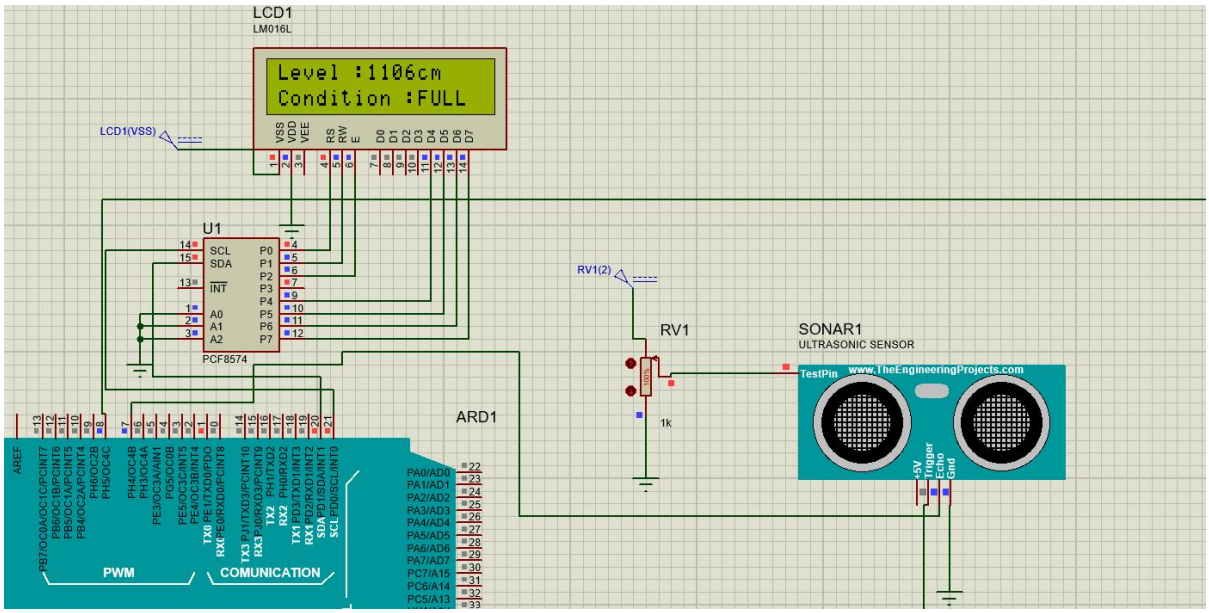

Figure 51: shown condition display "FULL" on 100% potentiometer

In early development of the waste sorting system the monitoring system is designed first.In figure 4.1.1 shown a system that will be used in future development.The ultrasonic sensor were use to detect the height of waste. Potentiometer is use to define as the level of the waste. When the level of waste increase the condition of the waste will be display in LCD . When it reach certain value that has been define by system for example if the level is below 50 % from the max potentiometer value it will display as safe.When the level reach above 50% value and below 80% it will display as warning.Finally, it will display as danger.

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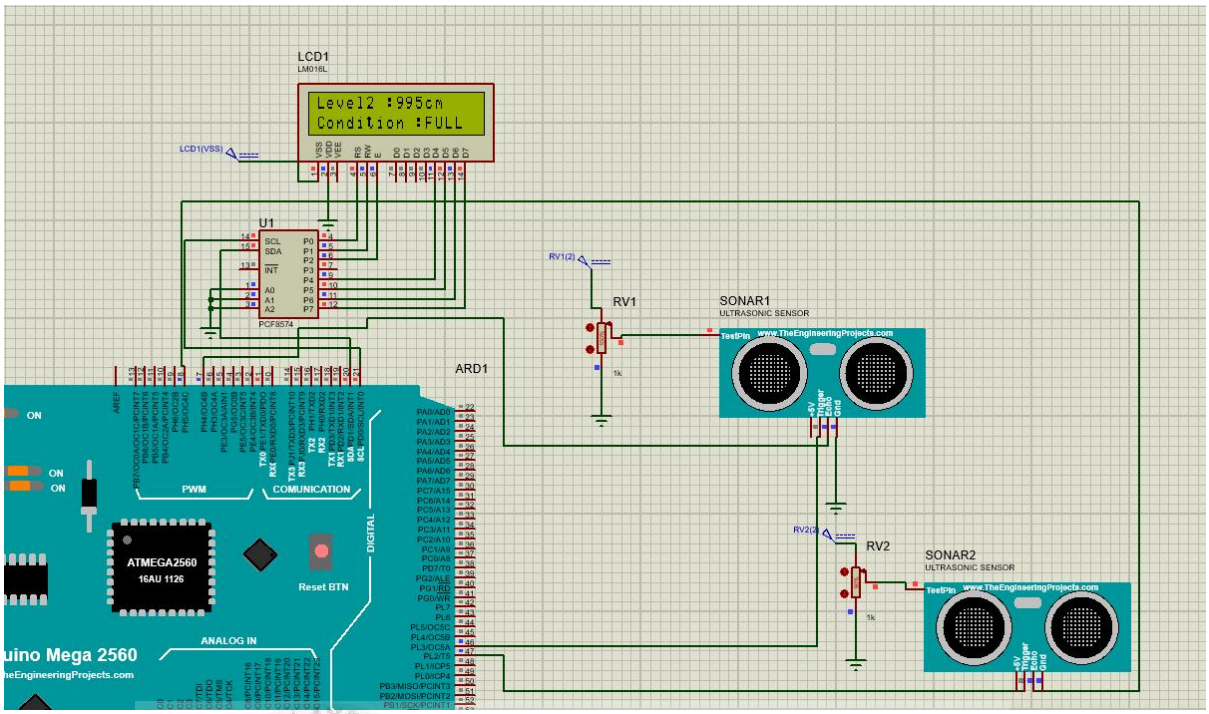

Figure 52: Shown display change after five seconds to second sensor

The system has been shown with two ultrasonic to determine the waste level for each bin.The first sensor will display it value and condition for couple of second then it will change to next sensor display.The working principle for both SONAR 1 and SONAR 2 is same but has time interval between the changing of it display.

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4.2.2 Programme Code

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
const int SAFE_THRESHOLD = 540;
const int WARNING_THRESHOLD = 1055;
const int DANGER_THRESHOLD = 1106;
const int trigPin = 46;
const int echoPin = 7;
const int trigPin1 = 47;
const int echoPin1 = 8;



// Set the LCD address to 0x27 for a 16 chars and 2 line display
LiquidCrystal_I2C lcd(0x20, 16, 2);

void setup()
{
  // initialize the LCD
  lcd.begin();

  // Turn on the blacklight and print a message.
  lcd.backlight();

  Serial.begin(9600);

  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);

  pinMode(trigPin1, OUTPUT);
  pinMode(echoPin1, INPUT);

}
```

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```
void loop()
{
  long duration, distance,duration1, distance1;

 digitalWrite(trigPin, LOW);
 delayMicroseconds(2);
 digitalWrite(trigPin, HIGH);
 delayMicroseconds(10);
 digitalWrite(trigPin, LOW);

 duration = pulseIn(echoPin, HIGH);
  distance = duration * 0.034/2;

lcd.setCursor(0, 0);
lcd.print("Level :");
lcd.print(distance);
lcd.print("cm");
lcd.println();

 if(distance <= SAFE_THRESHOLD){  //540
lcd.setCursor(0,1);
lcd.print("Condition :safe       ");
 }
 else if(distance > SAFE_THRESHOLD && distance <
WARNING_THRESHOLD){ //540 && 1055
lcd.setCursor(0,1);
lcd.print("Condition :WARNING       ");
 }
 else if(distance >= WARNING_THRESHOLD){ //1106
lcd.setCursor(0,1);
lcd.print("Condition :FULL      ");
 }
```

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```
delay(5000);
digitalWrite(trigPin1, LOW);
 delayMicroseconds(2);
 digitalWrite(trigPin1, HIGH);
 delayMicroseconds(10);
 digitalWrite(trigPin1, LOW);

   duration1 = pulseIn(echoPin1, HIGH);
  distance1 = duration1 * 0.034/2;

lcd.setCursor(0, 0);
lcd.print("Level2 :");
lcd.print(distance1);
lcd.print("cm");
lcd.println();
if(distance1 <= SAFE_THRESHOLD){  //540
lcd.setCursor(0,1);
lcd.print("Condition :safe       ");
 }
else if(distance1 > SAFE_THRESHOLD && distance <
WARNING_THRESHOLD){ //540 && 1055
lcd.setCursor(0,1);
lcd.print("Condition :WARNING       ");
 }
else if(distance1 >= WARNING_THRESHOLD){ //1106
lcd.setCursor(0,1);
lcd.print("Condition :FULL      ");
 }
 delay(5000);
}
```

Programming Code for the system

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4.2.3 Waste Segregation System Design

In this project the conveyor design was used to test the system efficiency in sorting the waste with other proximity sensor. A summary of design, hardware and control used to gain a data from the system is given in this section.

Plywood board is used in this project because of its affordability and durability when creating the prototype design. The conveyor's design is 130 cm long by 30 cm wide. This dimension was chosen so that the sensors would not be too close together, which could interfere with the system's ability to sort the objects. The purpose of the two support beams is to raise the conveyor so that there is a space between it and the ground for me to run wire underneath and position the bin beneath the ultrasonic sensor.

Important parts of this system are the Gear DC motor (which pulls the conveyor with more torque), the Arduino Mega microcontroller, the proximity sensor, the motor driver, the servo motor, the ultrasonic sensor, and the PWM servo motor driver PCA9685. The proximity sensor's detection and the ultrasonic sensor's reading are shown via the user interface on LCD screens. GSM is one of the project's components that must be implemented to communicate with users and accomplish the monitoring system's goal.

Finally, the combination of Arduino Mega microcontroller, DC motor and motor driver, Servo motor and PWM Servo motor driver, GSM , and proximity sensor make the system much more

versatile and not limited to one functionality beside sorting the waste .

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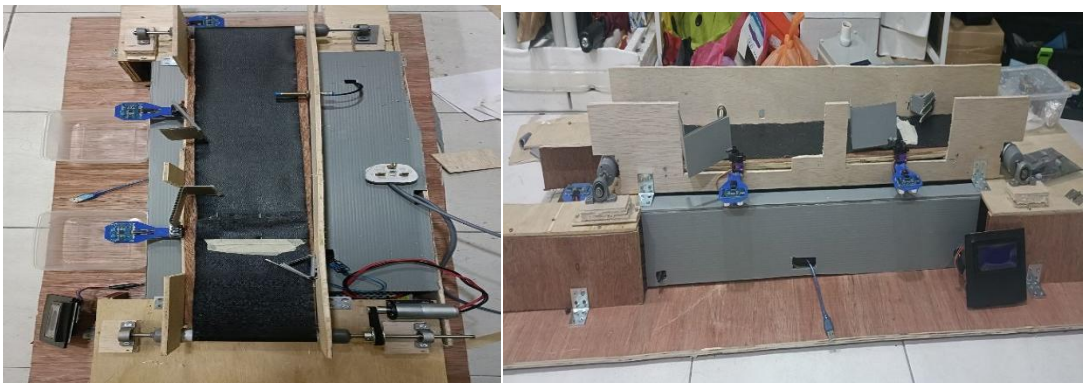

Figure 53: Prototype of hardware design

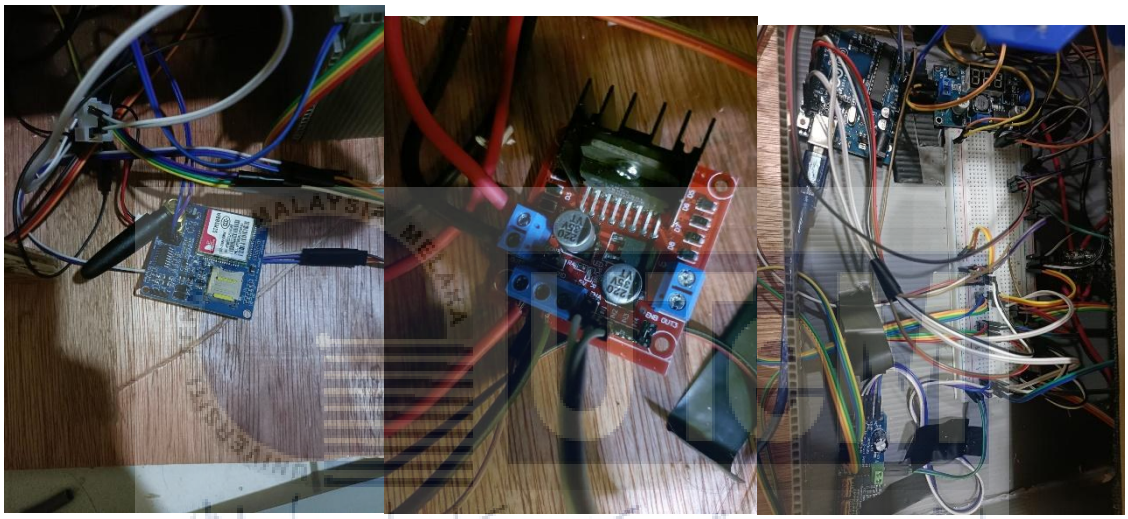

Figure 54: Prototype of Circuit Design

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4.2.4 Proximity sensor (Inductive and Soil Moisture Sensor)

Inductive sensor and Soil moisture sensor are the two main sensor that were implemented in this project to detect the object material. Inductive sensor use magnetic field to detect metal objects that are near to the sensor, while Soil Moisture sensor is use to detect the moisture inside the object .

Figure 55: Inductive sensor and Soil Moisture sensor

The moisture sensor is installed at an angle so that waste can touch both copper and enhance the likelihood that it will be detected by the sensor. In contrast, the inductive sensor is constructed such that objects can pass in front of it and be detected. Both sensors will work together with the LCD to display the detection status.

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Figure 56: LCD status of proximity sensor detection

In order for the both sensor to work a set of coding has been made so that Arduino Mega can do the function properly such as Inductive sensor and LCD.

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```
if (sensorValue == LOW) {
  lcd.clear(); // Clear the LCD when no object is detected
  Serial.println("Object detected!");
  lcd.setCursor(4, 1);
  lcd.print("Metal Detect");
  rotateServo(servoPin1, 180);
  lastObjectDetected = true;
} else {
  Serial.println("No object detected.");
  if (lastObjectDetected) {
    rotateServo(servoPin1, SERVO_DEFAULT_POSITION);
    lastObjectDetected = false;


  }
}
```

```
    lcd.setCursor(0, 3);
    lcd.print("Metal Waste: ");
    lcd.print(metalPercentage);
    lcd.print("%");
}
```

Figure 57: Coding for Inductive Sensor

The code is to checks if a sensor value is LOW, indicating the presence of an object. If an object is detected, it clears the LCD screen, prints a message, displays “Metal Detect” on the LCD. If no object detect LCD will clear and print other display.

```
  lcd.clear(); // Clear the LCD when no object is detected
if (moistureValue < 900) {
  Serial.println("Moisture detected! Rotating servo 180 degrees.");
  lcd.setCursor(3, 1);
  lcd.print("Moisture Detect");

  delay(1000);

  rotateServo(servoPin2, 180);

   delay(2000);

  controlDCMotor(255, true);
}  else if (moistureValue > 950) {
  Serial.println("Moisture level > 950. Returning servo to default position.");
  rotateServo(servoPin2, SERVO_DEFAULT_POSITION);
```

```
lcd.setCursor(0, 2);
lcd.print("Wet Waste: ");
lcd.print(wetPercentage);
lcd.print("%");
```

Figure 58: Coding for Moisture Sensor

The coding for moisture sensors has same function as inductive sensor, but it includes with value of detection. The max value for moisture sensors is 1024, in this coding the value has been changed to optimise the detection for moisture object and has been set to

900 below to detect moisture inside object. It will then display at LCD “Moisture Detect”. When the value is 950> it will clear LCD and display other function.

4.2.5 Ultrasonic Sensor

In this project I have include three ultrasonic sensors in different locations to monitor the level of waste. Value of waste level will be display to LCD so that users can know that the bin is full or not.

Figure 59: Metal Waste Monitoring

Figure 60: Dry Waste Monitoring

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Figure 61: Wet Waste Monitoring

The set of coding has been made so that ultrasonic sensors can send the data to the microcontroller and display it into LCD.

```
float readUltrasonicSensor(int trigPin, int echoPin, float containerHeight)
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);

  float duration = pulseIn(echoPin, HIGH);
  float height = duration * 0.034 / 2;
  fillPercentage1 = (containerHeight - height) / containerHeight * 100;

  if (fillPercentage1 < 0.00) {
    fillPercentage1 = 0.00;
  }

  return constrain(fillPercentage1, 0, 100);
}
```

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```
                lcd.setCursor(0, 1);
                lcd.print("Dry Waste: ");
                lcd.print(dryPercentage);
                lcd.print("%");

float wetPercentage = readUltrasonicSensor(ultrasonicTrigPin, ultrasonicEchoPin, 10.0);
```

Figure 62: Wet Waste Monitoring Coding

```
float readUltrasonicSensor2(int trigPin, int echoPin, float containerHeight) {
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);

  float duration = pulseIn(echoPin, HIGH);
  float height = duration * 0.034 / 2;
  fillPercentage2 = (containerHeight - height) / containerHeight * 100;

  if (fillPercentage2 < 0.00) {
    fillPercentage2 = 0.00;
  }

  return constrain(fillPercentage2, 0, 100);
}
```

```
lcd.setCursor(0, 3);
lcd.print("Metal Waste: ");
lcd.print(metalPercentage);
lcd.print("%");
```

```
float metalPercentage = readUltrasonicSensor2(ultrasonicTrigPin2, ultrasonicEchoPin2, 10.0);
```

Figure 63: Metal Waste Monitoring Coding

```
float readUltrasonicSensor3(int trigPin, int echoPin, float containerHeight) {
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);

  float duration = pulseIn(echoPin, HIGH);
  float height = duration * 0.034 / 2;
  fillPercentage3 = (containerHeight - height) / containerHeight * 100;

  if (fillPercentage3 < 0.00) {
    fillPercentage3 = 0.00;
  }

  return constrain(fillPercentage3, 0, 120);
}
```

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```
lcd.setCursor(0, 1);
lcd.print("Dry Waste: ");
lcd.print(dryPercentage);
lcd.print("%");
```

```
float dryPercentage = readUltrasonicSensor3(ultrasonicTrigPin3, ultrasonicEchoPin3, 10.0);
```

Figure 64: Dry Waste Monitoring Coding

The code defines a function named readUltrasonicSensor2 for an ultrasonic sensor to estimate the fill percentage of a container. It takes the trigger pin (trigPin), echo pin (echoPin), and the container's known height (containerHeight) as inputs. The function initiates the sensor, measures the duration of the echo signal, converts it to a height value, and calculates the fill percentage. To ensure the result is valid (between 0 and 100), it checks and adjusts if necessary and the value in float dryPercentage, wetPercentage and metalPercentage is set to 10.0 depend on the size of the bin. Finally, the function returns the constrained fill percentage, providing a straightforward way to gauge the container's fill level based on ultrasonic sensor data and then will display it on LCD with percentage.

4.2.6 LCD Display

The LCD displays is a display to create images. LCD are frequently used to provide visual presentation in a variety of electronic devices and machine. In this project, the LCD will serve as the system's interface. It will shows the status of the bin and the detection of sensor as in **Figure 5.2** when Inductive sensor or Moisture sensor detect an object.

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Figure 65: LCD display status of Bin level

For the LCD to display a value Arduino microcontroller is the main components in order for it to work. The coding of LCD include with with library "#include<LiquidCrystal_I2C.h>" and the initialize of the library that is "LiquidCrystal_I2C lcd(0x27,20,4)", to initialize the LCD we will have to use "lcd.init()"

and “lcd.backlight()” in the void setup of the arduino program to initialize the use of LCD in the program.In this coding I have added a set a program which display the level value for each type of waste. Lcd.setCursor (); is for determine where the word will be positioned and lcd.print() is to display on LCD.

```
        Serial.println("No object detected.");
        lcd.setCursor(0, 0);
        lcd.print("Insert Waste");

        lcd.setCursor(0, 1);
        lcd.print("Dry Waste: ");
        lcd.print(dryPercentage);
        lcd.print("%");

        lcd.setCursor(0, 2);
        lcd.print("Wet Waste: ");
        lcd.print(wetPercentage);
        lcd.print("%");

        lcd.setCursor(0, 3);
        lcd.print("Metal Waste: ");
        lcd.print(metalPercentage);
        lcd.print("%");
#include <Wire.h>
#include <LiquidCrystal_I2C.h>

LiquidCrystal_I2C lcd(0x27, 20, 4);

void setup() {
  // put your setup code here, to run once:
lcd.init();
lcd.backlight();
}
```

Figure 66: LCD Status Bin Coding

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4.2.7 GSM Interface

GSM is a communication electronic device that can send and receive a message or call to a user. This device mainly use to communicate with user to send a data from Arduino program. In this system I have make a program that will send a message to local authorities about the status of waste to alert the authorities to clean the bin to avoid it from overflowing. The message should look like this:

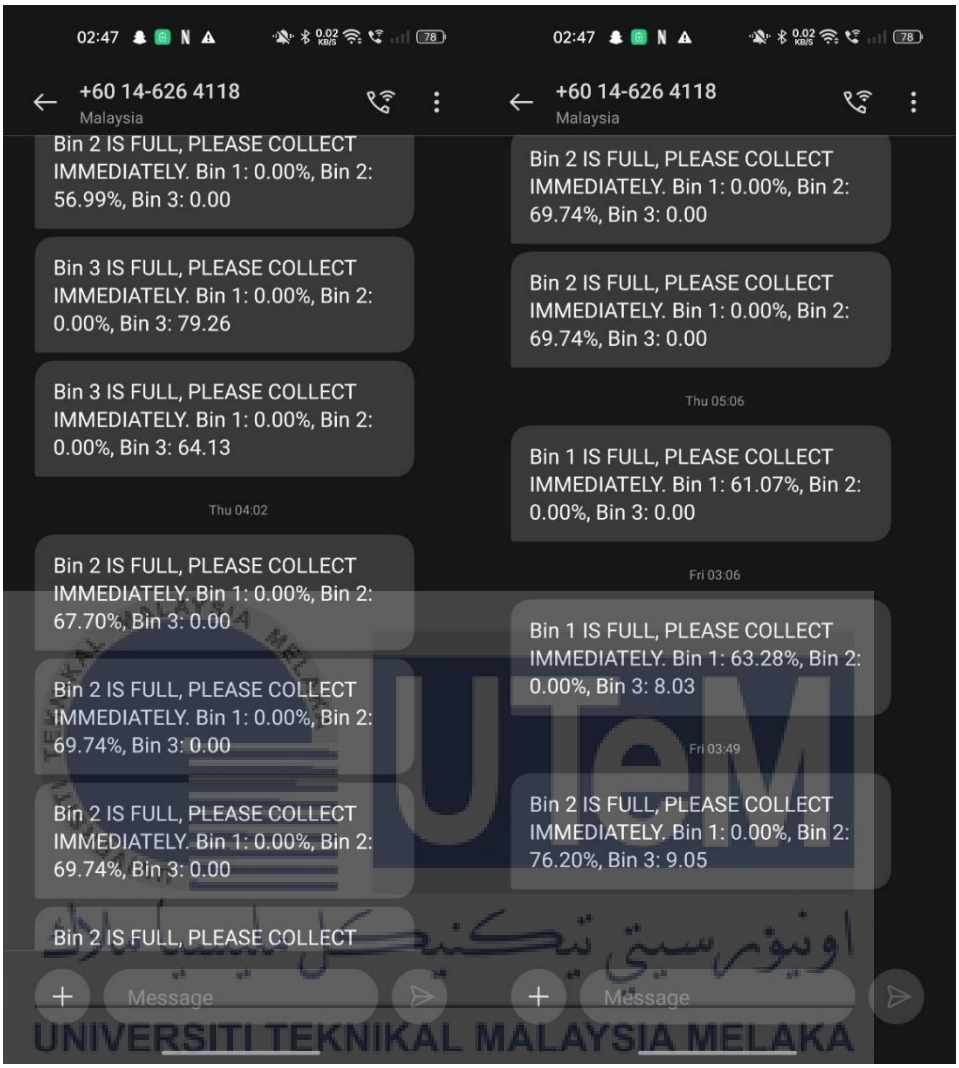

Figure 67: GSM message receive

This programme needs to be connected to an Arduino board and configured to transmit this kind of message in order to function. I must declare it and include library #include <SoftwareSerial.h> . The pin must then be announced initially. gsmSerial software serial (gsmRxPin, gsmTxPin). A message is sent to the user whenever the ultrasonic sensor's percentage value is more than or equal to 55%. The message is repeated 30 seconds later. gsm.Serial.println("AT+CMGS=\" authorities phone number\"); in this part it needs to add the phone number. After that, I have to figure out which bins are full by creating ”if” function to show the message. This is necessary in order for the message to look like **Figure 67** and send message to authorities number.

```
#include <Wire.h>
#include <SoftwareSerial.h>

// Pin configuration
const int gsmRxPin = 3;
const int gsmTxPin = 2;

SoftwareSerial gsmSerial(gsmRxPin, gsmTxPin);
```

Figure 68: Declaration of GSM

```
if (fillPercentage1 >= 55.0 || fillPercentage2 >= 55.0 || fillPercentage3 >= 55.0) {
    sendBinFullSMS(fillPercentage1, fillPercentage2, fillPercentage3);
    delay(3000);  //  30 sec delay before sending another message
```

Figure 69: Sending messages if percentage reach 55% and above

```
// Determine which bins are full
String fullBins;
if (fill1 >= 55.0) {
  fullBins += "Bin 1 ";
}
if (fill2 >= 55.0) {
  fullBins += "Bin 2 ";
}
if (fill3 >= 55.0) {
  fullBins += "Bin 3 ";
}

// Send SMS with bin information
if (fullBins.length() > 0) {
  gsmSerial.print(fullBins);
  gsmSerial.print("IS FULL, PLEASE COLLECT IMMEDIATELY. ");
  gsmSerial.print("Bin 1: ");
  gsmSerial.print(fill1);
  gsmSerial.print("%, Bin 2: ");
  gsmSerial.print(fill2);
  gsmSerial.print("%, Bin 3: ");
  gsmSerial.print(fill3);
} else {
  gsmSerial.print("ALL BINS FULL. PLEASE COLLECT. ");
  gsmSerial.print("Bin 1: ");
  gsmSerial.print(fill1);
  gsmSerial.print("%, Bin 2: ");
  gsmSerial.print(fill2);
  gsmSerial.print("%, Bin 3: ");
  gsmSerial.print(fill3);
}
  void sendBinFullSMS(float fill1, float fill2, float fill3) {
    Serial.println("Sending SMS: BIN IS FULL. PLEASE COLLECT");
    gsmSerial.println("AT+CMGF=1");
    delay(500);
    gsmSerial.println("AT+CMGS=\"+60109627870\"");
    delay(500);
```

Figure 70: Determine phone number and which bin are full and show the bin status

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4.2.8 Motor Configuration

In the Development of General Intelligence Waste Sorting System I have determine to used conveyor as part of the system. The conveyor consists of casing , roller and idle roller and most important it need moving mechanism which is dc motor. It is because DC motors are easy to program and control. They are important component for making conveyor.

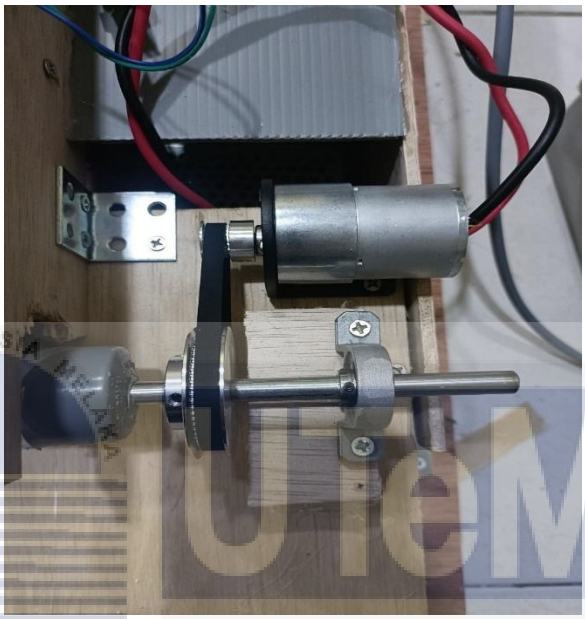

Figure 71: Set of DC motor with Pulley system

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In this project DC motor is use along with pulley to move an item from point A to point B. It then tie with shaft and roller where the belt will wrap around it. For the motor to move it need to program in Arduino IDE which it very straightforward. The motor needs to connect to it driver which is motor driver L298N and declared each pin connection to Arduino. When program analogWrite(motorEnablePin, 255); is needed to enable speed control of DC motor. The PWM value can be set between 0 to 255 maximum. Then controlDCMotor(255, true); is include in void loop so the motor can move with maximum speed. The true value is to make sure that motor is moving, if it set to false it will stop the motor.

```
#include <Wire.h>
const int motorEnablePin = 5;
const int motorIn1Pin = 4;
const int motorIn2Pin = 6;

void setup() {
  // put your setup code here, to run once:
pinMode(motorEnablePin, OUTPUT);
  pinMode(motorIn1Pin, OUTPUT);
  pinMode(motorIn2Pin, OUTPUT);
}
```

Figure 72: Declaration pin of Motor Driver L298N

```
void loop() {
  // put your main code here, to run repeatedly:
 controlDCMotor(255, true);
 //Sensor and other coding
}
```

Figure 73: Coding to control motor speed

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4.2.9 Data Analysis on Efficiency of the system

In this subtopic it will cover the data that have been obtained from the project to achieve the objective. This data analysis's main objective is to assess the Waste Sorting System's overall effectiveness, with a focus on the sorting procedure and the GSM communication subsystem in particular. Through the use of data gathered throughout the system's operating phase, our goal is to derive significant insights on performance indicators, possible bottlenecks, and optimisation prospects.

4.2.10 Waste Sorting Efficiency

I ran a test with varying RPMs to see how effective the system was. It's because the system's efficiency will decrease if the RPM is set too high while it's operating. I've discovered that the system may respond to the sensor a little slowly at first, which is why

the RPM will be changed. The RPM that is use in this test is 300 RPM and 100RPM, the metal and wet waste only tested to gain data since both of this material required sensor. The material that will be use is shown in figure below.

Figure 74: Metal waste Aluminium Foil and Beverage Can

Figure 75: Wet waste Sponge and Tissue

In Arduino it only shows the PWM of motor DC not the actual value of RPM. So, we need to calculate RPM using the formula below:

$$RPM = (\text{Current PWM Value} / \text{Max PWM Value}) \times \text{Max RPM}$$

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4.2.11 Metal Waste Test Based on RPM

Number of Test	Pass/Fail
1	Fail
2	Pass
3	Pass
4	Fail
5	Pass

Table 6: Beverage can/300 RPM

Number of Test	Pass/Fail
1	Fail
2	Fail
3	Pass
4	Pass
5	Fail

Table 7: Aluminium foil/300RPM

Number of Test	Pass/Fail
1	Pass
2	Pass
3	Pass
4	Fail
5	Pass

Table 8: Beverage can/100 RPM

Number of Test	Pass/Fail
1	Pass
2	Fail
3	Pass
4	Pass
5	Fail

Table 9: Aluminium foil/100 RPM

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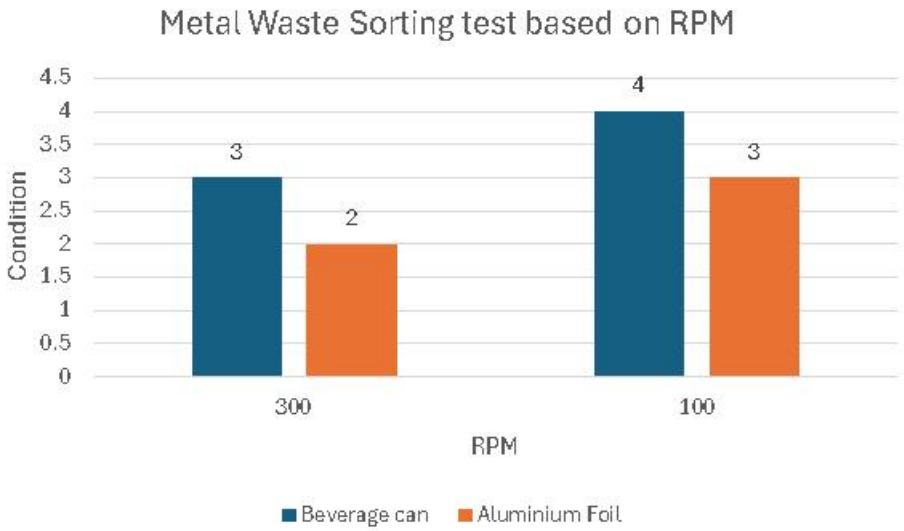

Figure 76: Data analysis Number of pass VS RPM graph of Metal Waste

Type of Waste	RPM	Efficiency Rate
Beverage Can	300	60%
Aluminium Foil	300	40%
Beverage Can	100	80%
Aluminium Foil	100	60%

Table 10: Efficiency Table

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4.2.12 Wet Waste Test Based On RPM

Number of Test	Pass/Fail
1	Fail
2	Fail
3	Pass
4	Fail
5	Pass

Table 11: Sponge/300 RPM

Number of Test	Pass/Fail
1	Fail
2	Fail
3	Pass
4	Pass
5	Fail

Table 12: Tissue/300 RPM

Number of Test	Pass/Fail
1	Fail
2	Pass
3	Pass
4	Pass
5	Pass

Table 13: Sponge/100 RPM

Number of Test	Pass/Fail
1	Pass
2	Pass
3	Pass
4	Fail
5	Fail

Table 14: Tissue/100RPM

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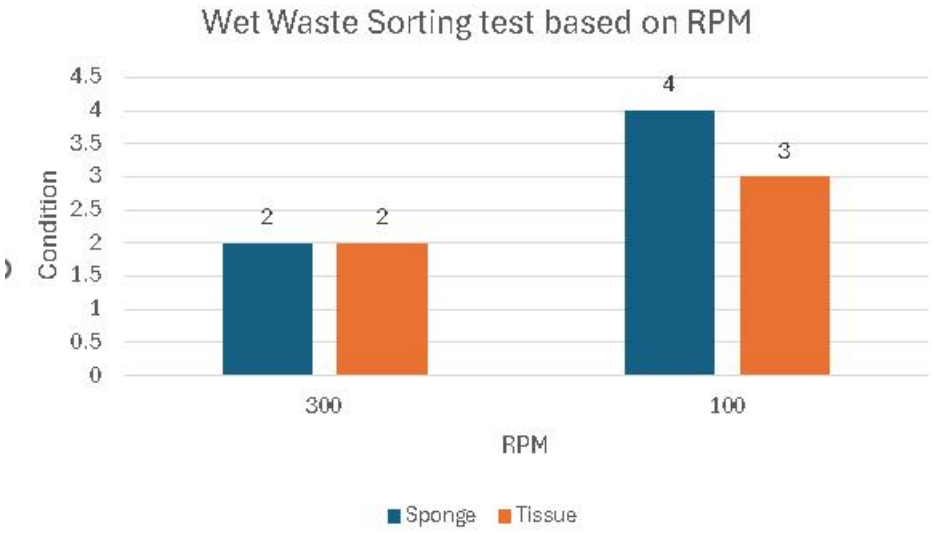

Figure 77: Data analysis Number of pass VS RPM graph of Wet Waste

Type of Waste	RPM	Efficiency Rate
Sponge	300	40%
Tissue	300	40%
Sponge	100	80%
Tissue	100	60%

Table 15: Efficiency Table

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4.2.13 GSM sending message

In this part I have test the efficiency on how well the GSM will send the message to user. In each number of test the message will be send every 30 seconds.

Number of Test	Message send every 30 seconds
1	Send
2	Send
3	Not send
4	Send
5	Send
6	Send
7	Send
8	Send
9	Send
10	Not Send

Table 16: Data GSM mesage status receive by phone

4.3 Summary

In conclusion, we are aware of the effectiveness of our waste sorting system using GSM based on all the data we have collected. A portion of the failure could be caused by a sensor's detection. The inductive sensor that was utilised has a 10 mm low detection range. A portion of the inductive sensor's failure can be attributed to the object's distance from the sensor, which prevents the sensor from detecting it. The material being tested needs to be extremely wet for the moisture sensor to pick up on moisture since the model it is using is not very sensitive. Since both sensors have trouble recognising objects, the slower the RPM, the more difficult it is for the sensor to detect an object, which is why the data is collected using RPM. For GSM the message was not send due to unstable line at the area located.

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CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In order to increase trash management efficiency, this project has methodically researched and developed a waste sorting system with GSM connectivity. The project's objectives and importance were established in the introduction. The literature analysis emphasised the possible advantages of integrating GSM into waste sorting systems while offering a thorough overview of pertinent technology. The methodology chapter provided a useful framework for the project's implementation by outlining the systematic methods used to evaluate sorting and communication efficiencies. Key findings were presented in the results and discussion section, demonstrating how well the system works to precisely sort waste and send real-time data over GSM. These realisations serve as the foundation for upcoming improvements that will bring the project into line with the more general goals of smart technology integration and sustainable waste management. To put it simply, this initiative shows how important technology is to solving today's environmental problems while also advancing ongoing efforts to develop creative waste processing solutions.

5.2 Potential for Commercialization

Our proposal presents a novel solution, the garbage Sorting System with Proximity Sensors and GSM Connectivity, in response to the growing difficulties in garbage management. This system efficiently identifies and classifies different waste products by

using proximity sensors. By integrating GSM connectivity, users can remotely oversee the system's performance and receive timely updates. This provides a layer of real-time monitoring and control.

This waste sorting system's primary operation depends on proximity sensors that are positioned carefully to identify various waste kinds. Accurate identification is ensured by these sensors, eliminating the need for intricate AI systems. Accurate sorting at the source is made possible by the distinct responses that are elicited by each type of garbage. By enabling users to remotely supervise the sorting process, GSM connectivity improves the functionality of the system. This capability enables quick modifications, guaranteeing peak performance and flexibility.

Furthermore, the carbon footprint resulting from needless transit and physical interventions is decreased by the remote monitoring capabilities. Purchasing the Waste Sorting System with Proximity Sensors and GSM Connectivity is a concrete step towards environmentally friendly waste management techniques that supports international initiatives for a cleaner, greener future.

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5.3 Future Works

Future development of the Waste Sorting System with GSM indicate that enhanced sensor integration is a crucial area for research. Modern sensor technologies, like computer vision systems and artificial intelligence algorithms, can greatly improve the efficiency and accuracy of the system's sorting. This evolution guarantees adaptability to new trash types and also promises improved waste categorization. Furthermore, investigating environmental sensors can offer a more thorough comprehension of the system's influence by gathering information on temperature and air quality.

Using machine learning techniques to provide adaptive sorting systems is another exciting avenue for future research. By using past sorting data, the system is able to continuously learn from and improve its sorting methods, allowing it to adjust to changes in the composition of waste. The system's long-term sustainability is improved by this dynamic approach, particularly in settings where waste properties may change over time. Predictive analytics can also be used to optimise maintenance scheduling, guaranteeing that the system runs as efficiently as possible.

Future-oriented factors for the Waste Sorting System include scalability and integration with smart grid technology. As the system develops, paying close attention to hardware, connectivity, and power needs is necessary to investigate its scalability to handle bigger waste quantities in varied environments. Integration with smart grid technology creates opportunities for improved grid management and energy efficiency. Investigating energy-aware algorithms, renewable energy sources, and bidirectional communication between the garbage sorting system and smart grids meshes with the broader objective of developing sustainable and linked urban ecosystems. These upcoming paths promise to advance environmental sustainability and intelligent technology integration in addition to increasing waste management efficiency.

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REFERENCES

Wager PA. Waste Management in Switzerland–Achievements and Perspectives. *ResearchGate*. Published online January 1, 2007. https://www.researchgate.net/publication/229047585_Waste_Management_in_Switzerland-Achievements_and_Perspectives: [1]

Wikipedia contributors. Waste sorting. *Wikipedia*. Published online June 17, 2023. https://en.wikipedia.org/wiki/Waste_sorting [2]

Greg, Greg. Waste Sorting: A Complete Guide to How and Why Your Business Must Do It - Anis Trend. Anis Trend. Published May 24, 2022. https://www.anis-trend.com/waste-sorting-a-complete-guide-to-how-and-why-your-business-must-do-it/#:~:text=Waste%20sorting%20is%20the%20process,material%20end%20up%20in%20landfills: [3]

Vasconcelos L, Silva FM, Ferreira F, Pires A, Pires A, Ferreira JMF. Collaborative process design for waste management: co-constructing strategies with stakeholders. *Environment, Development and Sustainability*. 2021;24(7):9243-9259. doi:10.1007/s10668-021-01822-1[4]

Abdel-Shaf HI, Mansour MSM. Solid waste issue: Sources, composition, disposal, recycling, and valorisation. *Egyptian Journal of Petroleum*. 2018;27(4):1275-1290. doi:10.1016/j.ejpe.2018.07.003[5]

Managing and Reducing Wastes: A Guide for Commercial Buildings | US EPA. US EPA. Published March 2, 2023. https://www.epa.gov/smm/managing-and-reducing-wastes-guide-commercial-buildings [6]

Smith H. How Improper Waste Disposal Affects the Environment. *Clean Management Environmental Group, Inc*. Published online January 4, 2022. https://cleanmanagement.com/blog/how-improper-waste-disposal-affects-the-environment/ [7]

What a Waste: An Updated Look into the Future of Solid Waste Management. World Bank. Published September 20, 2018. https://www.worldbank.org/en/news/immersive-story/2018/09/20/what-a-waste-an-updated-look-into-the-future-of-solid-waste-management[8]

Fang, B., Yu, J., Chen, Z., Osman, A. I., Farhadi, M., Ihara, I., Hamza, E. H., Rooney, D. W., & Yap, P.-S. (2023). Artificial intelligence for waste management in smart cities: a review. *Environmental Chemistry Letters*. https://doi.org/10.1007/s10311-023-01604-3[9]

Torres-García A, Rodea-Aragón O, Longoria-Gandara O, Sánchez-García FJ, González-Jiménez LE. Intelligent Waste Separator. *Computation Y Sistema's*. 2015;19(3). doi:10.13053/cys-19-3-2254 [10]

Mittal G, Yagnik KB, Garg M, Krishnan NC. *Spot Garbage*.; 2016. doi:10.1145/2971648.2971731[11]

Mittal G, Yagnik KB, Garg M, Krishnan NC. *Spot Garbage*.; 2016. doi:10.1145/2971648.2971731
Copy to clipboard [12]

Prasad R. IOT BASED WASTE MANAGEMENT IN SMART CITY USING IR. *www.academia.edu*. Published online June 7, 2018. https://www.academia.edu/36803762/IOT_BASED_WASTE_MANAGEMENT_IN_SMART_CITY_USING_IR [13]

Al-Fayyad, H. R., Ali, S., & Abode, B. (2021). Modelling an Adaptive Learning System Using Artificial Intelligence. *Web ology*, *19*, 1–18. https://doi.org/10.14704/WEB/V19I1/WEB19001 [14]

Balakrishnan K, Swathi RTB, D ST. Automatic Waste Segregator and Monitoring System. *ResearchGate*. Published online January 1, 2016. https://www.researchgate.net/publication/317720527_Automatic_Waste_Segregator_and_Monitoring_System [15]

Advantages of GSM | Disadvantages of GSM. https://www.rfwireless-world.com/Terminology/Advantages-and-Disadvantages-of-GSM.html [16]

Jalani, J., Hang, C. J., Syafiq Sadun, A., Wahab, Z. A., & Ali, R. (2021). *Automated Recycle Dustbin System with GSM Module for Waste Management*. *20*(3), 56–64. www.elektrika.utm.my
[17]

Arduino Mega 2560. (n.d.). [18]

EFY Bureau. GSM/GPRS Module Explained | Definition, Working, AT Commands. *Electronics for You*. Published online December 9, 2022. https://www.electronicsforu.com/resources/gsm-module [19]

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Handson Technology User Guide I2C Serial Interface 1602 LCD Module. (n.d.). www.handsontec.com [20]

Wikipedia contributors. Proteus Design Suite. *Wikipedia*. Published online December 15, 2022. https://en.wikipedia.org/wiki/Proteus_Design_Suite [21]

Arduino Integrated Development Environment (IDE) v1 | Arduino Documentation. https://docs.arduino.cc/software/ide-v1/tutorials/arduino-ide-v1-basics[22]

Jnanasangama, B. (n.d.). *VISVESVARAYA TECHNOLOGICAL UNIVERSITY "Automatic Waste Segregation System."* http://203.201.63.46:8080/jspui/bitstream/123456789/6317/1/PR3291%20Automatic%20Waste%20Segregation%20System%20Chethan%20Siddeshwar%20K%20R%20_%20Gunasagar%20C%20M%20_%20Hemanth%20S%20_%20K%20Pavan%20Kalyan%20Reddy%20Venkatesh%20Naik-Aug-2021.pdf [23]

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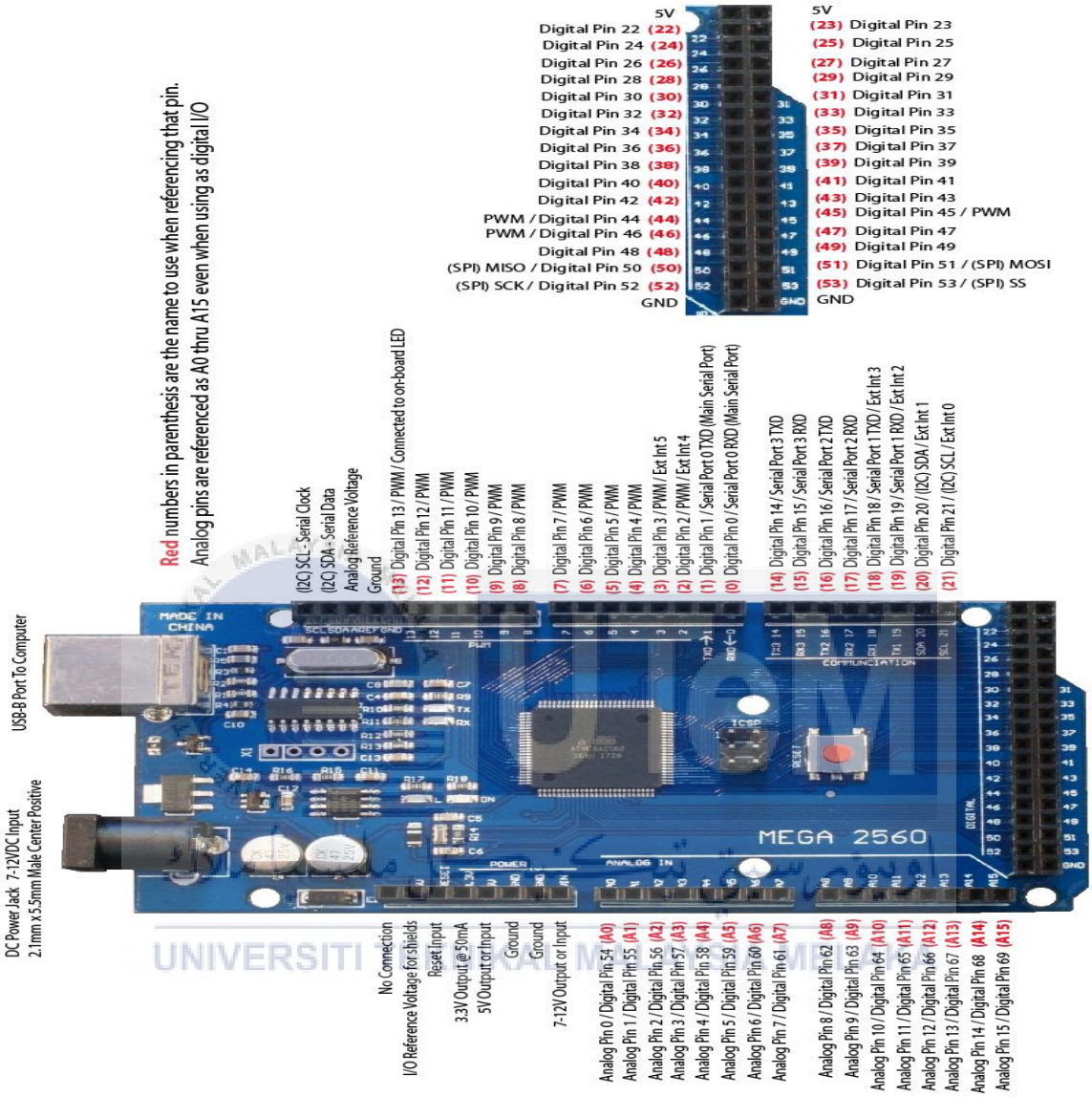

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