SMART GARBAGE MONITORING SYSTEM

AMALIA WITRA BINTI JAILANI

Bachelor of Computer Science

UNIVERSITI MALAYSIA PAHANG

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ID Number : CA15083

Date : 3 JANUARY 2019

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AMALIA WITRA BINTI JAILANI

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ABSTRAK

Antara salah satu cabaran untuk berinovasi dan mencipta penyelesaian IOT membolehkan dalam pemantauan dan pengurusan alam sekitar. Pengumpulan produk sampah menggunakan Internet Thing (IoT) dengan teknologi sensor wayarles pintar yang akan dapat mengumpulkan data dari tong sampah. Ini salah satu cabaran kepada pihak berkuasa tempatan ialah bagaimana memantau karya pekerja yang berkesan dan cekap dalam pengurusan sisa. Dari hasil penyelidikan ini, dapat disimpulkan bahwa, di satu pihak, aplikasi ICT, melalui pengurusan mengumpulkan data dari sukarelawan oleh pihak yang berkepentingan, dapat meningkatkan visualisasi sistem manajemen sisa pintar cerdas. Dokumentasi ini akan memberi maksud kepada pihak berkuasa tempatan pelaksanaan pengurusan sisa pintar untuk meningkatkan dan meningkatkan pengurusan bandar, dan menyediakan perkhidmatan yang lebih baik kepada orang ramai ke arah aplikasi pintar bandar.

ABSTRACT

One of the challenges to transform and make an Internet of Things (IoT) is in monitoring and managing of the environment. One of the challenges to the local authority is how to monitor the works of employee effective and efficiency in waste management. Waste product collection utilizes the IoT with the technology of sensors that will able to collect the data from a garbage bin. From the finding of this investigation, it can be concluding that through management of collecting data from the volunteer by stakeholders can enhance the visualization of intelligent smart waste management system. This documentation will purpose to the local authority the implementation of smart waste management to provide better services to the public towards smart city applications and improve and increase the city management.

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CHAPTER 1

INTRODUCTION

1.1 Project Background

In this era, we are living in age where everything must be done in a short time but efficient. Tasks and systems are fusing together with the influence of Internet of Thing (IoT) to have a more fast and efficient system of working. IoT is the network of associated physical objects that can interconnect and interchange data among themselves without human intervention. IoT permits human to gather information and data from all kind of medium. IoT is unalike Internet as it aiding everyday objects to communicate with each other using the existing Internet technology.

One of the main concerns during this present era is solid waste management. Lack of monitoring and managing solid waste has affects the health and environment of our society. The manual way of monitoring the waste is an inefficient process and use more human effort, time and cost. This inefficient process can be avoided with present technologies.

The garbage truck use to go around the town to collect garbage every three days. This system was very inefficient as the garbage fills up really fast and spill out from the garbage bin in a crowded area or the garbage bin is not even half full after two days in a seclude area. It can lead to an unhealthy environment and smell pollution.

In this paper, the proposed system is the immediate collecting the garbage called Smart Garbage Monitoring System. This garbage monitoring system helps solve this problem as an ultrasonic device on top of a garbage bin will detecting and collect the data that the volume of the waste product has reached its maximum value from its threshold value and then, transmit the status to mobile phone via SMS. This system also can detect a garbage bin that half full but it is two or more days old. This is to prevent smell environment. Then, the data transmitted to the hand phone via SMS.

1.2 Problem Statement

The disadvantage of the existing system are that the environmental companies cannot assume the volume of solid waste in garbage bin daily so the employees have to check the garbage bins every day resulting in high cost. Because of that, the garbage bin is over spilled. It can attract pests and lead to unhealthy environment.

Another problem that needs to be solved is the age of the garbage. If supposing a particular garbage bin is not even full and then for a week, the garbage truck not collect the garbage, it will start rotting and leading to a smelly surrounding. Therefore, this proposed system will tackle the problem with our system's tolerance level is set to two days so if the garbage bin is not full but it is two days old it then also need to be emptied.

Table 1.1 Problem Statement of Smart garbage Monitoring System.

No.	Problem	Description	Effect
1	Volume of solid waste	The environmental management company cannot assume the volume of solid waste in garbage bin in a day.	Over spilled of garbage bin can attract pests and it can lead to unhealthy environment
2	Time	The garbage is two or more days old as the garbage trucks not collect it because the bin is not even full.	It can lead to smell pollution and the society will live in an uncomfortable environment

1.3 Goal / Aim & Objectives

1.3.1 Goal / Aim

The goal for this project is to develop a real-time garbage monitoring system for UMP.

1.3.2 Objectives

The objectives of this project are:

i. To build a garbage monitoring system.

ii. To send the garbage volume status to mobile phone by sending SMS.

1.4 Scope

The scopes of the project are:

i. To focus on detection of volume and age of waste product in garbage bin and the data is transmitted to hand phone by sending SMS.

ii. To focus on the installation of Arduino UNO, ultrasonic sensor and GSM module.

iii. To focus on testing the system can detect the volume of garbage and transmit the data to user.

1.5 Significance

The significance of this project is:

i. Facilitate environmental management company in making a better environment of society.

ii. Improve the previous project by adding an additional feature.

1.6 Report / Thesis Organisation

This thesis for smart garbage monitoring system project comprises of five chapters. Chapter 1 discusses on introduction of project. Chapter 2 discusses about literature review, where we describe the existing systems. Chapter 3 discusses about methodology. Implementation, testing and results will be discussed on Chapter 4. Finally, in Chapter 5 will conclude the entire project of smart garbage management system.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, more discussion will be explaining more aspect based on previous systems that similar to Smart Garbage Monitoring System. There are some technologies that will be implementing to the project of this Smart Garbage Monitoring System.

2.2 Material Outline

2.2.1 Garbage Bin

Garbage bin (Figure 2.1) is a bin for temporarily storage for garbage and is usually made out of metal or plastic. Some common terms are dustbin, waste container, garbage can and trash can. In 1875, the first personal garbage bin was invented in Britain.

In cities and towns, there is a garbage collection service which collects domestic waste from the curb side. Commercial curb side garbage bin are often larger dumpsters (Figure 2.2) or skips (Figure 2.3).

Figure 2.1 Garbage bin

Figure 2.2 Dumpster

Figure 2.3 Skip

2.2.2 Arduino Uno

Arduino in an open source and programming association that produce microcontroller packs for making programmed devices and smart object that can detect and control problems in the real world. Arduino UNO is a series of a little tiny chip for peoples to study it. A single board computer has been invented by Arduino UNO Foundation in UK to teach basic computer science. The Arduino UNO device (Figure 2.4) is look like a motherboard and includes the entire component that we need to gather the data of the volume inside the garbage. We get the input and output via connection from wireless. The other component at the Arduino UNO is ARM CPU/GPU. ARM CPU and GPU is made up by Broadcom BCM2835 System on a Chip (SoC). Handled graphics of GPU is shown in Figure 2.5.

Figure 2.4 Motherboard of a Arduino UNO

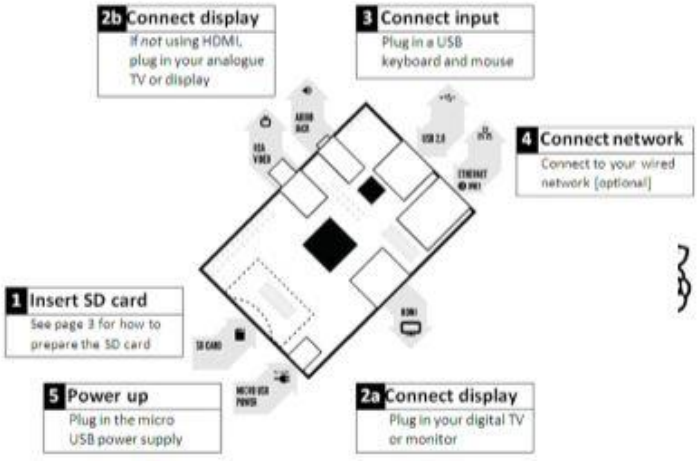

Figure 2.5 Handled graphics of GPU

2.2.3 Ultrasonic Sensor

The ultrasonic sensor (Figure 2.6) is used to measure and sense the distance between objects with high precision and constant readings. It has four pins which of the two are VCC, GND, Trig and Echo. The sonar sensor will sense, collect and transfer the data by Arduino UNO via wireless Internet connection to control centre in the form of data packet (Figure 2.7).

Figure 2.6 Ultrasonic sensor

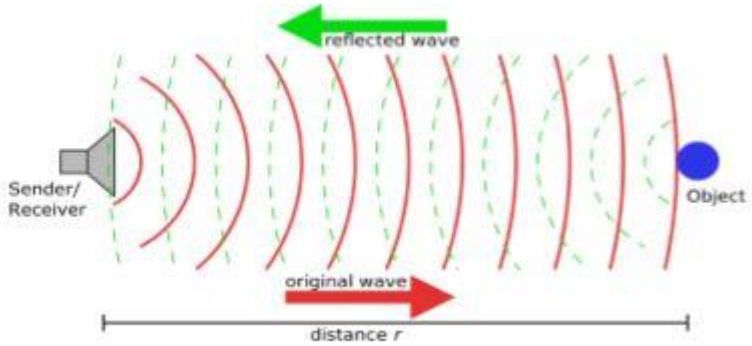

Figure 2.7 Data packet

2.2.4 GSM Module

A GSM Module is connected to a PCB with different types of output taken from the board – say TTL Output (for Arduino, 8051 and other microcontrollers) and RS232 Output to interface directly with a PC. The board will also have pins or provisions to attach mic and speaker, to take out +5V or other values of power and ground connections. These types of requirements differ with different modules.

GSM means global system for mobile communication (GSM). The GSM was established at Bell Laboratories in 1970 and it is widely used mobile communication system in the world. GSM is an open and digital cellular technology used for

transmitting mobile voice and data services operates at the 850MHz, 900MHz, 1800MHz and 1900MHz frequency bands.

SIM900A GSM Module (Figure 2.8) is built with Dual Band GSM/GPRS based from SIMCOM. It works on frequencies 900 or 1800MHz and it also can search these two bands automatically. The baud rate is configurable from 1200-115200 through AT command. The user can connect with Internet via GPRS as the GSM/GPRS Modem is having internal TCP/IP stack. This is a complete GSM/GPRS module in a SMT type and designed with a very powerful single-chip processor integrating AMR926EJ-S core.

Figure 2.8 SIM900A GSM Module

2.2.5 Breadboard and Jump Wires

A breadboard is a solderless device for momentary model with electronics and test circuit projects. A breadboard is utilized to build and test circuits faster and efficiency. The breadboard has many holes into which route components like integrated circuits and resistors can be connected. A breadboard is shown in Figure 2.9. Jump wires are uses to establish connectivity with breadboard is shown in Figure 2.10

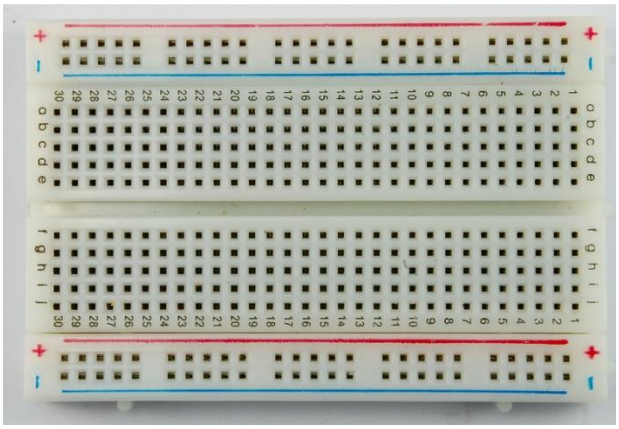

Figure 2.9 A breadboard

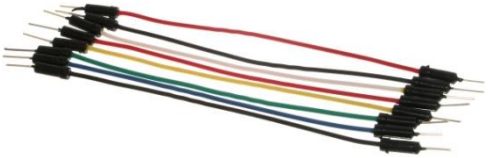

Figure 2.10 Jump wires

2.3 Investigation Existing Systems

There are many present applications that are already invented to the community. This project could be almost the identical with other project, but this project is differing from the other based on the three criteria; network type, network application and communication module. The differences from selected existing application are shown in following part.

2.3.1 Smart Dustbin – An Efficient Garbage Monitoring System

This system (Monika *et al.*, 2016) was built on an Arduino UNO which was implemented with a an ultrasonic sensor and GSM modem. As the garbage reaches the level of threshold that has been set, the sensor will trigger the GSM modem which alerts the related authority till the garbage in the bin is emptied.

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2.3.2 IoT Based Waste Management for Smart City

For this system (Tambare *et al.,* 2016), the authors proposed that the bins are linked to the internet to get real time data of the smart bins. There are some bins situated, which it is interfaced with microcontroller based system with IR sensor and RF modules. IR detects the level of the waste product and sends the signal to microcontroller. Then it is sends through RF transmitter and it is received by RF receiver and internet connection is enabled through a cable from modem. The data has been analysing in the cloud, which shows the status of the garbage on the web browser.

2.3.3 A Novel approach to Garbage Management using Internet of Things for Smart Cities

The authors (Kasliwal *et al.,* 2016) recommended a technique to organize the collection of garbage in the cities. In this system, the data is send to the control room from level of garbage was sensed by the ultrasonic sensor using GSM module. The different of this system is GUI. The GUI was based on MATLAB to check the information that was related to the garbage for different locations. Two units were built in the system which is slave unit and master unit. The sensor will check the level of garbage and send it to the slave unit which then send the data to the master unit and then notify the authorities to collect the garbage in bin.

2.4 Comparison between the Existing Systems

There are some differences that have been recognize and studied between the three existing systems of smart garbage system. The differences between them are network type, network application and communication module.

All of them have same objectives that are making the smart garbage bin for a smart city. As that have been described previously, smart garbage is a device that improve waste collection routes. The sensor has been set up to sense and transfer the data in the garbage bin to control centre.

Table 2.1 below shows the comparison between the existing systems.

Table 2.1 Comparison between existing system

Systems	**Network Type**	**Network Application**	**Communication Module**
Smart Dustbin – An Efficient Garbage Monitoring System	MAN	Web browser	GSM module
IoT Based Waste Management for Smart City	MAN	Web browser	RF (Radio Frequency) module
A Novel Approach to Garbage Management using Internet of Things for Smart Cities	MAN	MALTAB-based GUI	GSM module

2.5 Conclusion

To conclude, the most popular technology for the existing systems is GSM module. Besides, there are many technologies used such as ZigBee, Wi-Fi, Bluetooth and Radio Frequency which has its own advantages and disadvantages. In this project, the SGMS use GSM SIM900A module in the proposed system. The details of this technology are discussed in the next chapter.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In this chapter, additional discussion will be more about the software processes and methodology to be applied in creating the smart garbage monitoring system. There is various kind of software methodology, and each of it has its own advantages and disadvantages. Several methods used to develop the Smart Garbage Monitoring System (SGMS) are discussed, along with the requirements of the system and how it is used on the development of this system.

Methodology is significant as it is a standard to ensure that this project can be carried out efficiently by following the flow methodical. It is a kind of documentation that consists of the procedures, a schematic representation of tools and materials to be used. Each methodology is different from the others due to what the system needed and its intricacy. For this system, the most suitable model for complete it, is waterfall model. Further explanation will be done on this chapter later on.

3.2 Methodology

In this project, the suitable and acceptable model for the development of the SGMS is waterfall model. Waterfall model followed in the chronological order and so we move to next phase as the earlier phase finalized positively. Waterfall model (Figure 3.2) is a suitable method for the small project and the requirements are very clear. The name itself describes that testing or development is carried out descending like waterfall. Once the waterfall model is followed, we cannot go back to the previous phase to improve.

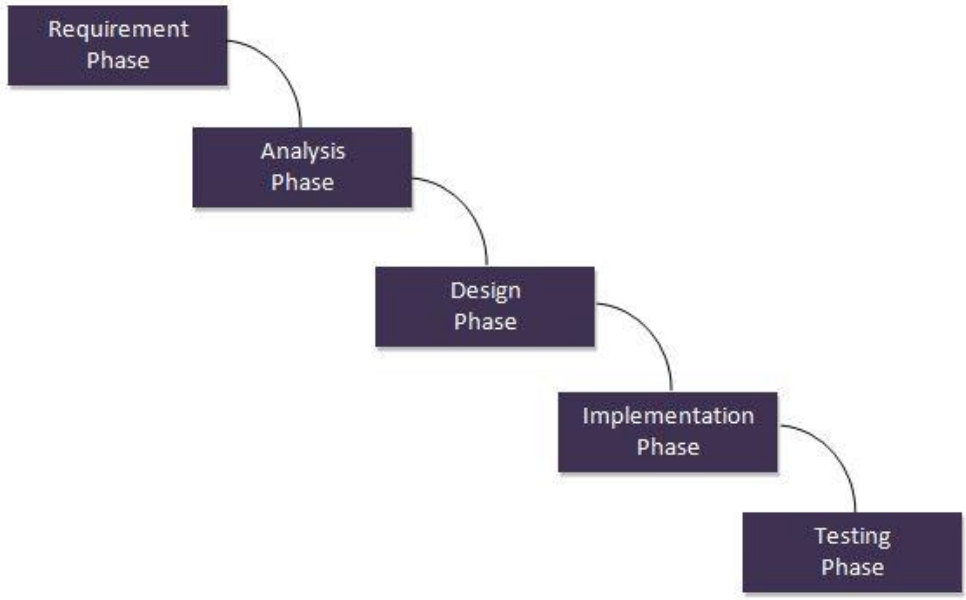

Figure 3.1 Waterfall Model

This project has decided to choose waterfall model. It is because the requirements are very clear and fixed based on the project. Technology used is well understood so project can develop without any trouble. Every type of process model has their advantages and disadvantages. It is applied to waterfall model too. Table 3.1 shows the advantages and disadvantages of waterfall model.

Table 3.1 Advantages and disadvantages of waterfall model

Advantages	**Disadvantages**
A good approach for small projects	Not useful for larger project
Easy to use and follow	Less effective if requirements are not clear
Cost effective	Very hard to move back
Each phase completely developed	More probabilities of bugs to be found
Sequential steps make it very less chance to rework.	High risk
Easy to manage	Less flexible
Easy documentation	

3.2.1 Requirement Phase

This is the first phase of progress where all the requirements are gathered. In this phase, pinpointing the goal, objectives, project scope, and requirement of the system specification is very important to make sure that this system successful. The goal of SGMS is to develop a real-time garbage monitoring system in UMP. The objectives of SGMS are to build a garbage monitoring system and to transmit the garbage volume status to hand phone by sending SMS. The scope of this project is to focus on detection of volume and age of waste product in garbage bin and the data is transmit to hand phone by sending SMS also to focus on the installation of Arduino UNO, ultrasonic sensor and GSM module. The last scope is to focus on testing the system can detect the volume of garbage and transmit the data to user.

Figure 3.2 shows the workflow of the proposed system. This project will detect the volume of garbage in the bin if it exceeds the threshold value and the age of the garbage automatically. The information then sends to mobile phone for further actions. The hardware requirements for this project are Arduino UNO as microcontroller, two ultrasonic sensors to detect the volume and age of the garbage, and GSM module to send status to mobile phone. Meanwhile, the software requirements for this project are Arduino IDE. The details of the requirements will be discussed in other parts in this chapter.

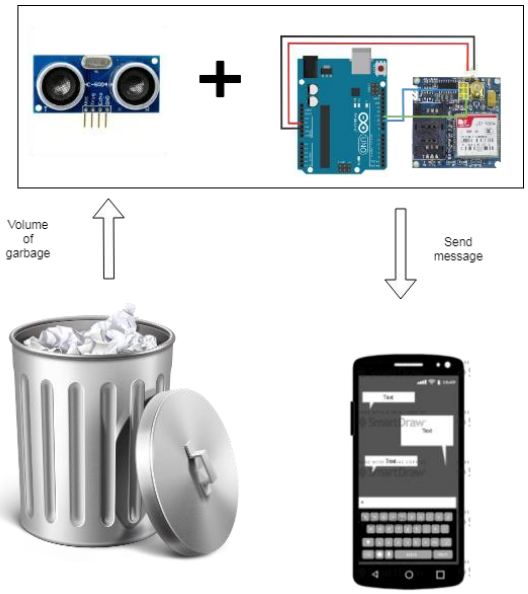

Figure 3.2 Workflow of the proposed system of SGMS

3.2.2 Analysis Phase

The second phase is analysis. In this phase, we analyse the requirements. The main point of this project is about the microcontroller programming. We needs to ensure the connections of Arduino UNO with other hardware are working. The details of these connections are:

i. Connection between Arduino UNO and ultrasonic sensor.

ii. Connection between Arduino UNO and SIM900A GSM module.

3.2.3 Design Phase

In design phase, all the system design is analysed and identified. It will consist of the Architecture Diagram, Context Diagram, Flow Chart and Use Case Diagram.

3.2.3.1 Architecture Diagram

Architecture diagram shows the connection between systems. Based on Figure 3.3, the ultrasonic sensor detects the volume of garbage in the garbage bin. Then, the data is sent to Arduino UNO. The Arduino UNO is communicates with GSM module to send the data regarding the volume of the garbage.

Figure 3.3 Architecture Diagram of SGMS

3.2.3.2 Context Diagram

Context diagram below shows the input and output of the SGMS. The sensor that attached at Arduino UNO will detect and send the data to the system. The output then sends to the user for further actions such as collecting the garbage.

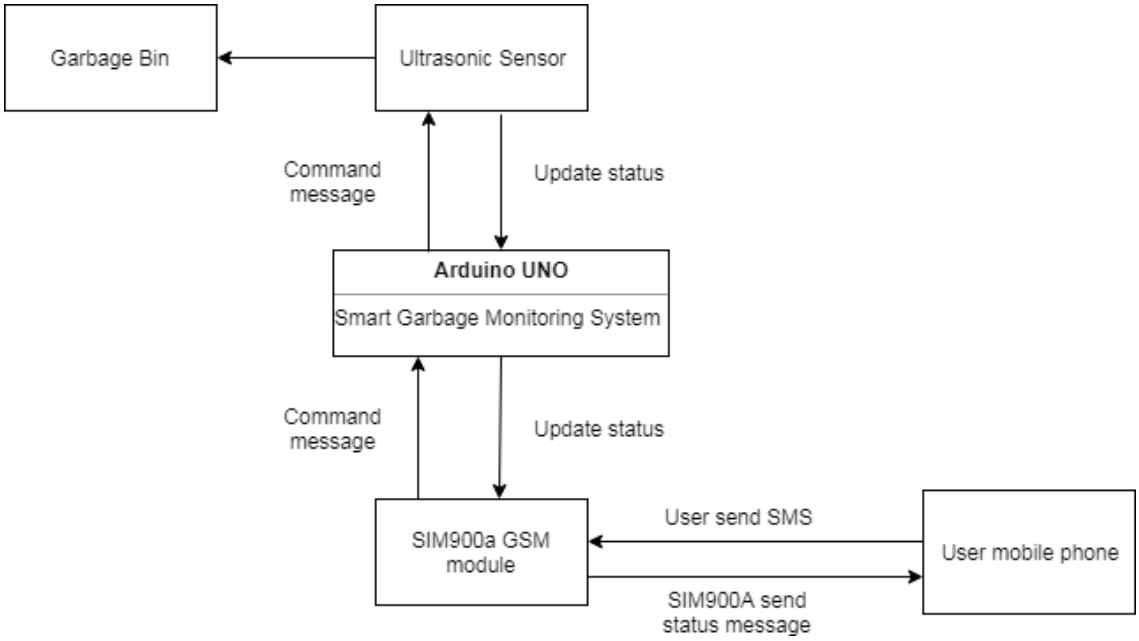

Figure 3.4 Context Diagram for SGMS

3.2.3.3 Flow Chart

Flow chart below shows algorithm and workflow of the system.

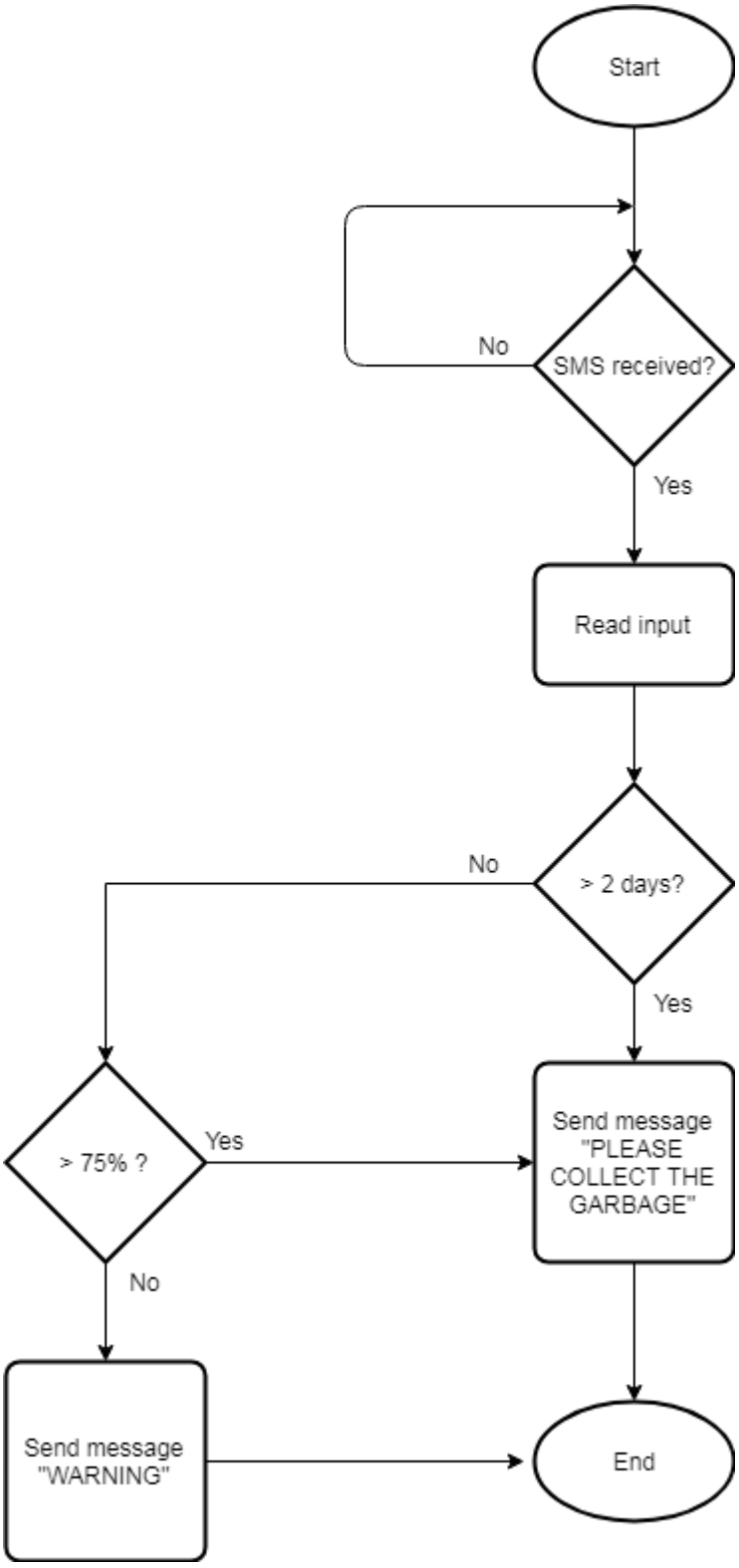

Figure 3.5 Flowchart of SGMS

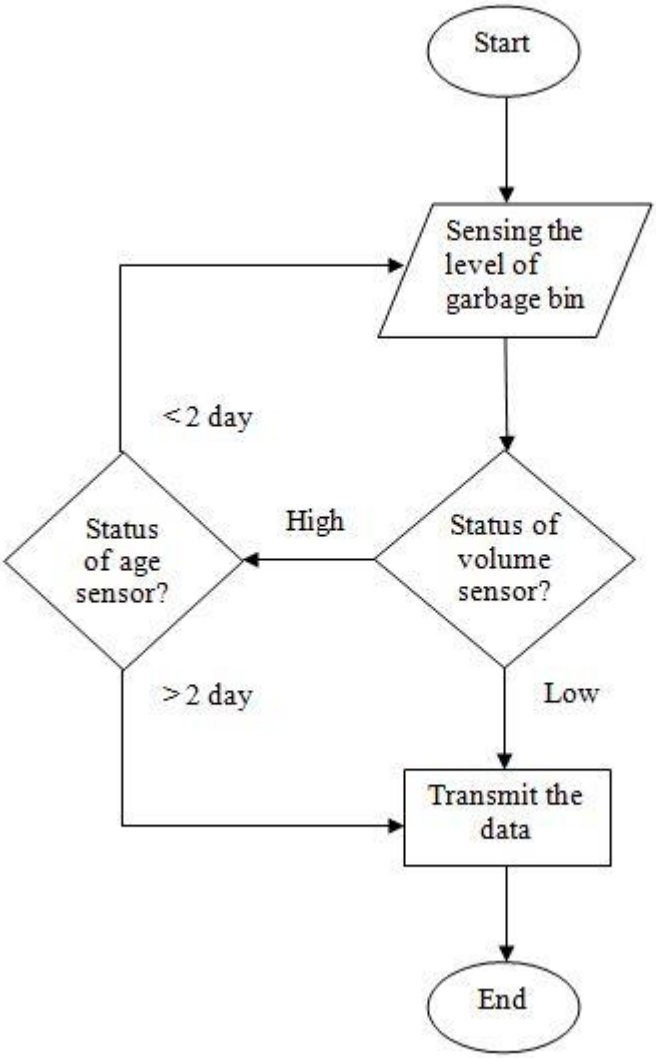

Figure 3.6 Flowchart of Transmitter section of SGMS

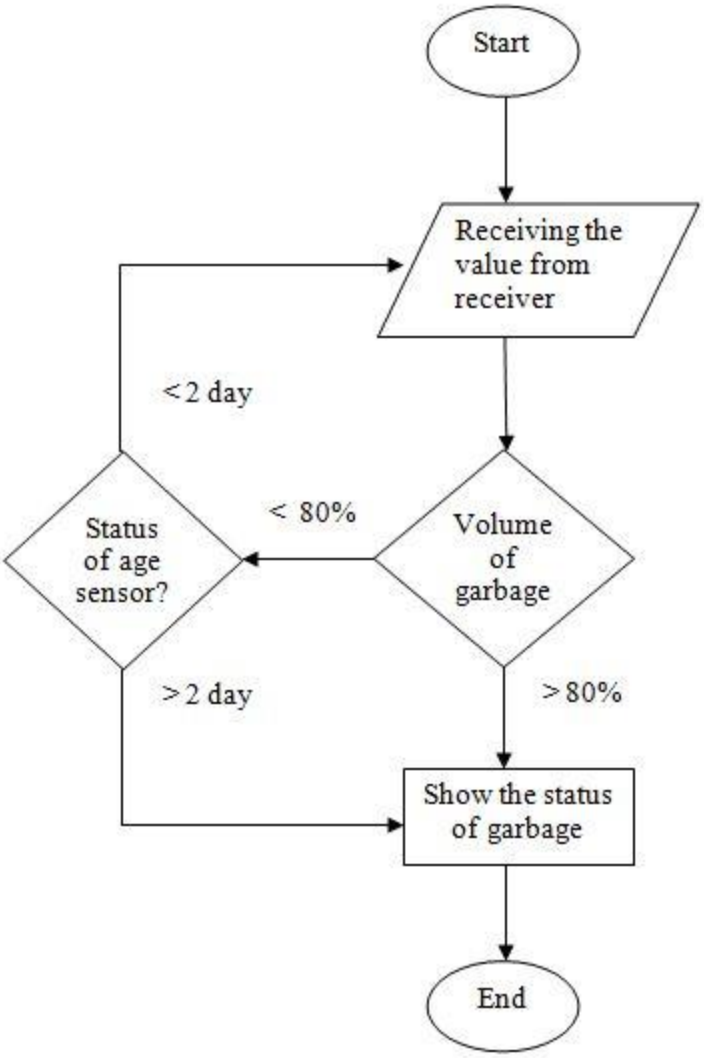

Figure 3.7 Flowchart of Receiver section of SGMS

3.2.4 Implementation Phase

The implementation phase is about physical assembly of the software as established in the design phase. The objective of this phase is to translate the system design into a working system. Two elements are required to complete the implementation phase successfully; a complete set of plan specification and proper methods and tools. Figure 3.8 shows the proposed physical construction of the SGMS.

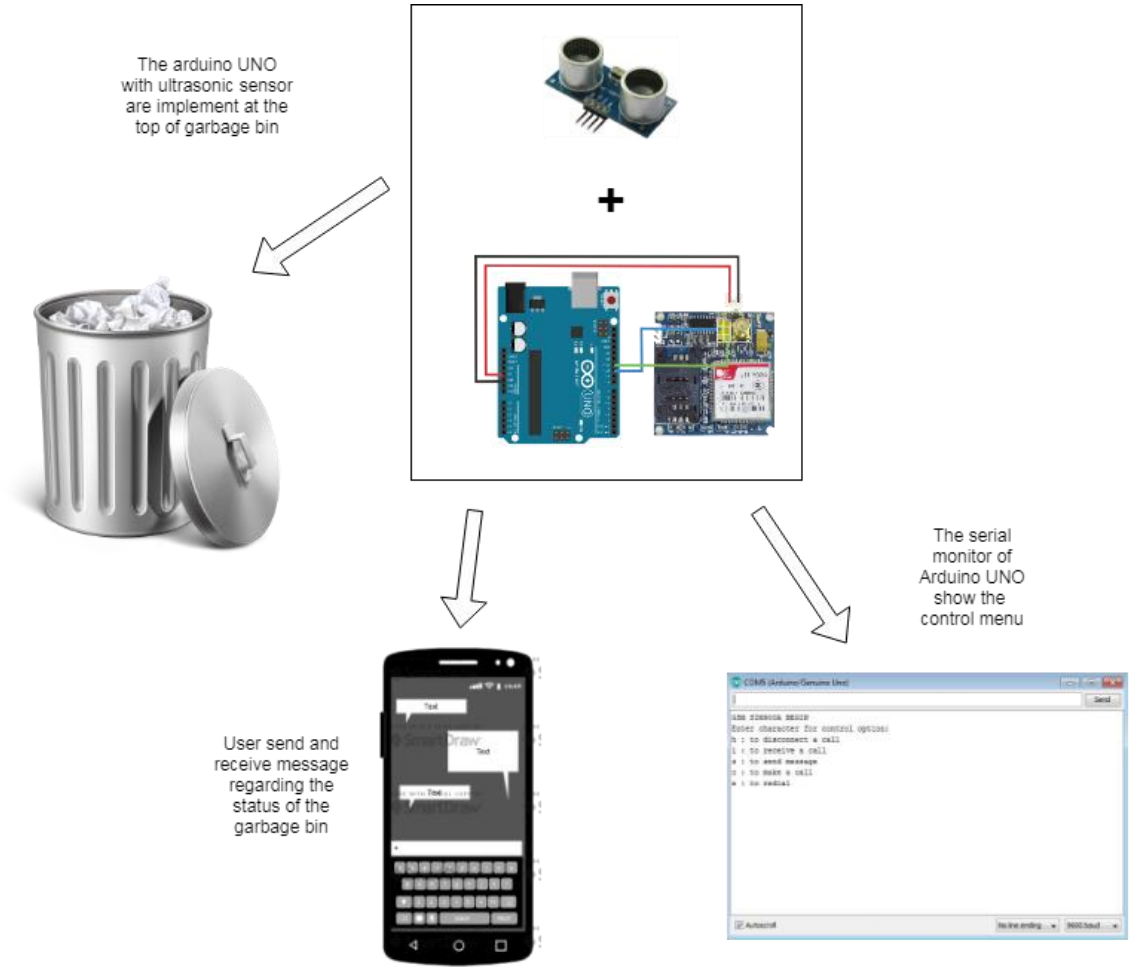

Figure 3.8 The proposed physical construction of SGMS

3.2.5 Testing Phase

As soon as the implementation phase completed, testing phase start and in this phase, we test each part or module and make sure the established components are working as proposed. Testing phase is the rehearsal of creating unbiased judgements based on extent to which the system linking outdoes or fails to accomplish the objectives in this project. For this project, the objectives of testing to guarantee that the sensor can sense the volume of garbage in the garbage bin and update the status to mobile phone.

3.3 Hardware and Software Requirement

The tables below show the hardware and software requirement for the SGMS.

Table 3.2 Hardware requirement for SGMS

Hardware	Purpose
Garbage bin	To store the garbage
Arduino UNO	As a microcontroller of the system
Ultrasonic sensor	To detect he volume of the garbage inside the bin
SIM900A GSM Module	To receive message from the mobile phone and send message to Arduino.
Mobile phone	To send message to Arduino UNO
Laptop	To configure the code on Arduino and to make the report.
Breadboard	A board for devices
Jumper wire	As connector to each device

Table 3.3 Software requirement for SGMS

Software	Purpose
Arduino IDE	Application to run the programming code
Microsoft Office Word 2007	Used for report documentation
Microsoft Office Powerpoint 2007	Used for making presentation slides
Draw.io	Used to design architecture diagram, context diagram, flow chart and use case diagram

3.4 Gantt Chart

The Figure 3.7 below is the Gantt Chart that shows the development process of this project.

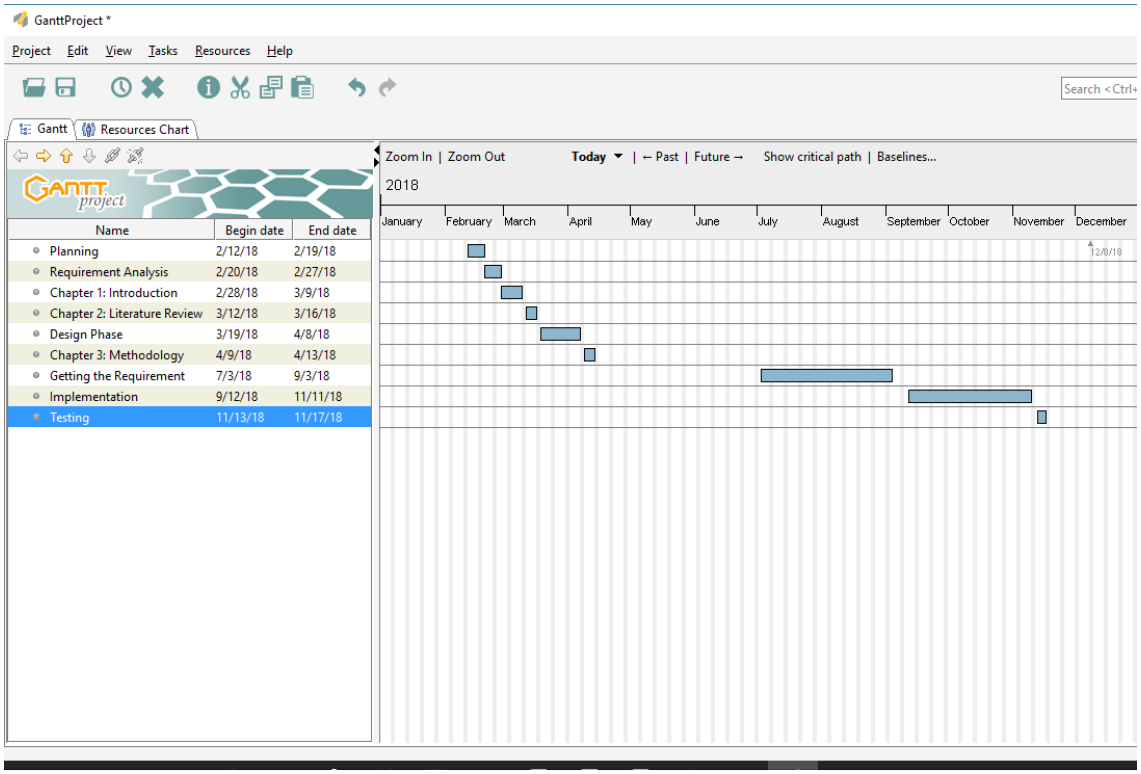

Figure 3.9 Gantt Chart of the project.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

Chapter 4 will be discussing about the system's implementation, design, testing and result of Smart Garbage Monitoring System. The important stage in this project is implementation stage which the system is developed based on requirements and the proposal that have been discussed before. The coding got the most significant part in this stage where it used to complete the objective in Smart Garbage Monitoring System will be explained in this chapter.

Other than that, the most important thing in this phase is the placement of the jumper wire to the correct port between Arduino Uno, ultrasonic sensor and GSM module. The application flow and test for this project will be described more detail in this chapter.

4.2 Implementation

In this phase, the implementation of Arduino UNO and implementation of hardware will be described more.

4.2.1 Implementation of Hardware

The implementation starts by configured the components. A mini breadboard is connected to microcontroller, ultrasonic sensor, and the GSM module using the jumper wires. The breadboard is use to connect numerous inputs to a single pin on the Arduino board. Figure 4.1 shows the connection of hardware parts.

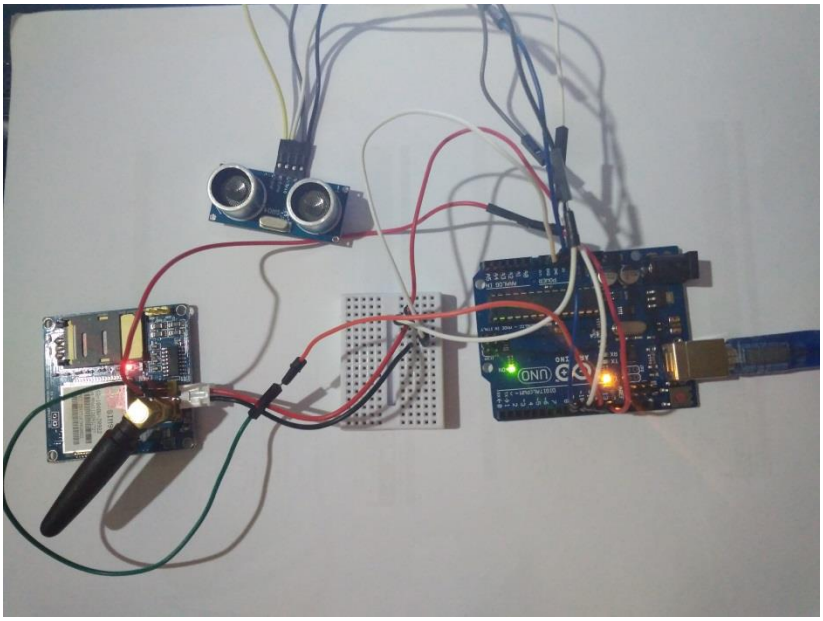

Figure 4.1 Connection of hardware

4.2.2 Implementation of Arduino Uno

Arduino Uno is the main role in this project. The coding is implemented in the Arduino Uno to sense the volume of the garbage in garbage bin with the construction of ultrasonic sensor. Figure 4.2 shows the coding for the Arduino UNO in the Arduino IDE.

Figure 4.2 Coding of Arduino UNO

4.3 Testing and Result

Next phase is testing the systems. In this phase, the process that will be tested is the sending and receive message. The message received from user would be send from SIM900A GSM module to Arduino UNO. Moreover, to run the system smoothly, all the error detected is solved. The system will be debugging to abolish present error. The Figure 4.3 and 4.4 below show the testing result.

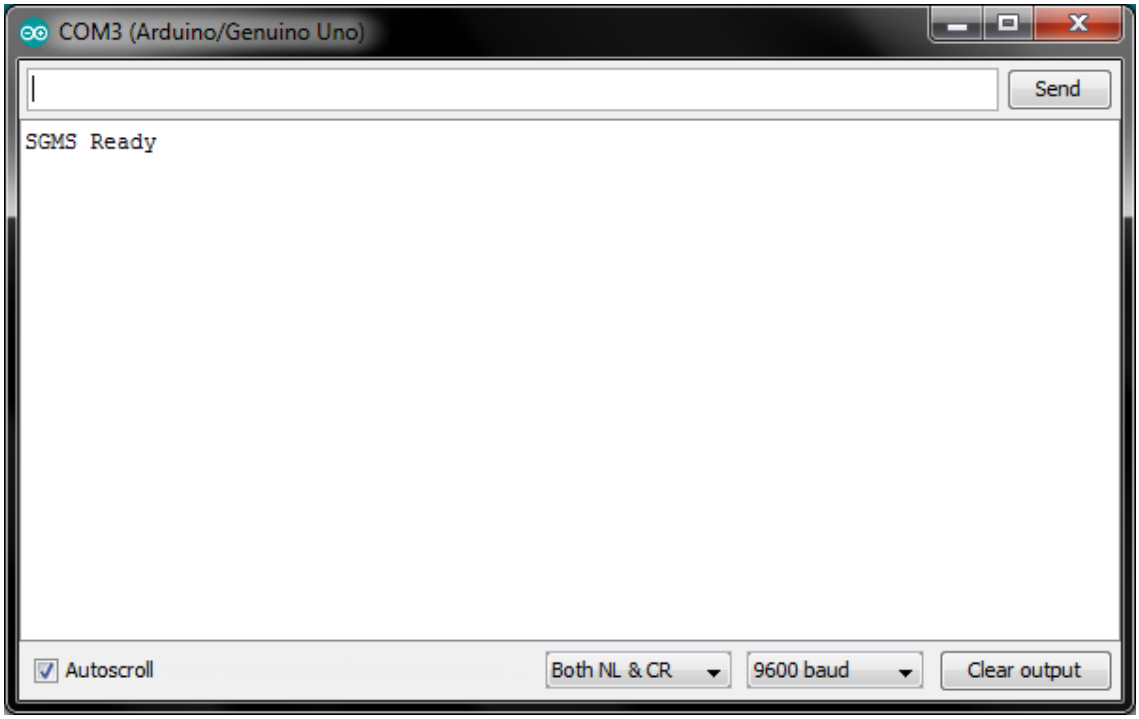

Figure 4.3 Serial monitor shows the system is ready.

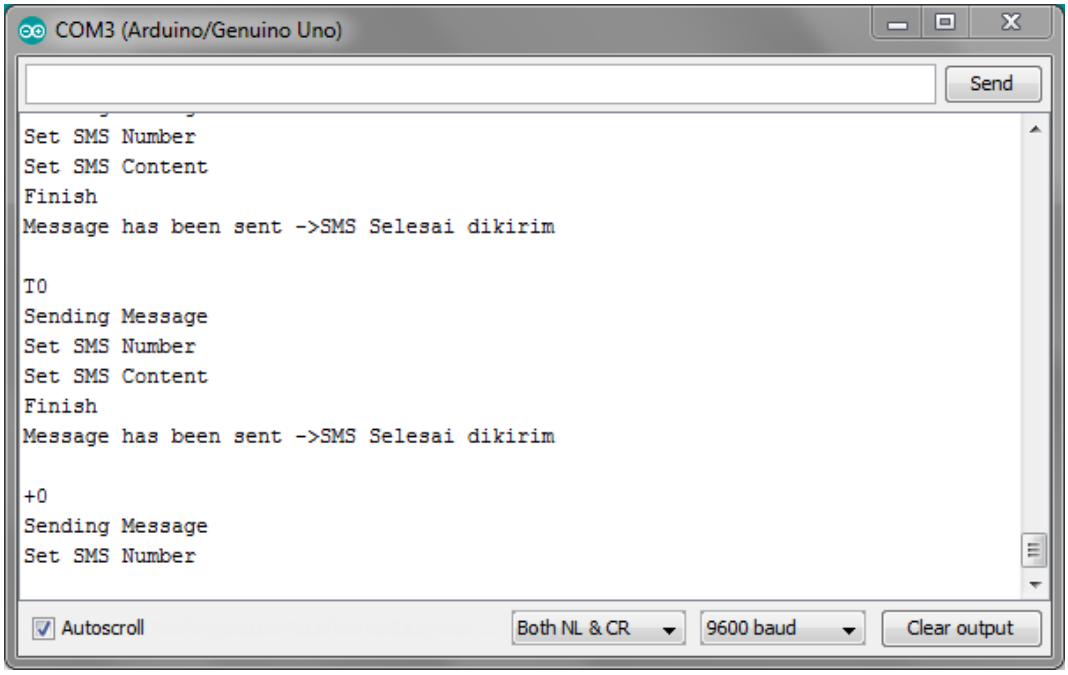

Figure 4.4 Serial monitor shows that message is sends to user

Figure 4.5 below shows the message is received from Arduino UNO telling that the garbage is full.

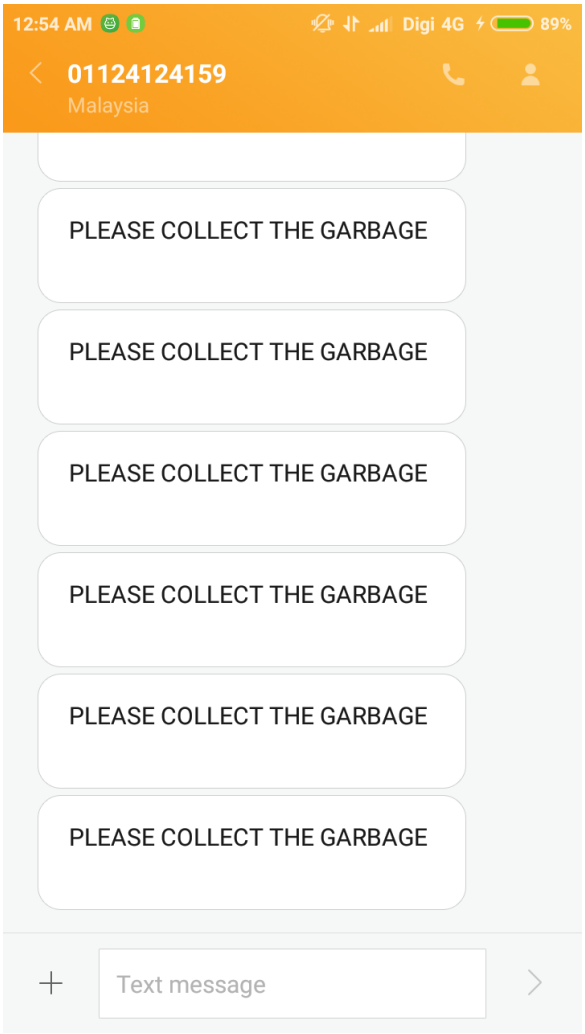

Figure 4.5 The message received telling that the garbage is full.

The SGMS cannot solve the problem of the age of the garbage which it is proposed before because the system is not completed as it cannot detect garbage for more than two days.

CHAPTER 5

CONCLUSION

5.1 Introduction

The reason of this chapter is to conclude the whole process in the project. This chapter also will discuss the objective of the whole project and things that cannot be accomplished. Moreover, this chapter also discuss about the system error that happen in the project.

The objective of this project is to build a garbage monitoring system which can transmit the garbage volume status to hand phone by sending SMS. If the garbage bin has reached the maximum threshold then the employee can be notified and they can take certain actions immediately

5.2 Research Constraint

Every development of project has its own constraint as well as Smart Garbage Monitoring System. There are some of constraints in this project that limit the development process. The first challenge in this system is the constancy of Arduino UNO. During the first development stage of this project, Arduino UNO can compile and run the code seamlessly. But, the Arduino UNO has a problem when the device used for a long time. Apparently the sensor cannot detect the volume of the garbage bin as there interruption between the connection of Arduino UNO and ultrasonic sensor.

Furthermore, the ultrasonic sensor also has limitation. The consistency, density and material can alter the sensor's reading. The ultrasonic sensor must detect a solid and level of surface to get adequate sound wave reverberation but the materials make the data quite difficult to collect.

5.3 Future Work

The Smart Garbage Monitoring System can be used as a benchmark for the future work in implementing non-real time garbage monitoring by using a smart garbage bin to gather the garbage. Besides, in future, in order to get more detailed output and other function, there are numerous types of sensor that can be used with the ultrasonic sensor.

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