SMART WASTE MANAGEMENT SYSTEM

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Dedicated to my beloved family especially my parents, supervisor, lecturers and all my friends who helping me whether directly or indirectly.

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ABSTRACT

Smart Waste Management System is a new approach to help reduce the overflow trash in the garbage bin. The traditional waste management are still applied in Malaysia and it is not efficient to alert the worker in wide range of area. As an alternative, this system had been integrated with Internet of Things (IoT) in order to monitor the trash level through a cloud database called Ubidots platform. An IoT approach also provide the user a real-time monitoring system. This mean the user can monitor the trash level in the office without check the garbage bin one by one. This project utilized Ultrasonic sensor to detect the trash level in the garbage bin. In addition, the Wemos D1 mini is used as a microcontrollers that will process the input and output of the system. It also will sent a data to the Ubidots platform. By utilizing this system, it shows that the waste monitoring system is successfully implemented in a real-time monitoring and the warning message also can be sent to the workers that in-charge in collecting the trash. This system will benefits the community and authorities because it will save cost and man power in managing the waste.

ABSTRAK

Sistem Pengurusan Sisa adalah satu pendekatan baru untuk membantu mengurangkan limpahan sampah di dalam tong sampah. Sistem pengurusan sisa yang terdahulu masih dipraktikkan di Malaysia namun ianya tidak dilengkapi dengan sistem yang mampu memberi amaran kepada pekerja. Sebagai alternatif, sistem ini telah dilengkapi dengan Internet of Things (IOT) untuk memantau tahap kepenuhan sampah di dalam tong sampah melalui pangkalan data iaitu Ubidots. Pendekatan IOT juga menyediakan pengguna dengan sistem pemantauan masa kini. Ini bermakna pengguna boleh memantau tahap tong sampah di pejabat tanpa memeriksa tong sampah satu demi satu. Projek ini menggunakan sensor ultrasonik untuk mengesan tahap kepenuhan sampah di dalam tong sampah. Di samping itu, mini Wemos D1 digunakan sebagai pengawal mikro yang akan memproses data masuk dan data keluar dari sistem. Ia juga akan menghantar data ke internet melalui Ubidots. Dengan menggunakan sistem ini, ia menunjukkan bahawa sistem pemantauan sisa berjaya dilaksanakan dalam pemantauan masa nyata dan mesej amaran juga boleh dihantar kepada pekerja-pekerja yang bertanggungjawab mengutip sampah di sesuatu kawasan. Sistem ini akan memberi manfaat kepada masyarakat dan pihak berkuasa kerana ia akan menjimatkan kos dan bilangan pekerja dalam menguruskan sisa pembuangan.

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LIST OF ABBREVIATION

Wi-Fi	-	Wireless Fidelity
LED	-	Light Emitting
IDE	-	Integrated Development Environment
GSM	-	Global System for Mobile Network
MHz	-	Mega Hertz
PCB	-	Printed Circuit Board
DC	-	Direct Current
IoT	-	Internet of Things
GPIO	-	General Purpose Input / Output
AP	-	Access Point
IP	-	Application Program Interface
3D	-	Three dimensional
LTE	-	Long-Term evolution

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

This chapter is discussed about the project background, the problem of the project, objectives of the project and project scope.

1.1 Background

The waste management is an important requirement that is needed in all countries. Therefore an efficient waste management becomes an issue in today society as it becomes a global problem due to the rapid growth of population, disorganization of a municipal company and lack of awareness program.

According to the UN, the population will be increased by 20% to reach 8 billion occupant until 2025. With the growth in population, the responsibilities towards waste management also increase. Based on the statistic that had been carried out in Malaysia, 16,000 tons of the domestic waste per day are generated and the amount per capita vary from 0.45 to 1.44 kg per day count on the economic status of the area concerns. On average, 50% of the municipal operating cost is spent on the waste management system and 70% is spent on the collection of waste.[1]

The Internet of Things is a communication technology that had been envisioning near the future. This means that the embedded system that consists of the microcontroller, transceiver for the digital transmitting and IP protocol will communicate each other which can be described as Machine to Machine (M2M) and Machine to Human through an internet. [2]

The purpose of this project is to reduce the pollution by implementing the Smart Waste Management System that uses the concept of Internet of Things. Besides, this system also can minimize the municipal operating budget and cost of collection waste. Therefore, this project should be able to minimize the garbage disposal problem by providing a real-time monitoring system. This project will be using Wemos D1 mini as a microcontroller board and ESP-8266EX as its IOT devices. The microcontroller board will be interfaced to the Ultrasonic sensor. This system will notify the disposal company through an alert message once the dustbin is full.

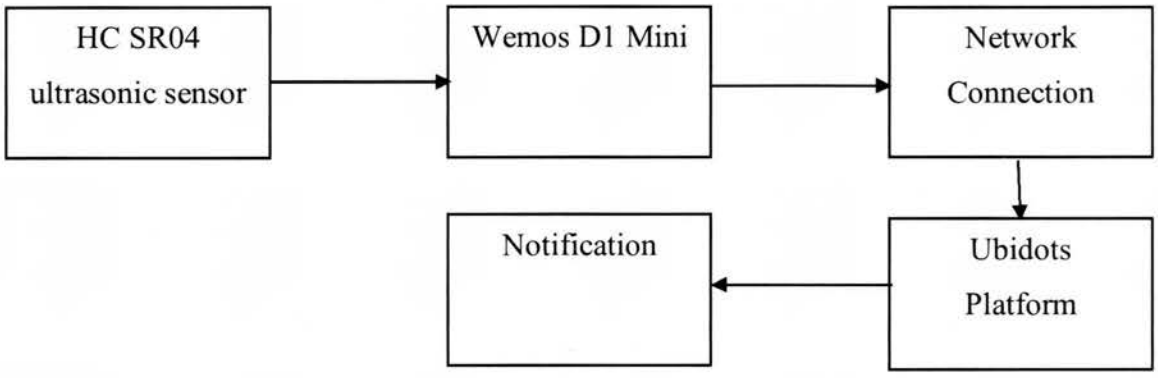

Figure 1.1 Block diagram of the system

1.2 Objectives of This Project

The main goals of this research are to implement Smart Waste Management that provides an efficient collection of waste management. Specifically, the objectives are:

I. To design the hardware device of the Smart Waste Management System.
II. To develop an IoT- based monitoring system with cloud database using the Ubidots platform.
III. To integrate both hardware and software design into a complete monitoring system prototype.

1.3 Problem Statement

The problem of this study is the dustbins placed at the public places are overloaded. It also creates unhygienic conditions for people as well as ugliness to that place leaving a bad smell. In addition, the traditional waste collection has been inefficient because it was targeting all the trash bin without really knowing if the bins were full or empty. Besides, checking the waste containers regularly might have also been difficult due to remote locations or difficult access. Therefore, this system will provide users the capability of knowing the fill level of the waste container in real time so that they can take data-driven actions ahead of time. The managing waste also can take a huge bite of the municipal budget. Hence, this system will reduce waste collection cost because fewer collections mean less use of the manpower.

1.4 Scope of Project

The scope of this project is to design and develop a complete monitoring system prototype. This project should be able to monitor the garbage levels status in a real-time. This project will be implemented in the shopping complex and indoor buildings only. This project also will be used an ultrasonic sensor that is interfaced with Wemos D1 mini that acts as microcontroller of this system. Besides, the programming language that will be used on this project is processing language by using an Arduino IDE programmer compiler. Then, the data will be monitored using Ubidots platform and an alert notification will be sent by SMS.

1.5 Report Structure

This thesis consist of a combination of five chapters that contain the introduction, literature review, methodology, result and discussion and the last chapter is conclusion and recommendation of the project.

Chapter 1 is discussed on the introduction of the project. In this chapter, we will explain the background and objectives of the project. The concept behind the project and overall overview of the project also will be discussed within this chapter. Chapter 2 tells about the literature review of the hardware and software used on the project based on previous research done.

Chapter 3 will explain about the project methodologies of the project. This chapter will show the steps and flow for problem-solving in such a specific method used to design the prototype and implementation of IoT on the prototype.

Chapters 4 describe the expected result from this project and justify its performance to make sure it meets the objectives of the research.

Finally, Chapter 5 will conclude the whole research and proposes the future progress of the project.

CHAPTER 2

LITERATURE REVIEW

This chapter will is discussed about the review of the previous research that is related to this project. A literature review is important in order to achieve successful project because it helps to identify the problem that is occurred in an existing project. Besides, it also helps to identify the best approach that can be used to accomplish the objective of the project. This chapter focused on the study of the component of the project, implementation of an Internet of Things and comparison on the existing project prototype.

2.1 Smart Waste Management System

The smart waste management system is a project that contributes to green technology environment. Aside from Malaysia, there are several countries that had turns into smart cities using the smart waste management system in order to manage the collection of the garbage. As stated by M. Lawrence, smart waste is a new technology that will give an impact on the collection, energy recover, and processing on the traditional waste management system.[3]

The Solleftea hospital in Sweden had implemented the world first automatic waste collecting system in 1961, and then it had been implemented for the household waste management. Until today, this technology is used by using the basic function as in the late 1960s. There are many of research had been done, in order to contribute in a waste management field that can save energy and costs. The researcher also do a research about

the monitoring system. However, there is minimum research on the real-time monitoring system.[4]

There are a lot of concepts are used by the researcher in order to implement the Smart Waste Management System. One of the earlier projects that used a Radio Frequency Identification (RFID) technology stated that it was a modern mobile communication technology. This technology used a tag that is attached on the trash as its reference.[5] However, this technology required more information about the trash that will be thrown by the user as it required the trash tag. It also needs to give an information to the user about the type of garbage bin in order to avoid faulty reading of the tag.[6]

The Swedish producers association had taking an action, which applied about 3330 bins around the country with the sensor that has a less wire applied on it in order to measure the level of the trash in the garbage bin. The four infrared LED and tilt sensor are placed in each bin. The sensing sensor will be activated in every hour to measure the trash level in the garbage bin. The signal will be sent an alarm along with the message through GSM if the three out of four infrared LED beam are broken. Then the second alarm will be send if the other one LED beam is broken. The strength of this system is that it can measure the level of the trash in a garbage bin and will alert the user every one hour. However, the weakness of this system is it cannot measure the exact distance of the trash level also with the delay response of the system.[4]

The smart waste management system also needs to implement an IoT application in order to apply a real-time monitoring data on the system. There are a lot of network access that permit the user to monitor the real time monitoring system. Based on the research study, all the articles reviewed emphasized the advantage using GSM compared to ZigBee except M.F Omar that used ZigBee on his project. This might due to the lack of research evidence at that time.[7] However, V Bhor and K Monica both agree that the ZigBee technology had a short range, low complexity, and low data speed compared to the GSM module.[8][9]. On the other hand, M Chaware stated that an ESP 8266 is more relevant for the IoT application as it is more stable and powerful enough to be implemented with the sensor because it has a higher storage capability and has a minimal external circuitry.[2]

Besides, the IoT implementation also will give the user real-time monitoring on the system. According to M A Hannan, he emphasizes that "an efficient, cost effective and environment-friendly solution for real-time trash level monitoring, collection and transportation of municipal solid waste always become a major factor to the local municipal authorities. Based on this article a theoretical model using a rule-based decision algorithm had been implemented.[4] This means that by implement the real-time monitoring system on the garbage bin will decrease the cost of the municipal authorities in order to manage the garbage issue.

The Waste Management System also had been implemented by researcher F. Vicentini at Pudong New Area Shanghai. The project is combines the ICT and camera that can be measured trash level and the trash weight. This study emphasizes on the enhancement of the variety of a sensor and cameras. However, this system is not compatible with a wireless sensor network neither support the RFID technology that are used in identification. In addition this project also need a huge cost because it applied the GPRS on the system.[10] The camera that had been applied also will create a low-quality image as the lens got dirty in the garbage bin.

2.2 Component of Smart Waste Management System

2.2.1 Microcontrollers

Microcontroller is often described as a single chip of the computer. They also can be defined as the brain of the system. On the other hand, microcontroller are used to enable the user to control the action of the system.

There are several types of microcontroller that can be used on the project prototype such as PIC24F16KA102 microcontroller board. It is a 16-bit microcontroller produced by Microchip with extremly low power technology and consume at Nano watts of power. It also can be run on a different power management model such as run, idle, doze, sleep and deep sleep. The operating voltage range is from 1.8V until 3.6V.[11]