UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF IOT BASED GARBAGE MONITORING SYSTEM USING A MICROCONTROLLER

NUR AZREEN ATIKAH BINTI ZULKIFLEE

Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours

2023

DEVELOPMENT OF IOT BASED GARBAGE MONITORING SYSTEM USING A MICROCONTROLLER

NUR AZREEN ATIKAH BINTI ZULKIFLEE

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

Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2023

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI TEKNOLOGI KEJUTERAAN ELEKTRIK DAN ELEKTRONIK

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : Development of IoT Based Garbage Monitoring System Using A Microcontroller

Sesi Pengajian : Sem 1 2022/2023

Saya Nur Azreen Atikah Binti Zulkiflee mengaku membenarkan laporan Projek SarjanaMuda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (✓):

☐	**SULIT***	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)
☐	**TERHAD***	(Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☑	**TIDAK TERHAD**	

Disahkan oleh:

(TANDATANGAN PENULIS)

(COP DAN TANDATANGAN PENYELIA)

Alamat Tetap:

TL 65/4, Parit Pinang Seribu Darat,
Jalan Temenggong Ahmad,
84150, Muar, Johor

SYED MOHAMAD SHAZALI BIN SYED ABDUL HAMID
PENSYARAH
FAKULTI TEKNOLOGI KEJURUTERAAN ELEKTRIK DAN ELEKTRONIK
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Tarikh: 13 January 2023

Tarikh: 13 January 2023

*CATATAN: Jika laporan ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali tempoh laporan ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I declare that this project report entitled "Development of IoT Based Garbage Monitoring System Using A Microcontroller" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree.

Signature	:	
Student Name	:	Nur Azreen Atikah Binti Zulkiflee
Date	:	13 January 2023

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 ElectronicsEngineering Technology (Industrial Electronics) with Honours.

Signature :

Supervisor Name : Syed Mohamad Shazali Bin Syed Abdul Hamid

Date : 13 January 2023

DEDICATION

This research is dedicated to my parents, Zulkiflee Bin Subari and Aidah Binti Siam, who have always encouraged me. They have given me the discipline support and motivation I need to approach this task with eagerness and dedication. Without their love and support, this project would not have been possible.

ABSTRACT

The neat and clean surroundings are the main driving force for any university residential college to be called a "clean university." The increasing number of students in universities generates a bunch of garbage. As a result, trash collection and garbage management in universities have to deal with this critical issue, and this matter must be addressed by university administrators. To maintain the residential college’s clean environment, the residential college’s management needs to take care of the cleanliness of the bins placed on every level of the residential college's block by checking and collecting the garbage at every single dustbin daily. This will require more human work and time. Other than that, the garbage will overflow and a bad smell will arise if the cleaning staff does not come to collect the garbage right on time because they do not know the status of the dustbin. So, this project's concept is to design the "Development of an IoT-Based Garbage Monitoring System Using Microcontroller" by continuously monitoring the garbage level and notifying cleaning staff wirelessly by sending a notification via the Blynk app on their smartphone every time the garbage bin is full. By using this system, the issue of garbage overflow can be solved. The suggested system included ultrasonic sensors that were strategically positioned under the lid of the dustbin to identify the garbage level and compare it to the depth of the dustbins. To save data, the system displays the status of garbage on a liquid crystal display (LCD) and Blynk application in real time and sends an alert notification to the cleaning staff. The system is expected to create a cleaner and more comfortable environment due to its ability to monitor and control garbage collection intelligently through the Internet of Things (IoT).

ABSTRAK

Keadaan persekitaran yang kemas dan bersih menjadi penggerak utama bagi mana-mana kolej kediaman universiti untuk digelar sebagai "universiti bersih". Peningkatan bilangan pelajar di universiti menjana sekumpulan sampah. Akibatnya, kutipan sampah dan pengurusan sampah di universiti terpaksa berhadapan dengan isu kritikal ini dan perkara ini perlu ditangani oleh pihak pentadbir universiti. Bagi menjaga kebersihan persekitaran kolej kediaman, pihak pengurusan kolej kediaman perlu menjaga kebersihan tong sampah yang diletakkan di setiap peringkat blok kolej kediaman dengan memeriksa dan mengutip sampah di setiap tong sampah setiap hari. Ini akan memerlukan lebih banyak kerja dan masa manusia. Selain itu, sampah akan melimpah dan timbul bau busuk sekiranya petugas pembersihan tidak datang mengutip sampah tepat pada masanya kerana tidak mengetahui status tong sampah. Jadi, konsep projek ini memperkenalkan untuk mereka bentuk "Pembangunan Sistem Pemantauan Sampah Berasaskan IoT Menggunakan Mikropengawal" dengan memantau tahap sampah secara berterusan dan memaklumkan secara wayarles kepada kakitangan pembersihan dengan menghantar pemberitahuan melalui aplikasi Blynk pada telefon pintar mereka setiap kali tong sampah penuh. Dengan menggunakan sistem ini, isu limpahan sampah dapat diselesaikan. Sistem yang dicadangkan termasuk penderia ultrasonik yang diletakkan secara strategik di bawah penutup tong sampah untuk mengenal pasti paras sampah dan membandingkannya dengan kedalaman tong sampah. Untuk menjimatkan data, sistem memaparkan status sampah pada paparan kristal cecair (LCD) dan aplikasi Blynk dalam masa nyata dan menghantar pemberitahuan amaran kepada kakitangan pembersihan. Sistem ini dijangka dapat mewujudkan persekitaran yang lebih bersih dan nyaman kerana berkebolehan untuk memantau dan mengawal kutipan sampah secara bijak melalui Internet of Things (IoT).

ACKNOWLEDGEMENTS

We praised God for giving us the strength and courage to complete this project. First and foremost, I would like to express my gratitude to my supervisor, Syed Mohamad Shazali Bin Syed Abdul Hamid for their precious guidance, words of wisdom, and patience throughout this project.

I am also indebted to Universiti Teknikal Malaysia Melaka (UTeM) for the financial support which enables me to accomplish the project. Not forgetting my fellow colleague and housemate for their willingness of sharing their thoughts and ideas regarding the project.

My highest appreciation goes to my parents and family members fortheir love and prayer during the period of my study. An honorable mention also goes to my mom, Aidah Binti Siam for all the motivation and understanding.

Finally, I would like to thank all my colleagues and classmates, the Faculty members, as well as other individuals who are not listed here for being cooperative and helpful.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

kg	**-**	kilogram
s	-	second
m	**-**	meter
cm	**-**	centimeter
mm	**-**	millimeter
V	**-**	voltage
A	**-**	ampere
M	**-**	Mega
Hz	**-**	Hertz

LIST OF ABBREVIATIONS

IoT	Internet of Things
GSM	Global System for Mobile Communications
LCD	liquid-crystal display
IR	Infrared
VCC	Voltage Common Collector
VDD	Voltage Drain
RX	Receiver
TX	transmitter
PWM	Pulse Width Modulation
Vin	Voltage Input
GND	Ground
USB	Universal Serial Bus
I/O	Input and Output
IDE	Integrated Development Environment
API	Application Program Interface
IDE	Integrated Development Environment
Wi-Fi	Wireless Fidelity

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

Nowadays, everything must be completed in a timely and effective manner. The Internet of Things has emerged as the most popular innovation right now. IoT is nothing more than a technology that connects all physical objects, mostly through wireless networks, with the least amount of human intervention possible to keep the environment clean. With the influence of the Internet of Things (IoT), tasks and systems are fusing to create a more rapid and efficient working system. The IoT is an emerging paradigm that is a crucial part of our lives. The term "Internet of Things" was coined by Kevin Ashton in 1999, when he included it in the title of a presentation he made at Procter & Gamble [1]. For example, with the implementation of smart devices, it is possible to develop a garbage monitoring system that can monitor the level of garbage in a dustbin through the IoT. This shows that IoT is becoming essential to our lives.

The management of solid waste, which affects the environment and health of our society, has been one of the key environmental problems. The goal of smart or interconnected gadgets is to close the gap between the real world and the digital one, raising living standards in the process. The creation of a "smart city," where machines will regularly interact with people to carry out numerous daily tasks, is the most significant application. Our goal is to create an IoT garbage monitoring system that will ensure garbage collection is done on time and the problem of overflowing garbage can be avoided. The proposed system should overcome such problems by alerting users to the status of garbage in the dustbin.

In today's world, efficient garbage disposal has become a major source of concern in many Malaysian universities and institutions. Due to the ever-increasing number of students, the amount of waste generated has also increased. However, due to ineffective management, we observed a lot of rubbish spilling out of the dustbin, which has left the area smelling unpleasant. If this garbage is not disposed of promptly, various illnesses may spread. A dustbin is considered a basic need to maintain the rate of cleanliness in residential colleges, so it is very important to clean all the dustbins as soon as they get filled. Garbage is classified into two types: dry waste and wet waste. Wet waste is any garbage that is made from food leftovers. In residential colleges, there is a very common situation where the garbage is overloaded and spilled out. This eventually leads to pollution.

Waste management in residential colleges at this time is still limited. The cleaner will clean up at a specified time according to the schedule. This is very ineffective because the delay in garbage collection will cause the garbage in the dustbin to overflow and stink since the dustbin was full before the garbage collection schedule. To maintain the residential college's clean environment, the residential college's management needs to take care of the cleanliness of the bins placed on every level of the college block. So, garbage monitoring is critical for optimizing management and resources and reducing the staff required to conduct garbage collection activities. The traditional method of manually monitoring the garbage in the dustbin is a time-consuming procedure that necessitates more human labor, time, and money, all of which can be avoided with today's technologies, which provide a real-time indication of the garbage level in a dustbin at any given time by monitoring it via the Blynk app on the smartphone. With this technology, the number of insects, germs, and viruses that may infect people would increase rapidly as a result of the waste volume created by ineffective waste management.

Smartphones have become a highly frequent resource and the primary means of communication for everyone in the world to communicate with each other. So, of course, everyone has a smartphone. Therefore, we can take advantage of the existing smartphone by developing a garbage monitoring system that can monitor the level of garbage in the dustbin using only a smartphone. This appears to save them time. With the benefit of cleaners collecting garbage on time, the rate of cleanliness at residential colleges would rise proportionally. Smartphone development encourages users to prefer mobile apps. IoT allows communication between networking devices based on requirements. This mobile app was created to allow you to check the current level of garbage in the trash can wherever you are.

1.2 Problem Statement

As students, we can see that there is a lot of garbage at the residential colleges. This is because there is no novel or systematic method for monitoring the level of garbage in dustbins so that garbage can be collected promptly [4]. The detection, monitoring, and management of garbage are some of the primary problems of the present era. The cleaning staff must check every level of each residential college block to collect the garbage daily. The task will become more tedious if the residential college block has many levels and requires more human work and time. Besides, if the cleaning staff does not come to collect the garbage on time because they do not know about the status of the dustbin, the garbage will overflow and a bad smell will arise. Other than that, sometimes the garbage falls at area around the dustbin while trying to open the dustbin lid to throw away the garbage. These problems are sanitary issue that might cause diseases and may raise the chance of contracting diseases such as cholera, dengue fever, typhoid fever, food poisoning, gastroenteritis, and other serious illnesses caused by flies.

1.3 Project Objective

The objectives of this project are:

a) To design a prototype dustbin with an IoT-based garbage monitoring system that can monitor the level of the garbage in the bin and display the status of the dustbin in Blynk and at LCD attached to the dustbin.

b) To create a prototype dustbin with an automatic lid that opens and closes.

c) To develop a smart alert system for garbage clearance by giving notifications via the Blynk application to the cleaner's mobile phone.

1.4 Scope of Project

To avoid any uncertainty about this project due to some limitations and constraints, the scope of the project is defined as follows:

a) In this project, the NodeMCU microcontroller serves as the brain, controlling the components and sensors.

b) ESP8266 WiFi was used for communication between the NodeMCU and the mobile application developed using the Blynk application to monitor the garbage level and notify the person in charge when the dustbin is full.

c) Using two ultrasonic sensors, one is placed on the lid of the dustbin to detect the level of garbage, and another is placed in front of the dustbin to make the lid of the dustbin open and close automatically.

d) This dustbin is implemented for localized and small-scale cases, such as residential colleges.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, an IoT-based garbage monitoring system has been explained from a selection of papers and journals that describe comparable approaches and subjects. The flow of the study started with collecting sources, for instance, journal articles, books, documents from websites, and conference papers, and analyzing them to extract useful information. The information collected was tabulated to show the comparison between each find clearly. Other researchers have compared their comparable current system, identical sensors, and IoT board. Lastly, the analyzed and synthesized information was evaluated by comparing their trade-offs to find the best approach that can be applied to this project. The outcome of the evaluation was then summarised and written about in the last part of this section.

2.2 Research

2.2.1 Monitoring System

Extensive research has been done on waste management throughout the world. The majority of them were concerned with manual garbage collection, distribution, and recycling. People have begun to use technology in recent years to monitor and effectively collect garbage. The essential premise of a monitoring system is to allow users to acquire data, process it, and disseminate it systematically. Based on data obtained in the field, the monitoring system allows us to measure trends in numerous variables. An effective and efficient monitoring system is required to examine system activity, determine if applications are running well, and inform the user if necessary.

2.3 Review and Comparison of Previous Work

2.3.1 Wireless Communication Technologies

Wireless communication technology is information that can send out data across long distances without much hindrance.

Table 2.1 Comparison between GSM, Wi-Fi, and Bluetooth

NO.	Name	Operating Frequency	Range	Transfer Rate	Cost	Power
1.	GSM [2][4][6]	850 - 900MHz	2 – 35 Km	168 Kbps	High	Low
2.	Wi-Fi [1][5]	2.4 - 5GHz	10 – 100 m	11 Mbps	Low	High
3.	Bluetooth [11]	2.4 – 2.485 GHz	10 m	1 Mbps	Low	Low

Based on table 2.1, a GSM module is used to communicate between a computer and a GSM system. This wireless communication technology will incur a lot of monetary issues and also have issues with the database and usage [27]. GSM needs to solve the connecting issue. They need to consider all the garbage bins and apply a SIM card to each of the garbage systems. This raises the budget for data subscriptions [27]. Besides, it generally requires a lot of energy to operate since it needs to communicate with the user server consistently. As for Bluetooth, it is generally used for short-range communication [28]. It works at 2.4 to 2.485 GHz, consumes very little power, is available at a very economical price, and is a very simple yet effective communication technology. Bluetooth Low Energy (BLE) and Bluetooth 4.0 are the latest versions of this technology, which consume much less power than the former version [28]. Wi-Fi is a communication technology used to connect devices wirelessly, provide internet access, and also to connect different devices to a wired network. Wi-Fi can be used to share the internet, files, and other resources between devices. It has a range of more than 100 meters and operates at either 2.4 or 5 GHz. This high frequency can carry more data [28].

2.3.2 Type of Sensors

From previous research, there are several techniques for detecting the level of garbage in the trash can by employing various types of sensors. IR and ultrasonic sensors are active sensors that need power to operate [22]. Each sensor has its unique strengths and weaknesses. Table 1 below lists some of the sensors used in the prior study.

Table 2.2 Comparison between Ultrasonic Sensor, IR Sensor, and Weight Sensor

Point of Comparison	Ultrasonic Sensor [34] [1] [2] [3] [4] [5] [6]	IR Sensor [3] [10] [20]	Weight Sensor [20]
Function	• Determines the quantity of garbage in the dustbin. • To detect the presence of people throwing garbage into the dustbins	• Determine how much garbage is in the dustbin. • To detect the presence of people throwing garbage into the dustbin	• To detect the weight of the garbage in the dustbin.
Measuring Distance	< 16 meters	< 6 meters	-
Resolution	High	Variable according to distance	-
Detecting Angle Range	Narrow or wide according to its model	Small	-
Output Linearity	Linear	Non-Linear	-
Mobility	Portable	Portable	-