GARBAGE DETECTION SYSTEM WITH GARBAGE LEVEL PREDICTION USING MACHINE LEARNING IN INTERNET OF THINGS (IOT)

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FACULTY OF COMPUTING AND INFORMATICS
UNIVERSITI MALAYSIA SABAH
2022

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THESIS SUBMITTED IN PARTIAL FULFILLMENT FOR THE DEGREE OF BACHELOR OF COMPUTER SCIENCE WITH HONOURS (NETWORK ENGINEERING)

FACULTY OF COMPUTING AND INFORMATICS
UNIVERSITI MALAYSIA SABAH
2022

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DECLARATION

I declare that this written submission represents my ideas in my own words and where others' ideas have been included. I have cited and referenced the original sources.

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ACKNOWLEDGEMENT

First and foremost, I am thankful to God, the Almighty for His blessings throughout this project.

I would like to express my deep and sincere gratitude to my supervisor, Dr Leau Yu Beng for providing me motivations and invaluable guidance throughout this project.

I am extremely grateful to my parents and sister for all the support and prayers for me in completing this project.

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28 January 2020

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ABSTRACT

There has been a rise in the development of waste in recent years, particularly in university hostels, where there are limited number of bins and shared among all the students. Due to the spill over of waste in the hostel area, the contaminated condition may trigger various serious diseases in the surroundings. This project proposes a Garbage Detection System with Garbage Level Prediction using Machine Learning in Internet of Things (IoT) where the system would measure the current level of waste in all garbage bins available around the area and notify the hostel management to collect the waste whenever the bin is loaded. The machine learning model will be required to learn and predict the waste that will be produced in the future. The methodology that will be used in this project is iterative and incremental model. Through this project, manual monitoring will not be needed anymore since this project will be able to send push notifications indicating that the garbage is almost full and predict the current waste level based on current day and time.

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ABSTRAK

(SISTEM PENGESANAN SAMPAH DENGAN RAMALAN TAHAP SAMPAH MENGGUNAKAN PEMBELAJARAN MESIN DALAM INTERNET PELBAGAI BENDA (IOT))

Terdapat peningkatan di dalam bahan buangan sisa sampah dalam beberapa tahun kebelakangan ini terutamanya di asrama university, di mana terdapat bilangan tong sampah yang terhad dan dikongsi di kalangan semua pelajar. Keadaan yang tercemar boleh menyebabkan pelbagai penyakit yang serius di persekitaran. Projek ini mencadangkan Sistem Pengesanan Sampah dengan Ramalan Tahap Sampah menggunakan Pembelajaran Mesin dalam Internet Pelbagai Benda (IoT) di mana sistem akan mengukur tahap sisa semasa dalam semua tong sampah yang terdapat di sekitar kawasan asrama dan memberitahu pengurusan asrama untuk mengutip sisa apabila tong dimuatkan. Model pembelajaran mesin akan diperlukan untuk mempelajari dan meramalkan sisa sampah yang akan dihasilkan pada masa hadapan. Metodologi yang akan digunakan di dalam projek ini adalah model berulang dan pertambahan. Melalui projek ini, pemantauan manual tidak diperlukan lagi kerana projek ini dapat menghantar pemberitahuan yang menunjukkan sampah hampir penuh dan meramalkan tahap sisa sama berdasarkan hari dan waktu.

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TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENT	I
ABSTRACT	II
ABSTRAK	III
TABLE OF CONTENTS	IV
LIST OF TABLES	V
LIST OF FIGURES	VI
LIST OF APPENDICES	VII
CHAPTER 1 INTRODUCTION	
1.1 Introduction	1
1.2 Problem Background	1
1.3 Problem Statement	2
1.4 Project Goal	2
1.5 Objectives	3
1.6 Project Scope	3
1.7 Project Timeline	5
1.8 Organization of Report	6
1.9 Conclusion	7
CHAPTER 2 LITERATURE REVIEW	
2.1 Introduction	8
2.2 Concept of Detection System	8
2.3 Review on Existing Garbage Detection System	8
2.3.1 Internet of Things Based Wireless Garbage Monitoring System	8
2.3.2 IoT Based Smart Garbage Monitoring System using Zigbee	10
2.3.3 IoT Based Smart Garbage Monitoring & Collection	12

UMS
UNIVERSITI MALAYSIA SABAH

2.3.4 IoT Based Garbage Monitoring & Clearance Alert 14

2.3.5 Arduino-based Smart Garbage Monitoring System: Analysis 15

2.4 Method of Garbage Detection 16

2.4.1 Linear Regression 18

2.4.2 Random Forest Algorithm 19

2.5 Conclusion 19

CHAPTER 3 METHODOLOGY

3.1 Introduction 22

3.2 Selection of Development Methodology 22

3.2.1 Planning 22

3.2.2 Requirement Analysis 22

3.2.3 Design 23

3.2.4 Implementation 23

3.2.5 Testing 23

3.3 Hardware and Software Requirements 23

3.4 Conclusion 24

CHAPTER 4 SYSTEM ANALYSIS AND DESIGN

4.1 Introduction 25

4.2 System Analysis 25

4.2.1 Interview Finding 25

4.2.2 Reviewing of Related Systems 26

4.3 System Design 26

4.3.1 Entity Relationship Diagram (ERD) 26

4.3.2 Context Diagram 27

4.3.3 Data Flow Diagram 28

4.3.4 Data Dictionary 28

4.4 User Interface Design 30

UMS
UNIVERSITI MALAYSIA SABAH

4.5 Conclusion 34

CHAPTER 5 SYSTEM IMPLEMENTATION

5.1 Introduction 36

5.2 Tools for Development 36

5.3 Database Implementation 37

5.4 System Implementation 38

5.4.1 Login and Logout Authentication 37

5.4.2 Forgot Password 38

5.4.3 User Profile 39

5.4.4 Bin Level 41

5.4.5 Collect Bin Report 42

5.4.6 Daily Updates 42

5.4.7 Bin Status Report 43

5.4.8 Post Updates 43

5.4.9 Register New User 44

5.4.10 Predict Garbage Level 45

5.5 Predict Garbage Level 46

5.6 Summary 47

CHAPTER 6 TESTING

6.1 Introduction 48

6.2 Unit Testing 48

6.2.1 Login and Logout Authentication 50

6.2.2 Home Page 51

6.2.3 Bin Level 52

6.2.4 User Information 53

6.2.5 Register New User 55

6.2.6 Edit Hostel Employees 55

UNIVERSITI MALAYSIA SABAH
UMS
UNIVERSITI MALAYSIA SABAH

6.3 Integration Testing 56

6.3.1 View Bin Status Report Details 57

6.3.2 View Daily Updates 58

6.3.3 View Garbage Level Prediction 59

6.4 System Testing 61

6.4.1 System Testing as Administrator 61

6.4.2 System Testing as User 61

6.5 Testing on the Research Element 62

6.5.1 Evaluation Method 62

6.5.2 Results and Discussion 63

6.6 Summary 64

CHAPTER 7 CONCLUSION

7.1 Introduction 65

7.2 Achievement 65

7.3 Project Constraints 66

7.4 Lesson Learned 66

7.5 Future Work 67

7.6 Conclusion 67

REFERENCES 68

APPENDIX 69

UMS
UNIVERSITI MALAYSIA SABAH

LIST OF TABLES

	Page
Table 1.1 : Project Module	3
Table 2.1 : Comparison of Existing and Proposed System	16
Table 3.1 : List of Hardware Used	23
Table 3.2 : List of Software Used	23
Table 4.1 : User Data Dictionary	28
Table 6.1 : Unit Testing for UMS Garbage Detection System	46
Table 6.2 : System Integration Testing for UMS Garbage Detection System	55
Table 6.3 : System Testing for UMS Garbage Detection System	58

UMS
UNIVERSITI MALAYSIA SABAH

LIST OF FIGURES

	Page
Figure 2.1 : System Block Diagram	9
Figure 2.2 : Proposed System Architecture – Multiple Nodes	11
Figure 2.3 : Implementation of Garbage Monitoring System	12
Figure 2.4 : Smart Garbage Monitoring and Clearance Alert System	14
Figure 2.5 : System Architecture	15
Figure 2.6 : Simple Linear Regression	18
Figure 2.7 : Random Forest Diagram	19
Figure 3.1 : Iterative and Incremental Model	20
Figure 4.1 : Entity Relationship Diagram (ERD)	26
Figure 4.2 : Context Diagram (CD)	26
Figure 4.4 : Welcome Screen Interface	29
Figure 4.5 : Sign In Interface	30
Figure 4.6 : Forgot Password	30
Figure 4.7 : Main Menu Interface	31
Figure 4.8 : Bin Level Interface	31
Figure 4.9 : Collect Bin Interface	32
Figure 4.10 : User Information Interface	32
Figure 4.11 : Change Password Interface	33
Figure 4.12 : Predict Garbage Level Interface	33
Figure 5.1 : Hardware Used for Development	35
Figure 5.2 : Distance, Garbage Status and Report	36
Figure 5.3 : Updates	36
Figure 5.4 : Users' Information	37

UMS
UNIVERSITI MALAYSIA SABAH

Figure 5.5 : Login Interface 38

Figure 5.6 : Logout for Users 38

Figure 5.7 : Forgot Password 39

Figure 5.8 : User Profile 39

Figure 5.9 : Change Password 40

Figure 5.10 : Check Bin Level 40

Figure 5.11 : Collect Bin Report 41

Figure 5.12 : Daily Updates 42

Figure 5.13 : Bin Status Report 42

Figure 5.14 : Post New Updates 43

Figure 5.15 : Register New User 43

Figure 5.16 : Predict Garbage Level 44

Figure 5.17 : Train the Model 1 45

Figure 5.18 : Train the Model 2 45

Figure 6.1 : Email is Required 48

Figure 6.2 : Password is Required 48

Figure 6.3 : Failed to Login 49

Figure 6.4 : User 1 49

Figure 6.5 : User 2 50

Figure 6.6 : User 3 50

Figure 6.7 : Sensor Bin Level 51

Figure 6.8 : Notifications from NodeMCU 51

Figure 6.9 : Change Phone Number 52

Figure 6.10 : Change Password 52

Figure 6.11 : Password Changed 53

Figure 6.12 : Register New User 53

Figure 6.13 : Edit Hostel Employees 54

UMS
UNIVERSITI MALAYSIA SABAH

Figure 6.14 : Delete Hostel Employees 54

Figure 6.15 : User Enters Information 56

Figure 6.16 : Report Details 56

Figure 6.17 : Admin Posts Updates 57

Figure 6.18 : Daily Updates 57

Figure 6.19 : Garbage Full 58

Figure 6.20 : Garbage Not Full 58

Figure 6.21 : Admin Home Page 59

Figure 6.22 : User Home Page 60

Figure 6.23 : Check Accuracy Score 60

Figure 6.24 : Actual and Predicted 61

Figure 6.25 : Plot Difference 61

Figure 6.26 : Final Accuracy Score 61

Figure 6.27 : Actual and Predicted 62

Figure 6.28 : Graph Difference 62

UMS
UNIVERSITI MALAYSIA SABAH

LIST OF APPENDICES

			Page
Appendix A	:	Interview Questions	69

UNIVERSITI MALAYSIA SABAH

CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter addresses the project's goal and development process. An effective and systematic "Garbage Detection System" using the Internet of Things (IoT) system was developed for this project. The proposed system detects the garbage level and compares it to the depth of the garbage bins using an ultrasonic sensor mounted over the bins. The proposed system is needed for immediate dustbin cleaning.

1.2 Problem Background

Universiti Malaysia Sabah, UMS' hostels do not have an effective and systematized method for the monitoring and collection of waste. Sometimes, the garbage bins are left to be overloaded since it is cumbersome for the hostel employees who are in duty to check on the garbage bins one by one.

Take an example Kampung E as one of the residential colleges in UMS. It has 5 blocks and are put 4 garbage bins at each level. The hostel employees will monitor and collect the waste daily for 5 corresponding blocks with 4 floors.

This traditional system is clearly ineffective, since the hostel employees have to walk around the block every few hours to check on the levels of garbage bins. The problem will get even more complicated if one of the hostel employees is absent on that day. It will cause so much work, require significant human effort and time will be wasted. The hostel employees already have so much in their hands. The overloaded garbage can produce strong odour and aggregate number of diseases such as dengue, cholera, and diarrhoea.

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By proposing this system, the smart garbage detection system will assist to ease the work of hostel employees and keep the hostel surroundings clean as the garbage bins are emptied the moment the bins are full. The ultrasonic sensor will be put at the highest level of the garbage bin and employees will be notified as soon as the particular garbage bin is full. This new method will facilitate the employees to only empty the bin when there is an alert and give a plus value for the hostel management since the hostel now will only require a few employees since the job now have been made easier.

1.3 Problem Statements

The traditional method has some problems that are being discovered where it is cumbersome for the hostel employees to walk around the block for every few hours to check on the level of garbage bins to prevent the bins from being overloaded. It led to the idea of a new system which detects the maximum level of the garbage using a sensor and will be emptied in a short time. The problems are:

- The garbage bins get overflowed in advance before the waste disposal which will produce strong odour and may trigger various serious disease among UMS students and staffs.
- Infections, chronic diseases, and accidents are all concerns that the hostel employees face when picking up and handling overflowing garbage. Sharp items, needles, and possibly poisonous waste make picking up overflowing rubbish dangerous to hostel employees and UMS students too.
- UMS students cannot live comfortably in a place with ineffective garbage management.
- The manual way of tracking and collecting waste requires tremendous human effort and time, which leads to higher cost for UMS hostel management.

The recent Internet of Things based Garbage Detection System mostly focus on the notifications being sent to the user's mobile phone when a specific garbage bin is full. It is effective but at the same time it might also cause a little burden to the employees for emptying each bin at random times. The machine learning model will be required to learn about the garbage growth level and uses past information to predict garbage bin level based on the time of the day and different days of the week. This model will provide a more productive garbage collection process.

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1.4 Project Goal

The goal is to develop a garbage detection system with garbage level prediction using machine learning approach.

1.5 Objectives

i. To implement a garbage detection system that will send notifications to the hostel employees whenever the garbage bins are full.

ii. To design and develop a garbage detection system with prediction of garbage level behaviour using random forest algorithm in IoT.

iii. To evaluate the garbage detection system in terms of its function's performance by predicting garbage bin level based on the time of the day and different days of the week.

1.6 Project Scope

The scope of the project is defined and it will be implemented on UMS hostel specifically in Kampung E. A trained and skilled employee is required to manage the entire system and given the role admin. The user of the system are the hostel management employees. The modules that consist of registration, user profile, garbage bins monitor and garbage level prediction are listed in Table 1.1.

Table 1.1: Project Module

Module	Description	User
Registration/Login/Logout	• To own an account, the hostel employees will be registered by admin.	• Hostel employee • Admin

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	• The hostel employees can login their account and logout their account.	
User Profile	• The hostel employees will have their own user profile with their phone number and email shown on it. • The hostel employees can edit their user profile and change their password. • Admin can view and edit all the user information.	• Hostel employee • Admin
Garbage Bins Monitor	• The admin will assign the location of garbage bins to the hostel employees. • The hostel employees can view the current level of	• Hostel employee • Admin

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	garbage bins assigned to them, and the admin can view all the current level of garbage bins. • If the assigned garbage bins are full, a notification will be generated to the assigned hostel employees. • The employees need to update a report to the admin after they collect the garbage. • The hostel employees can view the admin's update from their account. • The admin can update notices, recent updates to the hostel employees.	

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Garbage Level Prediction	• The hostel employees and admin can enter the day in numerical and time and the model will predict if the garbage is full or not.	• Admin • Hostel Employee

1.7 Project Timeline

The project starts with a project planning which includes identifying problems, objectives, writing proposal and corrections from 15th March 2021 until 21st March 2021.

Next, the project goes on with conducting literature reviews, gathering requirements, and analysing the requirement specifications from 22nd March 2021 until 17th April 2021.

After that, the design phase begins. The design phase includes the system architecture, database, user interface and the whole setup of the model. The estimated time for design phase is 19th April 2021 until 14th June 2021.

The developing phase starts after all of the information has been gathered from 11th October 2021 until 24th December 2021.

After the project has been developed, the testing phase begins. Hardware testing, system testing, integration testing, error and bug troubleshoot will be carried out in this phase from 24th October 2021 to 10th January 2021.

1.8 Organization of Report

This report consists of five distinct chapters. Each chapter has a specific focus and objective. The titles of the seven chapters are Introduction, Literature Review, Methodology, System Analysis and Design, Implementation, Testing and Conclusion.

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Chapter 1 is the introduction to the Garbage Detection System with Garbage Level Prediction using Machine Learning in Internet of Things. It consists of the following: background of the study, statement of the problem, project goal, objectives, project scope with the details of every module, project timeline and how the report is organized.

Chapter 2 is the literature review. This chapter will discuss regarding the existing garbage detection system and the methods used.

Chapter 3 is the methodology. This chapter will focus on the methodology used in this project and further explanations regarding the methodology chosen. All of the activities are documented in every stage of this project. The required hardware and software will also be listed in this chapter.

Chapter 4 is the system analysis and design. This chapter will explain the context diagram (CD), data flow diagram (DFD), entity relationship diagram (ERD), data dictionary and user interface diagram.

Chapter 5 is the implementation of the project. This chapter is divided into four sections: tools for development, database implementation, system implementation and the conclusion of the chapter.

Chapter 6 is the testing of the project. This chapter This chapter is divided into four sections: unit testing, integration testing, system testing and the conclusion of the chapter.

Chapter 7 is the conclusion of the project. This chapter wraps up the report's content and summarizes all the project's progress to develop the system.

1.9 Conclusion

This first chapter of this report starts with the background of the garbage detection system and further describes on why the idea was brought up. This is followed by the project goal, project objectives, project scope and project timeline. The chapter concludes with the organization of report.

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter addressed and identified a few articles and previous journals that traced a similar technique and covered topics that can be used as references for the Garbage Detection System with Garbage Level Prediction using Machine Learning in IoT. This chapter also includes analysis focused on a similar existing system, sensors used, and an IoT board that can be used as a guideline or a model for upgrading or developing a new system that is better than the existing system.

2.2 Concept of Detection System

A detection system's fundamental concept is to allow users to collect, process, and disseminate data in a systematic manner. The detection system could be used to track patterns in a number of measures using data collected on the ground. An effective and efficient detection system is required to track system operations, check if applications are running, and, if possible, warn the user.

2.3 Review on Existing Garbage Detection System

There are many systems that were developed to detect garbage levels. There are five different systems were reviewed in this segment. The comparisons of the existing and proposed system are shown in Table 2.1.

2.3.1 Internet of Things Based Wireless Garbage Monitoring System

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