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AUTONOMOUS PARCEL COLLECTOR FOR THE DOMESTIC AREA USING MICROCONTROLLER

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2022

DECLARATION

I declare that this project report entitled "AUTONOMOUS PARCEL COLLECTOR FOR THE DOMESTIC AREA USING 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 candidature of any other degree.

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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 Electrical Engineering Technology (Industrial Automation and Robotics) with Honours

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DEDICATION

I want to express my sincere appreciation to my beloved parents for all of their love, sacrifices, and support throughout my life. At first, I'm grateful for their understanding and patience, which were necessary to finish making this job. For as long as the day I remember, I've been motivated by their struggle to learn how to read, write, and study. I was at a loss for words to express how grateful I was for their loyalty, encouragement, and belief in my capacity to realize my goals. Last but not least, I'd like to express my gratitude to everyone who helped, directly or indirectly, with my project. I want to thank everyone for their feedback and recommendations, which are essential to the successful conclusion of our study.



ABSTRACT

Autonomous robots have a significant part in society in this new era of globalisation. There have been many different types of autonomous robots developed. This technology is used in a variety of settings, including the office, military, hospital operations, sports, agriculture, education, and more. An autonomous line following robot, out of all the autonomous robots, has been intended to protect workers who work in hazardous settings. At the same time, it is practical and safe for people, as social separation is required during the COVID-19 pandemic to prevent the virus from spreading. This gives rise to the concept of a autonomous parcel collector robot. The robot may travel within a home area while collecting parcels for consumers using the line following method. This prototype of an autonomous parcel collector robot will be developed first by a computing unit. It is set up to give instructions to the other parts. Line following requires the use of a motor driver and sensors. The robot can receive and drop off objects using a servo motor and a loading base. The well-designed algorithm will be implemented in the computer unit for the purposes of carrying out instructions. This enables the robot to collect packages even when no one is present. The robot's lowest parcel collection time on that particular track was 48 seconds under steady conditions, which was much faster than any outcomes when the robot was carrying more weight. In addition, the robot's motors needed more power to move along the uneven road. Yet, the robot cannot move uphill even when the motor is driven at 100% duty cycle. To enable the robot to execute work more effectively and of higher quality, it is advised that the existing motors and chassis be replaced with stronger ones which comes with a larger power supply.

ABSTRAK

Robot autonomi mempunyai peranan penting dalam masyarakat dalam era globalisasi baharu ini. Terdapat pelbagai jenis robot autonomi yang dibangunkan. Teknologi ini digunakan dalam pelbagai tetapan, termasuk pejabat, tentera, operasi hospital, sukan, pertanian, pendidikan dan banyak lagi. Robot yang mengikuti garis autonomi, daripada semua robot autonomi, telah bertujuan untuk melindungi pekerja yang bekerja dalam tetapan berbahaya. Pada masa yang sama, ia adalah praktikal dan selamat untuk orang ramai, kerana pemisahan sosial diperlukan semasa pandemik COVID-19 untuk mencegah virus daripada merebak. Ini menimbulkan konsep robot pengumpul bungkusan autonomi. Robot itu boleh bergerak dalam kawasan rumah sambil mengumpul bungkusan untuk pengguna menggunakan kaedah garisan berikut. Prototaip robot pengumpul bungkusan autonomi ini akan dibangunkan terlebih dahulu oleh unit pengkomputeran. Ia disediakan untuk memberi arahan kepada bahagian lain. Garis berikut memerlukan penggunaan pemandu motor dan penderia. Robot boleh menerima dan menurunkan objek menggunakan motor servo dan tapak pemuatan. Algoritma yang direka dengan baik akan dilaksanakan dalam unit komputer bagi tujuan melaksanakan arahan. Ini membolehkan robot mengumpul pakej walaupun tiada sesiapa yang hadir. Masa pengumpulan bungkusan terendah robot di trek tersebut ialah 48 saat dalam keadaan stabil, yang jauh lebih cepat daripada sebarang hasil apabila robot membawa lebih berat. Selain itu, motor robot memerlukan lebih kuasa untuk bergerak di sepanjang jalan yang tidak rata. Namun, robot tidak boleh bergerak ke atas bukit walaupun motor dipandu pada kitaran tugas 100%. Untuk membolehkan robot melaksanakan kerja dengan lebih berkesan dan berkualiti tinggi, dinasihatkan agar motor dan casis sedia ada digantikan dengan yang lebih kuat yang disertakan dengan bekalan kuasa yang lebih besar.

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TABLE OF CONTENTS

DECLARATION APPROVAL DEDICATIONS ABSTRACT i **ABSTRAK** ii **ACKNOWLEDGEMENTS** iii **TABLE OF CONTENTS** iv LIST OF TABLES vi LIST OF FIGURES vii **CHAPTER 1** INTRODUCTION 1 1.1 Background 1 1.2 Problem statement 2 3 1.3 Objective 3 1.4 Scope 1.5 Summary 4 **CHAPTER 2** LITERATURE REVIEW 5 2.1 Introduction JNIVERSITI SIA MELAKA TEKNIKAL MAL 5 5 2.2 Autonomous robot 2.2.1 General-use autonomous robot 6 2.2.2 Military autonomous robot 7 2.2.3 Delivery robot 7 2.2.4 Construction robot 8 2.3 Autonomous line follower robot 9 2.3.1 Application of autonomous line follower robot 10 2.3 Methods on develop line following 12 2.3.1 Magnetic sensors 12 2.3.2 Bluetooth module 13 2.3.3 Infrared sensor 14 15 2.4 Summary **CHAPTER 3 METHODOLOGY** 17 3.1 Introduction 17 3.2 Overall flowchart 17 3.3 Design prototype of Autonomous parcel collector robot 19 3.3.1 Mechanical drawing 20 3.3.2 Electrical diargam 24

PAGE

3.3 Programs of auton	omous parcel collector robot	27		
3.3.1 Programs for movement				
3.3.2 Programs for loading base				
3.4 Summary		33		
CHAPTER 4	RESULTS AND DISCUSSIONS	34		
4.1 Introduction		34		
4.2 Track way design		34		
4.2.1 Checking	y patterns of garage	35		
4.2.2 Arrange	ement of obstacle	35		
4.2.3 Testing		35		
4.3 Travelling test		36		
4.3.1 Speed of	motors and travelling period	36		
4.3.2 Speed of	motors and travelling period with extra 50g	38		
4.3.3 Speed of	motors and travelling period with extra 100g	40		
4.3.4 Result co	omparison between loaded and unloaded robot	42		
4.3.5 Effect of	uneven surface	43		
4.3.6 Effect of	slope	45		
4.4 Gradients of joints	1	47		
4.4.1 Testing for	or carrying weight with different degree of joints	47		
4.4.2 Different	gradient of joints with sustainable weight	49		
CHAPTER 5	CONCLUSION AND RECOMMENDATIONS	51		
5.1 Introduction		51		
5.2 Conclusion		51		
5.2 Conclusion		52		
REFERENCES	Ukn	53		
Appendix A Gantt Cha	اونيوم سيتي تيڪنيڪل مليسيا م	57 57		
Appendix A Gantt Cha	art PSM2	58		
	ERSITI TEKNIKAL MALAYSIA MELAKA	50		

LIST OF TABLES

TITLE

PAGE

FIGURE

Table 4.1	Table for Duty cycle and time taken for robot to complete a cycle based on results obtained	36
Table 4.2	Table for Duty cycle and time taken for robot to complete a cycle with extra 50g based on results obtained	38
Table 4.3	Table for Duty cycle and time taken for robot to complete a cycle with extra 100g based on results obtained	40
Table 4.4	Table for Duty cycle and time taken for the robot to complete a cycle with and without extra load based on results obtained	42
Table 4.5	Table for Duty cycle and time taken for the robot to complete a 1.5-met distance track in straight line	er 44
Table 4.7	Table for servos possible duty cycle with sustainable weight	47
Table 4.8	Table for servos possible duty cycle with highest sustainable weight	50
	UNIVERSITI TEKNIKAL MALAYSIA MELAKA	

LIST OF FIGURES

FIGURE

TITLE

PAGE

Figure 2.1	General-use autonomous robot	6
Figure 2.2	AR drone using UAV	7
Figure 2.3	Waiter robot	8
Figure 2.4	Infrastructure sector	9
Figure 2.5	Towing Automated guided vehicle	13
Figure 2.6	LISA robot with disinfecting UVC light	14
Figure 2.7	Jackbot Mark I prototype and track	15
Figure 3.0	General flow chart for procedures of develop autonomous parcel collector robot	18
Figure 3.1	Top view (layout of autonomous parcel collector)	20
Figure 3.2	side view (layout of autonomous parcel collector)	21
Figure 3.3	Base view (layout of autonomous parcel collector)	21
Figure 3.4	Flowchart of mechanical structural design	22
Figure 3.5	Wiring Diagram (autonomous parcel collector)	24
Figure 3.6	Flowchart of electrical devices design	25
Figure 3.7	Flowchart of programming a microcontroller	28
Figure 3.8	function to enable GPIO pins of PI	29
Figure 3.9	Function to follow the lower-level numbering system	29
Figure 3.10	Functions to set up the pins for each output	29
Figure 3.11	Function of moving forward	29
Figure 3.12	Function of turning to right	29
Figure 3.13	Function of turning to left	30
Figure 3.14	Function of stop	30
Figure 3.15	Function for enabling the RPI.GPIO library and the sleep function	31
Figure 3.16	Function for reference to PINs	31
Figure 3.17	Function for setting output pin	31

Figure 3.18	Function of setting variable and starting point.	32
Figure 3.19	Function of setting the duty cycle	32
Figure 3.20	Function of clean up	32
Figure 4.1	Chart of duty cycle (PWM) vs time lapse per trip	37
Figure 4.2	Chart of duty cycle (PWM) vs time lapse per trip with load 50g	39
Figure 4.3	Chart of duty cycle (PWM) vs time lapse per trip with load 100g	41
Figure 4.4	Chart of comparison between results of duty cycle (PWM) vs time lapse per trip with and without load	42
Figure 4.5	Chart of results of duty cycle (PWM) vs time lapse per trip while travelling on uneven surface	44



CHAPTER 1

INTRODUCTION

1.1 Background

Over the past centuries, there have been changes in this society, technology affects people and allows them to use intelligent instruments in their lives, especially autonomous robots. It is an automatically operated machine that provides many advantages to people[1]. Each created robot have performed according to a set of behaviours from the big data.

Nowadays, autonomous robots have already become a part of our lives. Autonomous can substitute humans for completing some simple duties, such as those requiring a great deal of physical strength within a more extended period. So, free space for employees to focus on matters requires mental ability and creativity[2], [3]. After being programmed by software, an autonomous robot can perform task more precisely and efficiently. It also can improved product quality and quantity and decreases the rate of products failure.

In this new era of globalisation, autonomous robots play an important role in society. There are many kinds of autonomous robots created. People apply this technology in many fields, including office, military, hospital operations, sports, agriculture, education, and others[4]. The autonomous robot also involves material handling, driverless training, and others that provide faster production and efficient material transportation between the workstation or logistics instead of the traditional delivery system[5], [6]. These represent the advanced technology in this field and promise many beneficial advantages. From all the autonomous robots, an autonomous line following robots has been designed to protect workers that work in dangerous environments, such as radioactive, toxic, explosive or even monitoring[7], [8]. Both these help workers avoid unnecessary fatal accidents. At the same time, it is practical and safe for people

since social distancing is necessary during this pandemic COVID-19 to prevent the spreading of the virus.

Furthermore, rather than going out and shopping for goods, people are increasingly opting to buy things online and have them delivered by a courier, avoiding close contact with others who may be carriers of the positive virus. Some of the carriers are unaware that they are carriers of the positive virus. In this scenario, people collecting parcels had become a regular ritual; if an autonomous robot can collect parcels from courier services in place of people, not everyone will be able to manage their parcel at any time. As a result, an independent parcel collector is highly suggested.

The autonomous parcel collector is a self-contained robot with a line follower base that may collect freight from a courier service and return it to a container or location designated for it. The robot will then return to the station or a set position to await the following order. Users may be confident that the package collector will do the work safely and timely. This project is highly recommended because there have been several complaints from friends, neighbours, and even parents who have had difficulty getting packages. To summarise, an autonomous parcel collector is a robot that assists the owner in receiving the delivery in good condition and assures the owner's safety while doing so.

1.2 Problem statement

Due to the pandemic of covid-19, many cases of parcel delivery have occurred, the most common issue is that when the house owner is not present, the courier service will simply place the package in front of the door and leave it, or they will leave a message stating that no one has attempted to collect the package. This could be quite inconvenient for the parcel's owner. Aside from that, parcel damage from courier service throwing, parcels missing due to no one at home and perhaps taken by strangers, buyers exposing themselves to strangers who may or may not be from the courier company, and the virus covid-19 can easily transmit while in close contact with someone. These issues have led to the conclusion that if a robot can substitute a person, the owner can direct the parcel collector to receive the box from the mail carrier without being exposed to anyone. Even if the package contains a virus, sanitisation can be done before the owner accepts it. Besides, failing to attempt the collection of the parcel might cause the owner to collect the parcel at the courier company's warehouse or outlet.

1.3 Objective

The main aim of this project is to propose a systematic and helpful prototype to solve the problem of miss attempt to collect parcel from courier service, by combining both hardware and software, the objectives are as bellows:

- a) To develop a prototype of an autonomous parcel collector for the domestic area using a microcontroller.
- b) To design the line following algorithm software and embedded to a microcontroller
- c) To analyse the effectiveness of the proposed method for the parcel collector mechanism.

1.4 Scope

The work scope for this project is to develop a prototype of autonomous parcel collectors by using various components, including both software and hardware. At first, this prototype of autonomous parcel collectors will be carried out by a computing unit. A general-purpose, highlevel, interpreted programming language, which allows users to implement the instructions in form of code. Through the computing unit, the robot will execute the instructions according to the procedures. The motor driver is utilised to control the motions of a line follower-based autonomous parcel collection prototype. The prototype can follow the pre-determined course by employing an infrared sensor. This prototype has several limitations due to a lack of expert experience. Around 500 g is the maximum weight that may be sustained while collecting a parcel. While the service area is restricted to residential and landed houses exclusively. The operating time is determined by the length of the journey path as well as the time it takes the courier service crew to load the parcel onto the robot, therefore it may vary for various users. If there are any prospects in the future, certain modifications and innovations can be made to minimise the constraints and raise the robot's efficiency, such as replacing this project with a GPS module that does not require any set-up path. While boosting the chassis' stiffness to support the parcel's

increased weight.

1.5 Summary

The majority of the data relating to autonomous robots will be gathered in this study, including articles, books, papers, and videos. All of the gathered data will serve as resources for this project and be helpful. In conclusion, the objectives given above will guide this project to determine its efficiency in resolving the difficulties as a result of the issues that have already occurred in the present. The scope is here to fix the systems and approach that this project will use.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

An autonomous robot is one that can act independently of human control. In recent years, after a significant amount of work and effort, autonomous robots have become more prevalent in everyday life. The rapid advancement of automation, navigation, and robotics has drastically altered society's lifestyle and environment. By developing a system that employs a sensor to allow an automated robot to follow a designated path. Without any surprise, this kind of project has become of great importance in the field of automation[9].

2.2 Autonomous robot

Elmer and Elsie, the first autonomous robots, were built by W. Grey Walter in the late 1940s. They were the first robots in history to be designed to "think" like biological brains and to be capable of exercising free will. Because of their shape and the way, they moved, Elmer and Elsie were sometimes mistaken for tortoises. They were capable of phototaxis, which is the movement caused by light stimulation[10], [11]. Since autonomous robots have become a big topic, a lot of research has gone into changing, creating, and innovating them to make them easier to do the task ahead. Autonomous robots are capable of replacing humans as high-intensity employees without exposing them to hazardous working conditions, high energy consumption, or poor operation hours[6]–[8]. Due to the influence of automation in the 21st

century, people have grown accustomed to the presence of autonomous robots. Many different types of autonomous robots have been developed to make human and working life easier.

2.2.1 General-use autonomous robot

General-use Autonomous Robot is an intelligent machine that can multitask, doing all or most of the tasks assigned to it in each sector. It was made in a very broad sense. Thus, there is an autonomous robotic exploration using a utility function based on Renyi's General theory of Entropy[12]. It was created with the intention of performing exploration tasks while observing the landscape in order to properly incorporate fresh data into the map. All of this is useful not just for mapping, but also for searching and rescue operations during disasters. Besides, for human society, a general-purpose humanoid service robot with a set of simple action skills such as navigation, gripping and recognising items or people is being considered[13]. Working plans or steps are based on probabilistic methodologies when a complete voice command is provided.



Figure 2.1: General-use autonomous robot [12]

2.2.2 Military autonomous robot

This type of autonomous robot is developed for military use, especially scouting, adsorb enemy fire, engaging the target, either attacking or defending. Lethal autonomous weapons (LAWs) are a sort of autonomous robot warfare system that can search for and engage targets independently based on pre-programmed limitations and descriptions. It is possible to operate in the air, on land, on water, underwater, or in space. As of 2018, the autonomy of current systems was limited in that a human must give the ultimate command to attack, but there are exceptions with certain "defensive" systems[7], [14]–[16].



Figure 2.2: AR drone using UAV[14]

2.2.3 Delivery robot

An autonomous robot that provides delivery services. In specific cases where the robot cannot resolve itself, such as when it becomes caught in an impediment, an operator can watch and manage the robot remotely. Food delivery, package delivery, medical delivery, and room service are all possible applications for delivery robots. Delivery robot service for several sectors, including grocery, food and beverage, packaging, hospital, room service etc. The waiter robot is one of the solutions to restaurant automation. By pairing with LCD and keypad, endow the ability to order food and beverages, while approaching to order, the waiter robot can bring the cooked food along for delivering to customer.[6], [17]–[19]



2.2.4 Construction robot

It's an autonomous robot that works on construction sites and does heavy lifting, material handling, earthmoving, and surveillance. These robots must be able to move around and fix themselves to the work area, handle building supplies, and interact with humans and other machines. The existence of construction robots allows the workers to complete the assigned job efficiently while decreasing the risk on construction sites. Autonomous robotic take part in demolition, design support, production, and quality control are some of the construction phases where new robotic technologies could have a bigger impact in the coming years, in terms of increased safety and lower costs, and across a variety of industries[20]. As a result, a multipurpose construction robot has been designed specifically for civil applications[21]. It can be used to detect gas leaks in homes and businesses, to monitor shopping malls, parking lots, offices, industries, banks, and museums, aid rescue operations during natural disasters and their aftermath, and provide food and other essentials to people living in remote areas where human access is difficult or dangerous[22], [23].



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2.3 Autonomous line follower robot

Of all the different types of automated robots, the automated line follower robot is one of the most interesting topics that has recently gained a lot of interest in the robotic sector. Autonomous line follower robots are clarified under the 'Mobile Robot' They entail the assignment of operations and tasks such as movement, turning, obstacle recognition and avoidance, and other key parametric tasks to which the robot is subjected[1]. As a result, automated line follower robots have become the backbone of managing robots in the uncharted territory[19], [24]. Aside from that, automated line follower robots with advanced control technologies could be useful in the industrial sector. Because traditional delivery systems need

a lot of human energy and time, an automated line follower robot can be used to replace them as a more efficient and energy-saving delivery system[6], [25]–[27].



Figure 2.3: Line follower robot with real time Viterbi[28]

2.3.1 Application of autonomous line follower robot

There are various uses for autonomous line follower robots that are common in our environment. Every household needs to tidy its home. With the evolution of technology, autonomous line follower robots have been developed for domestic application use, which assist users in completing daily cleaning tasks such as floor cleaning, collecting garbage etc[25], [26]. For example, Mi Robot Vacuum-Mop, acts as a professional floor cleaning expert to keep the floor spotless. Besides that, this approach can be used in automobile applications. These robots allow vehicles to roam around autonomously and without a driver, while this automatic system using magnets allows traffic to flow smoothly and efficiently. These reduce the stress associated with long-distance driving and reduce the risk of an accident[3], [5]. Moreover, this technique can also be applied to industrial applications. These robots can be utilised in industries as automated equipment carriers, potentially replacing the old delivery system such as conveyor belts [2], [6]. For example, require a variety of components to accomplish item delivery and take up too much room in factories. Other than that, the line follower robot can be used as a guidance application too. These robots can act as ushers for those who require assistance. Apart from guiding, it can also assist disabled individuals with navigation[29]. Furthermore, a follower robot can be designed as a multi-purpose robot, meaning it can not only travel from point A to point B but also provide some assistance while doing so. With the help of a basic IR sensor circuit, the line following technique is constructed, and It is done to ensure that the vehicle is on the track or path that will allow the user to progress in the desired manner[1], [24]. While vehicle monitoring is an important procedure to follow when it comes to a situation involving an unmanned vehicle. Besides that, robotic technologies have proven to be effective in protecting workers from hazardous work conditions, such as those that are radioactive, poisonous, or explosive. Antipersonnel mines can be found in any setting near people, posing a danger to their life. These mines are more difficult to locate and remove, especially if they are in unstructured surroundings or near agriculture fields. The cost of mine clearance exceeds the budget of poor countries affected by mines. Unfortunately, this procedure is normally carried out manually, which is both slow and dangerous. As a result, instead of humans, demining robots have been utilised to carry out such hazardous tasks[7]. Despite the higher expense of building the landmine detecting navigation robot, it is still a better and safer approach to demine. Lastly, the use of robots in restaurants for automation is becoming increasingly popular. These robots can greet visitors, take orders, and serve clients food[17]. This is an obvious illustration of how robots give a great deal of convenience to the food and beverage industry, but there are still certain issues, such as service only at a consistent floor level, limited types of service, limited language, and so on.

2.3 Methods on develop line following

A line follower robot is a self-operating robot that identifies and follows a line to travel from origin to destination. While line follower robots can be built in a variety of ways, with the widespread development of microcomputers and embedded systems in recent years, it has become possible to produce low-cost alternatives[30]–[33]. A line follower robot may have varied configurations, for example, several sensors including infrared, ultrasonic, webcams, GPS, magnetic, etc, or different command and control algorithms, depending on their destination. They may also be monitored locally or remotely[8], [26].

2.3.1 Magnetic sensors

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Roman Osorio C (2006) created a path-following robot that uses a variety of magnetic sensors to move[2]. Magnetic sensing is a promising technology that has been developed for position measurement and guidance, with applications in advanced vehicle control and safety systems being particularly prominent. To obtain real-time navigation information, a magnetic-based sensor can determine the vehicle's position relative to the tape and it will use the sensor input to provide power to the appropriate wheels in order to stay within predetermined tolerances of the track[34]–[37]. Because of its double polarity, small size, and compatibility with various electrical systems, this efficient potential tool has been employed in industrial applications with great success since the 1990s. However, magnetic-based sensors are difficult

to get by these days and their initially small amount causes the lack of advantage in high traffic areas[35], [38].



Figure 2.5: Towing Automated guided vehicle[38]

2.3.2 Bluetooth module

The line follower robot is able to control by an Android-based application, an RC Bluetooth controller. The microcontroller is used for instruction processing and giving proper instructions, and Bluetooth technology is used to interface with Arduino and Android. So, by combining these two applications, the line follower robot allows the user to control manually and move to the desired destination within the Bluetooth network range[17], [39]–[41]. Yet, due to the Bluetooth range being restricted[42], [43], if the robot needs to move further, the users must also move in order to archive the target destination.



Others than that, line follower robots use an infrared sensor to finish their journey from point A to point B. To facilitate the operation of the line follower robot, this method requires coloured

guide tape. As the working principle, the infrared sensor will detect the difference in colour changes and trigger the driver to give the command to the wheels for moving purposes[6], [33], [44]. It's simple to apply and remove the guide tape, as well as relocate it if the course needs to be changed. When compared to magnetic tape and wires, coloured guide tape is initially less expensive. However, it is not recommended that the tape be embedded in high-traffic locations where it may become dirty and destroyed easily[3], [5], [45].



Figure 2.7: Jackbot Mark I prototype and track [6]

2.4 Summary

Various strategies have been used in line follower robots, each with its own set of pros and downsides. Magnetic tape is easy to apply as guided path and occupies a smaller space21]– [24], but due to magnetic-based sensors are more expensive and have restricted availability, despite their superior performance and efficiency. Using an Android-based programme called RC Bluetooth controller to install in a line follower robot is the best option. This is because the robot can be operated with any Android device, and the commands given to it will be more precise. It is not appropriate for long-distance control due to the maximum signal extension [17], [39]–[41], and it requires some basic programming and control abilities, making it unsuitable for old or senior users. Lastly, the infrared sensor will detect the changes and send a signal to the wheels, allowing the robot to travel along the track that the user has put up. Even while this approach necessitates the use of several tools and the coloured tape can be easily damaged, it is the simplest and most straightforward method for completing the movement [6], [33], [44]; it does not necessitate programming knowledge, and the tools can be obtained at a low cost almost anywhere. In conclusion, the prototype of autonomous parcel collector robot had become my best project choice, since the application and methods are meaningful to me, its not only helping the society, but also allow me to grab this chance on learning about autonomous robot.



CHAPTER 3

METHODOLOGY

3.1 Introduction

This section will look into the methods and processes used during the project. A project's methodology is significant. The methodology serves as a guide to ensure that the project's workflow is right and that the project is completed effectively. The content of the methodology included numerous sections in order to guide the project toward its objectives. There are several flow charts that assist to describe and clarify the workflow in this project.

3.2 Overall flowchart

This section shows the general working flowchart of the autonomous parcel collector. The working procedure start with reading output from sensor, which is the line following part. There are three conditions, move forward, turn left, and turn right. Based on the sensor output reading, the robot keep moving until the checkpoint. First checkpoint is behind the gate, then the robot raise up the loading base for 5 seconds to receive the parcel from courier service, then retract the loading base. After this, it starts again to move according to the output reading from the sensor. After it travel to the last checkpoint, the loading base will fall down to drop the parcel in the space prepared, then back to the starting position.



Figure 3.0: General flow chart for procedures of develop autonomous parcel collector robot

The entire operational procedure of the autonomous parcel collector robot is depicted based on the general flow chart above. After pressing the button to start, the infrared sensors that use line following to guide the robot will begin to send input signals to the microcontroller, allowing the wheels to move in accordance with the fixed line. The robot will turn to the left if the left infrared sensor detects a dark colour in front of it. The robot will turn to the right if the right infrared sensor detects a dark colour in the distance. When both sensors simultaneously detect a dark colour, the robot will stop moving; nevertheless, when both sensors simultaneously detect a bright colour, the robot will move in a straight line. The robot stops moving, raises the loading base, and waits for the next command when both sensors detect a dark colour, which is the first checkpoint. The sender of the object needed to press the button once more to start the robot for the subsequent step after the parcel or object had been placed on the loading base. When the button is pressed, the robot lowers the loading base and begins to move again utilising line following techniques. After passing the final checkpoint, it will halt and place the item or package in the compartment, then retract the loading base, and back to the initial position.

3.3 Design prototype of Autonomous parcel collector robot AMELAKA

Prototyping is an iterative process in which design teams turn abstract concepts into concrete forms, ranging from paper to digital. It requires both mechanical and electrical drawings that provide all the technical details in readable format. Apart from that, these drawings serve as a guide for the prototype process and ensure that the desired outcome is achieved. By combining two drawings as a design for the final layout.

3.3.1 Mechanical drawing

Mechanical design and prototyping are really important before fabrication happens. It's a draft version of an idea and also a stage where preliminary changes and product fixes occur. This section includes the overall layout of the autonomous parcel collector.



Figure 3.1: Top view (layout of autonomous parcel collector)



Figure 3.3: Base view (layout of autonomous parcel collector)



The mechanical structural design must be completed before building the mechanism to ensure that the outcome does not deviate significantly from the intended outcome. The process for performing mechanical structural design is shown in the flowchart above. First, this procedure begins with study and the hunt for concepts that could serve as a motivation for this undertaking. Since this project is intended to gather parcels and is based on the specification data from the devices that are used to carry holding objects, the load will be the first factor to be taken into consideration after developing a concept. Next, go on to the structural size, which requires a larger design space because it is where all the devices and components must be placed. In order to prevent accidents that could harm the devices, it is important to choose the structural body's materials carefully. For instance, materials that conduct electricity run the risk of damaging the microcontroller and any other electronic devices that are directly attached to the structural body. The robot's weight distribution and alignment are the final components to plan after the robot's body since they will determine how stable the robot is while moving and carrying objects. Finally, the fabrication process can begin if the design satisfies the need.



3.3.2 Electrical diargam



Figure 3.5 Wiring Diagram (autonomous parcel collector)

With the use of an IR sensor, the Line Follower Robot can track a line. An IR transmitter and receiver are included in this sensor. The light is transmitted by the IR transmitter (IR LED), and the light is received by the receiver (Photodiode). Only if an IR light is reflected by a surface will it return. IR light is not reflected by all surfaces; only white and black surfaces may totally reflect it. Two infrared sensors to determine whether the robot is on track with the line, and two dc motors to adjust the robot if it deviates off the path. A motor driver module is utilised while controlling the motors. which tracks the path and control the loading base. A microcontroller is utilised to control the whole unit.



Figure 3.6: Flowchart of electrical devices and circuit design

The specification and details of each device utilized in the application must be thoroughly studied in order to design an electrical circuit, therefore research and ideation are the initial steps in this process. Then, go ahead and get the equipment ready, including the servo motors, infrared sensors, microcontroller, motor driver, and dc motors with wheels. The schematic diagram has to be created after the devices are finished. Compile all embedded software with the help of the datasheet, then run the program to inspect the devices. This phase is regarded as calibration to make sure all the parts are connected correctly and capable of operating normally. Devices can be installed in accordance with the electrical design if there are no errors after calibration.



3.3 Programs of autonomous parcel collector robot

A robot is a mechanical device that is programmed to follow instructions. A computing unit, sensors to sense its surroundings, and motors and actuators to move its limbs or wheels are all included in the robot. So as autonomous line follower robots, it requires the ability to follow programmed instructions to complete the steps instead of just being controlled remotely. The program code for every step and movement will be the difference and then implemented in the microcontroller accordingly.



Figure 3.7: Flowchart of programming a microcontroller

According to the purpose and kind of microcontroller being used in this project, the variables must be declared and relevant libraries must be imported before creating the

programmes for the autonomous package collection robot. The codes should then be used in the project's operational order. Run the programme to check for errors, and if any are found, go back and redo the coding until the programme produces the desired results. Finally, implement that program into the microcontroller to enable it to send and receive signals to other devices to carry out tasks.

3.3.1 Programs for movement

A general-purpose programming language software, which is utilised to programme the autonomous parcel collector robot's movements. Forward, right, left, and stop are all included. To start the programming language for robot's movement, the GPIO pins of PI need to enable, and it can be renamed.



For the GPIO pins of PI, it is allowed either by pin number on board or by their function number. The function below shows that the whole programme will refer to the pins number that follow the lower-level numbering system defined by the Raspberry Pi's Broadcom-chip brain.

IO.setmode (IO.BCM)

Figure 3.9: Function to follow the lower-level numbering system

Last before the movement code apply, the pins for each output need to set up.

```
I0.setup(2,I0.IN) #GPIO 2 -> Left IR out
I0.setup(3,I0.IN) #GPIO 3 -> Right IR out
I0.setup(4,I0.OUT) #GPIO 4 -> Motor 1 terminal A
I0.setup(14,I0.OUT) #GPIO 14 -> Motor 1 terminal B
I0.setup(17,I0.OUT) #GPIO 17 -> Motor Left terminal A
I0.setup(18,I0.OUT) #GPIO 18 -> Motor Left terminal B
```

Figure 3.10: Functions to set up the pins for each output

When the IR sensors trigger, the autonomous parcel collector's movements begin. Both right and left IR sensors sense over the white surface and produce "True" while moving ahead. The autonomous parcel collector can proceed as long as this condition exists. The function below displays the prerequisites for progress.

```
if(IO.input(2)==True and IO.input(3)==True): #both white move forward
IO.output(4,True) #1A+
IO.output(14,False) #1B-
اويور سيخي تيكنيكا
IO.output(17,True) #2A+
IO.output(18,False) #2B-
```

Figure 3.11: Function of moving forward

The first right IR sensor comes over a black surface to make a right turn. The right motor will stop moving if this condition is met, but the left motor will continue to rotate.

```
elif(I0.input(2)==False and I0.input(3)==True): #turn right
I0.output(4,True) #1A+
I0.output(14,True) #1B-
I0.output(17,True) #2A+
I0.output(18,False) #2B-
```

Figure 3.12: Function of turning to right

After then, it's time to turn left. The second left IR sensor detects a dark surface, and if this condition is met, the right motor continues to rotate while the left motor stops.

```
elif(I0.input(2)==True and I0.input(3)==False): #turn left
I0.output(4,True) #1A+
I0.output(14,False) #1B-
I0.output(17,True) #2A+
I0.output(18,True) #2B-
```

Figure 3.13: Function of turning to left

Both the left and right IR sensors must sense over the black surface to stop the autonomous parcel collector from moving. If this condition is met, both the right and left motors will stop moving and remain stationary until the next command is issued.

else: #stay still IO.output(4, True) #1A+ IO.output(14, True) #1B-UNIVERSITI TEKNIKAL MALAYSIA MELAKA IO.output(17,True) #2A+ IO.output(18, True) #2B-

Figure 3.14: Function of stop

3.3.2 Programs for loading base

Besides from movement, the autonomous parcel collector needs a loading base to allow the courier service crew to load parcels on it. The procedures of collecting parcel are required to program in the microcontroller, to make sure the autonomous parcel collector robot work as desired

First, start the programming from import the RPI.GPIO library and the sleep function.



Connect the servo motor to pin 11 on the microcontroller.



Figure 3.17: Function for setting output pin

Next, name the variable for the servo as PWM and send a 50Hz PWM signal on that pin. Start the signal at 0.



Figure 3.18: Function of setting variable and starting point.

Furthermore, we can set the duty cycle by calculating the percentages at the beginning of this step.



Figure 3.20: Function of clean up.

3.4 Summary

This chapter has already explained the overall approach for working on the autonomous parcel collecting robot. A well-thought-out design creates a robot structure that is more suitable and capable. The load can be approximated more precisely using information derived from part specifications. The weight rigidity and alignment testing increase the rigidity of the robot's chassis, allowing it to hold parcels while moving in a more stable state. Furthermore, the schematic diagram that has previously been prepared and inspected can prevent various electrical faults that may occur if device component installation is done directly. Finally, because all of the prerequisites have been met, the programmes can be implemented into the microcontroller as an instructor. The autonomous parcel collector robot can work without the



CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

In this Chapter discusses and elaborate the collection of data in time taken to complete a full parcel collecting process. The track way is designed by using black tape and nylon fabric, which provide better grip and clean environment for any kind of domestic area's terrain. For the prototype, fully rubber made tire had been used for two-wheel drive system, castor wheel implement for well balancing. The DC motors powered by 5v and the speed controlling by PWM signal from the microcontroller. The data recorded based on the time lapse from timer and it will compare between different degree of incline road. For track way detection, multiple sensing range from IR sensor also recorded according to the setting. All recorded data were collected according to the features provided. There are multiple phases of parcel collecting where the track way need to be designed, and it's based on the environment of different housing area, placed the designed track way in provided space, run the robot, and track the pace for data collection.

4.2 Track way design

First, this process contains multiple phases before designing the desired path such as check the patterns of garage, arrangement of obstacle, and testing occurred after the track designed. During the stage of checking patterns of garage, the starting and ending point were fix. Next to the arrangement of obstacle, this step allowed the designed track way well calculated to avoid from any crashing or error happened while the robot perform parcel collecting. Thus, the robot will test run according to the earlier setup, and check whether there are any error occurred for both hardware and software. Throughout the trackway designing process stages, at least an hour taken to complete, and it might be different based on different types of housing garage and arrangement of obstacle.

4.2.1 Checking patterns of garage

This stage more focus on general part of garage's environment. There are many kinds of garage design for example houses that placed on sloping lot, this might cause the garage area slopes to the front, the back, or the sides. Then, a starting point was set in a covered place and it's nearby to the power source outlet. These increase the lifespan of the power pack of the robot and protect the robot from exposed to the sun and rain.

4.2.2 Arrangement of obstacle

The focus point of this stage is keeping the robot away from crashing to random obstacle that might occurred in the garage. With line following method, the designed track way will guide the robot on travelling smoothly to the destination. Before designing the track way, the arrangement of obstacle need to be fix, then the track way purposely guide the robot avoid from the obstacle while travelling.

4.2.3 Testing

This stage consider the last before completing the whole process, and it's focus on testing, which including software and hardware. The testing process will start on the major function, which is running the robot to travelling according to the track. Then next to the loading bay function, which carry the given item back to the ending point and place it in the container that had been prepared

4.3 Travelling test

Time taken by robot to complete a whole parcel collecting action are recorded. This process had repeated few times with different speed. Since it's a parcel collector robot, different load had been added during the data collection. These actions are to make sure the robot can be fully utilized and work efficiently.

4.3.1 Speed of motors and travelling period

The speed of motors controlled by pulse width modulation (PWM). PWM, or pulse width modulation, is a method that enables rapid power on and off to modify the average value of the voltage going to the electronic equipment. The duty cycle, or the ratio of the time the signal is ON to the time it is OFF within a given period, determines the average voltage. The user can simply connect a microcontrollers PWM output to the base of a transistor or the gate of a MOSFET, depending on the size of the motor, and then control the speed or position of the motor by manipulating the PWM output [[46]].

Table 4.1 Table for Duty cycle and time taken to complete a cycle based

No.	Duty cycle (%)	Time taken to complete a cycle (s)	
1	45	69	
2	50	62	
3	55	57	
4	60	52	
5	65	48	

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Figure 4.1: Chart of duty cycle (PWM) vs time lapse per trip

Based on this graph, it shows the results of time taken for autonomous parcel collector robot to complete a cycle against the duty cycle that feed to motors. In this project, the 100% of duty cycle allow the motors spin in 208 RPM without load. While all the results for this graph are taken with no additional load on the robot, and the total distance for a complete cycle is 2.55 meter. It can be seen the testing process start from feeding 45% of duty cycle to the robot, and RSITI TEKNIKAL MALAYSIA MELAKA it takes 69 seconds to complete the whole cycle. Next, the duty cycle increased to 50%, and so the time lapse had decreased to 62 seconds due to the speed of motors had increased. Third testing taken with 55% of duty cycle, as it shows the robot only take 57 seconds to complete the cycle. After that, the testing occur by increasing the duty cycle again to 60% and based on the graph it shows the time lapse decreased to 52 seconds. At last, the testing occur by increased the duty cycle to 65%, while from the graph it shows the time taken for robot to complete a cycle once again decreased to 48 seconds. From all the results obtained, this can be concluded as the greater the duty cycle feed to the motors, the lower the time taken for the robot to complete a cycle. In addition, the duty cycle that feed to the motors is lower than 45%, the robot cannot even move, this is because the power are not enough to carry the robot's weight while moving. When the duty cycle that feed to the motors is higher than 65%, the robot can move as usual, but it is too fast for the infrared sensors to detect the line, so end up the robot just pass by and run out of the line.

4.3.2 Speed of motors and travelling period with extra 50g

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The load is one of the main factors to affect the travelling period and the stability of the robot. While carrying parcel or items, the weight distribution of the whole chassis especially the top area cause imbalance during the robot travelling to destination especially the top area since the parcel will collect by loading bay.

Table 4.2	Table 4.2 Table for Duty cycle and time taken for the robot to complete a cycle				
	with extra 50g based on results				
No.	Duty cycle (%)	Time taken to complete a cycle (s)			
1	كنيكإ والبسيبا ملاك	اوىيۇم سىخ ئ			
1		······································			
2	NIVERSITI <u>50</u> EKNIKAL M.	ALAYSIA MEL77KA			
3	55	69			
4	60	61			
5	65	54			



Figure 4.2: Chart of duty cycle (PWM) vs time lapse per trip with load 50g

From the graph above, obviously the time taken by the robot with extra 50g load to complete a whole trip had increase. As usual, this testing occur in a track with total distance of 2.55 meter, and the duty cycle state in the results have 208 RPM when it's 100% feed without carrying any load. This graph shows the result directly proportional, due to the testing start from feeding 45% duty cycle to the motors, and the complete cycle takes 85 seconds for the robot to finished. As the table shows, the following test had been done by increased the duty cycle to 50% for the motors, and the robots take 77 seconds to complete a cycle. Next, the robots takes 69 seconds to complete the cycle, while the duty cycle feed to motors is 55%. For the next results shows the robots take 61 seconds to complete the cycle by feeding the motors with 60% of duty cycle. From the last result obtained, the motors had been feed by 65% of duty cycle tend to finish the whole cycle with only 54 seconds. From all the results, there's slightly difference occur in time taken for robot to complete the cycle. The results shows when the motors feed by 50% of duty cycle, the time lapse had increased from 92 seconds to 100 seconds which is 8 secs different. Compare to the result obtained while using 55% of duty cycle had only increased 6 secs, this is because the time taken for every starting step after stopping point may cause delay. So from the results may conclude as the greater the duty cycle feed to the motors, the lower the time taken for robot to complete a cycle. Besides, for the higher duty cycle from 65% may caused the robot off from track, while the lower duty cycle from 45% unable to trigger the movement of robot.

4.3.3 Speed of motors and travelling period with extra 100g

Based on the previous testing with applied 50g to the robot while running in track, another 50g which is total of 100g load is place on the robot. During the testing, the time taken for robot to complete a cycle with different duty cycle feed to motors are collect as the results that showing in table.

 Table 4.3
 Table for Duty cycle and time taken for the robot to complete a cycle

اويتوم

No.	NIVER Duty cycle (%) KAL M.	Time taken to complete a cycle (s)
1	45	88
2	50	80
3	55	73
4	60	66
5	65	58
6	70	54

with extra 100g based on results obtained



Figure 4.3: Chart of duty cycle (PWM) vs time lapse per trip with load 100g

From the graph above, it is clear that the robot needed more time to complete a journey after adding a 50g load. As per customary, the testing was conducted on a 2.55-meter-long test track. The duty cycle condition indicated by the data was 208 RPM when the engine was running at 100% feed without any load. Due to the testing starting with the motors being fed at 45% duty cycle and taking the robot 88 seconds to complete, this graph displays the outcome as being direct proportional. The subsequent test, as shown in the table, involved increasing the motors' duty cycle to 50% while allowing the robots 80 seconds to complete a cycle. The cycle is then completed by the robots in 73 seconds with a 55% duty cycle feed to the motors. According to the following results, the robots feed the motors at 60% duty cycle for 66 seconds in order to complete the cycle. According to the most recent results, motors that had been fed at 65% of their duty cycle tended to complete the entire cycle in 58 seconds. Lastly, due to the robot had been added with 100g load, it's able to travel in the track by feeding 70% to the motors, and it is able to complete a cycle with only 54 seconds. Before this, the robot will out from track due to the speeds of movement are too fast for infrared sensor to detect the line.

4.3.4 Result comparison between loaded and unloaded robot

From all the results obtained, it can be seen that the load are one of the main reason that effect the speed of robot movement, since it required to carry the object and move in stable manner to avoid damaging the object.

Table 4.4Table for Duty cycle and time taken for the robot to complete a cycle

with and without extra load based on results obtained



Figure 4.4: Chart of comparison between results of duty cycle (PWM) vs time lapse

per trip with and without load

Three findings in the chart are directly proportional to the graph, according to the chart and data that have been gathered. To gather all the data, the robot is run over a predefined course with a total length of 2.55 meters, including curves and checkpoints. While the motors' overall output at 100% duty cycle, without any load, was 208 RPM. The results of the testing without carrying any load are represented by the light blue colour element in the chart. The findings from the testing with an additional 50g weight are represented by the deep blue colour element, while those from the testing with an additional 100g load are represented by the orange colour element. The outcomes clearly demonstrate that the robot can move more freely without carrying any weight. The time it took the robot to complete a cycle increased somewhat once the additional 50g load was placed. The same is true of the findings of the previous tests; adding 100 g to the robot increased the cycle duration by a large amount, but it also made the robot capable of performing line following at 70% of duty cycle, allowing it to finish a cycle in only 54 seconds. All the data point to the fact that the robot can move more quickly even when carrying a load when the motors are fed at a greater duty cycle, although this is only true under ت, تنکنیک certain circumstances. اوىيۇم س

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4.3.5 Effect of uneven surface

All the previous testing had taken part in flat surface, which consider the road surface doesn't have any extra resistance to the moving wheels. So, for this session, the testing occurred while the track had been placed on the uneven surface. In this testing, the robot required to travel a total distance of 1.5 meter and its in a straight line.

Table 4.5Table for Duty cycle and time taken for the robot to complete a 1.5-meterdistance track in straight line

Duty cycle (%)	Time lapse (s)
60	0
70	0
80	52
90	44
100	36



Figure 4.5: Chart of results of duty cycle (PWM) vs time lapse per trip while travelling on uneven surface

The results that in chart above had been collect in a closed and safe area, while the uneven surface is relatively flat, which don't have big potholes, and bumps. Based on the results obtained, it can be seen clearly that resistance of uneven surface had increased the toughness for robot to travel around. First, the motors feed with 60% of duty cycle, but it cant even make a move. The same goes to the second result which motors had been feed by 70% of duty cycle, it got stop from the first step. Then the testing proceed with 80% of duty cycle, feeding to motors, and successfully make it a step ahead, and complete the trip in 52 seconds. After that, the robot got pick back and start again with 90% of duty cycle feed to the motor, and it manage to complete the trip in 44 seconds. Lastly, the robot goes with full 100% of duty cycle to the motors, and it manage to complete then trip in 36 seconds. From all these results, this can be conclude as the uneven surface did huge effect to the robot, which slowing down its travelling speed, and also consider as an obstacle that stuck in front the wheels to stop the robot from moving. In addition, there are several reason that also increased the difficulty for robot to move such as the weight of robot's body too heavy for the motors, low power supply and less torque to move the robots, smaller wheels that stuck in bigger potholes or obstacles.

4.3.6 Effect of slope

The slope road are also a factor to effect the robot's travelling speed, and it may cause UNIVERSITITEKNIKAL MALAYSIA MELAKA the robot losing stability while travel around. Ground features such as cambered slopes or undulations have much effect on the handling of cars under conditions in which control might possibly be lost. Besides robots consume fluctuating quantities of fuel when moving uphill versus as they perform additional work to overcome height differences on uphill roads [[47], [48]]. In this session, a straight upslope track was used, and the total distance is 1 meter only. So, the robot required to climb up the slope while the incline slope comes with a gradient of 10 degree.

According to the results, it is not possible to calculate the time needed to complete a journey at different speeds since the motors do not have the power to propel the robot up a hill, and the

robot's body weight is too great for the motors to handle. As a result of the findings, it can be inferred that moving a robot uphill is substantially more difficult for the robot's motors, therefore this prototype is not appropriate for garages with sloped driveways or gates. Additionally, while collecting data, the robot fell to one side and damaged a portion of it. This demonstrated that an uphill path may actually cause a robot to lose stability while moving.



4.4 Gradients of joints

The servo motors used in this project are in charge in controlling the joints that raise the loading base are important for sustaining the weight of objects that going to place on it. The correct gradients of each joint allow the loading base reach to the desired heights, and rigid enough to carry heavier. It also helps on increasing the stability of loading base position while travelling on track with objects on it. Other than that, well control joints movement able to place the objects in specified area with softer manner, to avoid the parcel got damage from dropping out the loading base on higher place.

4.4.1 Testing for carrying weight with different degree of joints

To run this testing, servos for right and left joint, had been set in several degree by using duty cycle. The range of the duty cycle start from 2 to 12, which stand for 0 ° to 180 °. Well combine duty cycle of two servos, provide certain angle that allow the mechanism (loading base) able to carry heavier load.

No. UNIVI	Possible duty cycle	Possible duty cycle	Sustainable weight
	of servo 1 (right)	of servo 2 (left)	(g)
1	4	5	30
		6	40
		7	100
		8	50
		9	30
2	5	4	40
		5	60

 Table 4.6
 Table for servos possible duty cycle with sustainable weight

		6	10
		7	0
		8	0
3	6	2	70
		3	40
		4	30
		5	0
		6	0
4	7	2	70
The second se	ALAYSIA 4	3	90
La	in the second	4	130
TI TE		5	0
19495		6	0
5	lundo 15		30
		3	60
UNIVI	ERSITI TEKNIKA	L MALAT SIA ME	LAKA 0
		5	0
		6	0
6	9	2	20
		3	30
		4	0
		5	0
		6	0

According to the table, this testing had some limitations because the mechanism's structural design prevented the servos from turning all the way. Due to this, testing was limited to particular duty cycles. It begins by setting the duty cycle for the servo 1 (right) to 4 and the duty cycle for the servo 2 to multiples of 4. As can be observed, the servo 2 turn occurs between duty cycles 5 and 9, and the sustained weight rises from 30 grammes to 70 grammes before falling back to 30 grammes. Servo 2 is set from 4 to 8 duty cycles away from servo 1, which is set with 5 duty cycles. The sustainable weight for this session ranges from 60g to 0g, according to the results. Following that, testing was conducted by setting servo 1 to 6 duty cycles and servo 2 to 2 to 6 duty cycles. Results with sustainable weight ranging from 70g to 0g were observed. The testing then started with servo 1 set to 7 duty cycles, servo 2 set to 2 to 6 duty cycles, and these combinations produced a sustainable weight range of 70g to 130g, then merely a drop to 0g. As servo 2 increases from 2 to 6 duty cycles, the testing continues with servo 1 in 8 duty cycles. These combinations demonstrate the effects of a sustained weight increase from 30g to 60g before a decrease to 0g. The last test was conducted with the servo at 9 duty cycles, while the duty cycles for the second servo were set to 2 to 6. Finally, the data reveal a sustainable weight increase of just 20g to 30g before dropping 0g. Due to the mechanism's limitations and the angles that can be reached when reclining, the remainder of the servo 1 duty cycle that is not listed in the table is regarded as being unable to carry a load. As a result, even if there is an object on the loading base, it will fall to the ground because gravity effects were present.

4.4.2 Different gradient of joints with sustainable weight

Based on the recent testing, different combination of duty cycle from servo 1 and servo 2, allow the mechanism to carry heavier weight in different degree. It does not have a fix theory to determine the heaviest load can be applied on specific gradients of joints. In fact, through all the results, the heaviest weight that can applied for different gradients of joints can be proved.

No.	Possible duty cycle	Possible duty cycle	Sustainable weight
	of servo 1	of servo 2	(g)
1	4	7	100
2	5	5	60
3	6	2	70
4	7	4	130
5	8	3	60
6	9	3	30

Table 4.7Table for servos possible duty cycle with highest sustainable weight

According to the results shown in the table, the mechanism's maximum sustainable weight, with servos 1 and 2 placed in positions 4 and 7, is 100g. The mechanism can support 60g of weight while servos 1 and 2 are operating at a duty cycle of 5. Combining servos 1 in 6 and 2 in duty cycle allows the mechanism to support a weight of 70g. The next step is to adjust servos 1 and 2 to 7 and 4 duty cycles, respectively, enabling the mechanism to achieve its maximum sustainable weight of 130g from all other gradients that could be applied. Then, servo 1 and servo were set to 8 and 3 duty cycles, respectively, and the mechanism's maximum sustainable weight for this combination was 60g. Last but not least, servos 1 and 2 have been tuned to 9 and 3 duty cycles, respectively, which only permits the mechanism to support 30g weight. Since both joints are kept in the centre of the mechanism's body, the joints are more rigid and less affected by momentum, as can be seen from all the findings, the combination of servos 1 and 2 with duty cycles of 4 and 7, respectively, allow the mechanism to sustain a maximum load of 130g, but it is not suitable while the robot travelling around, due to the height of it may cause greater friction, and it may cause the robot from losing stability.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter discusses about the conclusion and recommendations. Conclusion will be provided according to the data collections from all the testing that already been done. The time taken to complete every testing were recorded by phone timer and converted in unit seconds. Thus, the measurements have been clarified and analysed. By the end of PSM 2, this project had achieved the goal it had set on its own.

5.2 Conclusion

In this project, it could be concern on the effect of power consumption due to this robot consume a lot of power. The autonomous parcel collector robot using the coloured tape method with an infrared sensor to perform line following method, despite the fact that it is easily damaged. Furthermore, a well-thought-out design makes a robot structure more suited and capable to allow it to hold parcels while moving in a more stable manner. A schematic diagram that has been produced and verified in advance can help to prevent numerous electrical failures that can arise when device components are installed directly.

The targets from this project has achieved which are to develop a prototype of an autonomous parcel collector robot for the housing are with slope less garage, which trying to solve the problem of collecting parcel from courier when buyers fail attempt to collect parcel at house.

5.3 Recommendations

From this prototype, the purpose is to help out the user from the general concerning on the parcels been damage, missing, and need to book for extra delivery attempt or purposely attend to certain collection point for their parcel. From the data collected and all the incidents have been met during the testing, there are still lot of improvement can be done to allow this parcel collector robot to perform more efficient and optimize. Hence, several recommendations and suggestions provided as below to reduce the exposures in this study.

- 1. A better mechanism for both loading bay, chassis, wheels allow the parcel collector to travel in more stable manner, and the loading bay may sustain heavier parcel.
- Better infrared sensor module provide more precise line detection to avoid miss react while the parcel collector move in higher speed.
- 3. Power consumption of this parcel collector are considered high. A better, and stronger power source are required to allow the parcel collector work in longer duration and able to adapt different kind of terrains

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APPENDICES

Appendix A Gantt Chart PSM1

weeks	Week	Week	W eek	Week	Week	Week	Week	Week	Week	Week	Week	Week	Week	Week	Week
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Activities				AY C.											
Literature			MAG		4										
Reviews		13	7		100										
		- 3			No.	1									
Devices		X				6									
Familiarization		E E										1			
		-													
Data Analysis		Y.				- 1									
			Sa.												
			"AIN	1		- 12									
Research								1							
Methodology		5	Mal.		1.	16	-	\leq	S. 19		1.12	i. al			
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Software															
Drawing and		1.1.5	1570-1	DOLT		ZALL	C & 1		ANC			17.6			
algorithm		UN	IVE	SII	IIE	NNI	AL	MAL	STA.	IA N	IELA	INA			
design Formation of															
Chapter 1, 2, 3.															
4,5															

Appendix A Gantt Chart PSM2

weeks	Week 1	Week 2	W eek 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14
Activities		1.1.1	4/		Ma.									
Devices testing & instrument		EKIN		_	- F				P					
Electrical design & Mechanical design		TITIO					U				N			
Discussion with supervisor		4	Ja		10		.	/				ial		
Formation of Chapter 1, 2 and 3					I TE	KNII	 (A I			2		NAN		
Creation of Chapter 4, 5 & poster		UN	IVLI	(OII		CIVIT	VAL.	MAL	AIG	17-4 19		INA		
Preparation for presentation														