

**DESIGN AND DEVELOPMENT OF VISION GUIDED
HEIGHT ADJUSTABLE CONVEYOR PLATFORM ON
AUTOMATED GUIDED VEHICLE**

MUHAMMAD RAFIQ BIN ABDUL RAHIM

B051410032

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2017



**DESIGN AND DEVELOPMENT OF VISION GUIDED HEIGHT
ADJUSTABLE CONVEYOR PLATFORM ON AUTOMATED
GUIDED VEHICLE**

This report submitted in accordance with requirement of the University Teknikal Malaysia
Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering

(Robotics & Automation)(Hons.)

by

MUHAMMAD RAFIQ BIN ABDUL RAHIM

B051410032

930501-02-5005

FACULTY OF MANUFACTURING ENGINEERING

2017

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: **DESIGN AND DEVELOPMENT OF VISION GUIDED HEIGHT ADJUSTABLE CONVEYOR PLATFORM ON AUTOMATED GUIDED VEHICLE**

Sesi Pengajian: **2016/2017 Semester 2**

Saya **MUHAMMAD RAFIQ BIN ABDUL RAHIM (930501-02-5005)**

mengaku membenarkan Laporan Projek Sarjana Muda (PSM) ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. *Sila tandakan (√)

SULIT (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysiasebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)

TERHAD (Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

TIDAK TERHAD

Disahkan oleh:

Alamat Tetap:
BATU 2 ¾
PADANG TEMU
75050 MELAKA
MELAKA

Cop Rasmi:

Tarikh: _____

Tarikh: _____

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

DECLARATION

I hereby, declared this report entitled “Design and Development of Vision Guided Height Adjustable Conveyor Platform on Automated Guided Vehicle” is the results of my own research except as cited in reference.

Signature :

Author's Name : MUHAMMAD RAFIQ BIN ABDUL RAHIM

Date : 22 June 2017

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotics & Automation) (Hons.). The members of the supervisory committee are as follow:

.....
(DR. MOHD HISHAM BIN NORDIN)

ABSTRAK

Kenderaan berpandu automatik (AGV) adalah satu sistem automasi yang merupakan kenderaan tanpa pemandu, kebanyakannya digunakan dalam pemasangan 'Flexible Manufacturing Systems' (FMS). Perkara utama dalam kajian ini adalah untuk membuat AGV dengan keupayaan menyesuaikan ketinggian platform penghantar yang berada di bahagian atas AGV. Perisian seperti SOLIDWORK akan digunakan dalam tujuan ini untuk mereka bentuk beberapa pilihan dan seterusnya memilih satu yang terbaik berpandukan kriteria dan spesifikasi tertentu. Kajian ini terdiri daripada integrasi elektrik, mekanikal, dan reka bentuk disamping untuk membina dan menguji AGV termasuklah mekanisma seperti sensor, kamera penglihatan (pixycam), penghantar dan jack pengangkat elektrik untuk menjadikannya lebih fleksibel. Pengawal mikro seperti Arduino Uno dan Arduino Mega telah dikaji, diprogramkan dan dipasang sebagai kawalan daripada AGV. Ia telah direka dengan cara yang mudah untuk membuka atau diubah suai untuk menjadi lebih cekap. Di dalam projek ini, beberapa ujian telah dijalankan untuk menguji dan menganalisis prestasi AGV. Salah satu eksperimen yang telah dijalankan, warna hijau yang mempunyai saiz penanda 5cm x 5cm dipilih untuk pengesanan kamera menggunakan kamera Pixycam kerana keberkesanan warna ini untuk dikesan oleh kamera dan mencegah dari warna yang tidak dikehendaki berbanding warna lain. Di samping itu, ujian beban seberat 30 kg (maksimum) telah dipilih dan diuji dalam eksperimen ini untuk memerhati pergerakan (masa yang diambil) ketinggian boleh laras untuk AGV ini untuk bergerak ke atas atau bergerak ke bawah. Akhir sekali, ujian AGV mengikut garisan telah dijalankan pada kelajuan tertentu untuk bergerak lurus dan pada masa yang sama selaraskan ketinggian platform penghantar AGV dengan ketinggian platform penerima untuk proses menghantar dan menerima barang.

ABSTRACT

An automated guided vehicle (AGV) is an automation system which is a driverless vehicle, mostly used in several Flexible Manufacturing Systems (FMS) installations. The main item in this study is to make an AGV with the capability of adjusting the height of a conveyor platform attached on it. Software such as SOLIDWORK will be used in this purpose basically to design several options and to choose the best by following specific criteria and specifications. This study includes the integration of electrical, mechanical, and design for build and testing of the AGV including mechanisms such as sensors, vision camera (pixycam), conveyor and electric jack lifter to make it more flexible. Microcontrollers such as Arduino Uno and Arduino Mega have been studied, programmed and installed as the controller of the AGV. It has been designed in a way that can easily be disassembled or modified to become more efficient. For this project, several testings have been conducted to test and analyse the performance of the AGV. In this experiment, green colour which have marker size of 5cm x 5cm are selected for camera detection using Pixycam camera due to the effectiveness for camera to detect and prevent from unwanted colour compared to other colours. Besides, load testing of 30 kg (maximum) have been selected and tested in this experiment to observe the performance (time taken) of height adjustable for this AGV to move upward or move downward. Finally, line following testing have been conducted at a certain speed to move straight and to align the AGV conveyor height with the receiver conveyor's height for loading and unloading process.

DEDICATION

Specially dedicated to my beloved family, supervisor, Perodua supervisors industrial training(PEMSB), lecturers, seniors and friend who have guided and inspired me through my journey in education. Also thank you to their support, beliefs and motivation.

ACKNOWLEDGMENT

In preparing this progress report, many people have contributed towards my understanding and thoughts. First and foremost, I would like to express my heartfelt gratitude to my supervisor, Dr. Mohd Hisham Bin Nordin for his encouragement, guidance and enthusiasm given throughout the progress of this project. Without his continued support and interest, this project would not have been the same as presented here. My next appreciation goes to my family who has been so tolerant and supports me all these years. Thanks for their encouragement, love and emotional support that they had given to me. My sincere appreciation also extends to all my colleagues, and others who have provided assistance at various occasions and gave useful tips. Unfortunately, it is not possible to list all of them in this limited space.

TABLE OF CONTENTS

Abstrak	I
Abstract	i
Dedication	ii
Acknowledgement	iii
Table of content	iv
List of Tables	vii
List of Figures	viii
List of Abbreviations	x
List of Symbols	xi
CHAPTER 1: INTRODUCTION	1
1.1 Background of the Study	1
1.2 Problem Statement	3
1.3 Objective	4
1.4 Scope	4
1.5 Project Significance / Importance of Study	5
1.6 Organisation of the Report	5

CHAPTER 2: LITERATURE REVIEW	6
2.1 What is Automated Guided Vehicle	6
2.2 Type of AGV	9
2.3 Component of AGV	13
2.4 Guiding Principle of AGV	14
2.5 AGV with Loading and Unloading Mechanism	16
2.5.1 Loading and Unloading Mechanism	18
2.6 Control of Height Adjustable Platform Mechanism	20
2.7 Height Detection Method	23
2.7.1 Type of Cameras	23
2.8 Controllers, Programming and Interfacing	26
2.8.1 Micro C PRO for PIC	26
2.8.2 Raspberry Pi	27
2.8.3 Arduino	29
CHAPTER 3: METHODOLOGY	31
3.1 Introduction	31
3.2 Research Methodology	32
3.3 Planning of the Project	35
3.4 Designing the AGV with Lifting Mechanism	35
3.4.1 Preliminary Design of Conveyor Platform AGV	36
3.4.2 Pugh Selection Method	44
3.4.3 Block Diagram of AGV	48

3.4.4	Operational Flow Chart	50
3.5	The Final Design of AGV	51
3.6	Design of Experiment (DOE)	54
3.6.1	Detection Method	54
3.6.2	Aligning the AGV Conveyor Height with the Receiving Conveyor's Height	56
3.6.3	Schematic Diagram of Electrical Component of AGV	56
3.6.4	Fabrication, Assembles, Wiring of AGV	61
3.7	Summary / Expected Result	63
CHAPTER 4: RESULT AND DISCUSSION		66
4.1	Product of AGV	66
4.2	Colour / Camera Detection Using Pixycam Camera	71
4.3	Suitable Marker Size	72
4.4	Aligning the AGV Conveyor Height with the Receiving Conveyor's Height	75
4.5	Programming / Operation / Testing	78
4.5.1	Line Following Test	78
4.5.2	Load Testing	80
4.5.3	Direct Current Motor Analysis	81
4.6	Conclusion	82
CHAPTER 5: CONCLUSION AND RECOMMENDATION		83
5.1	Conclusion	83
5.2	Recommendation for Future Work	84

REFERENCES

APPENDICES

LIST OF TABLES

2.1	Specification of electric car jack	23
3.1	Parts of design 1	37
3.2	Advantages and disadvantages for design 1	38
3.3	Parts of design 2	40
3.4	Advantages and disadvantages for design 2	41
3.5	Parts of design 3	43
3.6	Advantages and disadvantages for design 3	44
3.7	Translation table	45
3.8	Screening	46
3.9	Ranking of the design	47
3.10	List of parts/components	52
3.11	List of the colours	55
3.12	Marker size of colour	55
3.13	Height alignment testing	56
3.14	Electronics part component	57
3.15	Fabrication / assembles of project (AGV)	61
4.1	Electrical component of AGV wiring	68
4.2	3D printing part	70

4.3	List of the colours	71
4.4	Marker size of colour (green)	72
4.5	Height alignment testing	75
4.6	Load test	80
4.7	Direct current motor Speed	81

LIST OF FIGURES

1.1	Industrial AGV	2
1.2	Lifter and Turn Table	3
2.1	Trays vehicles	7
2.2	Pallet vehicle	7
2.3	Carts vehicle	7
2.4	AGV systems	8
2.5	AGV towing vehicle	9
2.6	Unit load carrier vehicle	10
2.7	AGV pallet trucks	11
2.8	AGV electric forklift truck	12
2.9	AGV light load transporter	12
2.10	Component of an AGV system	14
2.11	Belts conveyor	18
2.12	Roller conveyor	19
2.13	Electric power hoist	20
2.14	Pneumatic cylinder	21
2.15	Electric car jack	22
2.16	Monochrome camera	24

2.17	Pixycam camera	25
2.18	Raspberry Pi Night Vision Camera	25
2.19	MikroC PRO for PIC IDE	26
2.20	Micro lab for PIC	27
2.21	Raspberry Pi	28
2.22	Screenshots programming raspberry pi	28
2.23	Arduino board	29
2.24	Arduino IDE Default Window	30
2.25	Arduino IDE: Uploading Blink	30
3.1	Flowchart of the process	33
3.2	Four view (front, side, top, isometric)	36
3.3	Design 1 of AGV	36
3.4	Four view (front, side, top, isometric)	39
3.5	Design 2 of AGV	39
3.6	Four view (front, side, top, isometric)	42
3.7	Design 3 of AGV	42
3.8	Connecting Block diagram AGV	48
3.9	Operational flow chart	50
3.10	Isometric view (Final design)	51
3.11	Fritzing diagram height adjustable detection (pixycam)	59
3.12	Schematic diagram height adjustable detection (pixycam)	60
3.13	Fritzing diagram line following sensor	60
3.14	Schematic diagram line following sensor	61

3.15	Expected result operation of AGV	64
4.1	Perspective view of AGV	67
4.2	Graph marker size of colour (green)	73
4.3	Green colour test	73
4.4	Green colour detected	74
4.5	Serial monitor	75
4.6	Loading and unloading station	79
4.7	Loading part	79
4.8	Unloading part	79
4.9	Loading and unloading junction	79
4.10	Graph time taken (minutes) vs load (kg)	80

LIST OF ABBREVIATIONS

AGV	-	Automated Guided Vehicle
CCD	-	Charge coupled device
ISO	-	International Standards Organization
SPI	-	Serial Peripheral Interface
UART	-	Universal Asynchronous Receiver/Transmitter
LED	-	Light-emitting diode
CSI	-	Camera Serial Interface
ANSI	-	American National Standards Institute
PIC	-	Peripheral Interface Controller
COFF	-	Common Object File Format
USB	-	Universal Serial Bus
DNS	-	Domain Name System
NTP	-	Network Time Protocol
CPU	-	Central processing unit
IDE	-	Integrated development environment
PWM	-	Pulse Width Modulation
ICSP	-	In-Circuit Serial Programming
PSM 1	-	Projek Sarjana Muda 1
PSM 2	-	Projek Sarjana Muda 2
AISI	-	American Iron and Steel Institute

LIST OF SYMBOLS

cm ²	-	Centi Metre Square (Area)
lbs or lb	-	Pounds
ft	-	Feet
ft/min	-	Feet per minutes
m/s ²	-	Metre per second squared
mV	-	Millivolts
°C	-	Degree Celsius
mA	-	Milli Ampere
mm	-	Millimetre
V	-	Volt
m	-	Meter
MPa	-	Megapascal
F	-	Farad

CHAPTER 1

INTRODUCTION

1.1 Background Of The Study

Nowadays, several types of industries have practiced the technology of automated guided vehicle (AGV) as the medium or transportation for material or product from one location to another location. The technology of AGV has been in existence since 1953, and this system was first introduced in the 1960s for industrial applications (Yaghoubi et al. 2012).

However, more than fifty years this system are known, a time in which various improvement have been made between actuators and energy supplies to entirely new sensor concepts. But these improved technologies are available mostly to the developed countries where applications of robotics are commonly applied. For the developing or underdeveloped countries, application of robotics is not very famous even in the field of industry. Low labour cost plays an important role for this situation in such countries. However, when the production speed and accuracy are not to be sacrificed, application of automation gives a solution. In the other hand, this is also true for cases with potentially hazardous industrial environments which may harm human workers (Ali et al. 2010).

Besides, the advantages of this system of automation technology can increase the reliability and reduced operating cost, means that it can reduce the manpower and also avoid from injuries in order to prevent loss of human lives by limiting human involvement in the

plant area. Currently, this system is widely used in industry to have a better process workability and completing the process as per schedule. There are many types of AGVs that can be seen at much type of industries, but mostly are used as transportation for supplying parts, materials, and products. The AGVs are capable of performing the tasks with fully automated at low cost. But in the other situation, these systems also need the backup AGVs in case the current AGV are not functioning or not good. This is to avoid from interrupting the process and effecting the production.



Figure 1.1: Industrial AGV (August 5, 2015, the fabricator.com)

The application of automation components such as line following sensors, proximity sensor and the others are mostly used in AGV compared to the system which use vision guided and height adjustable conveyor platform on AGV. Currently, the industries such as automotive industry are mostly using separated conveyor platform with AGV. Therefore, lifter, turntable, and conveyor are separated with AGV to supply the parts in production as shown in Figure 1.2. It shows (Figure 1.2) that turn table and lifter are separated which to supply the parts to the production line (conveyor line). In this case it uses sensors such as limit switch as a signal to receive or send the parts for the next process. However, the parts are supplied from the manpower manually using the trolley and these processes are repeated.

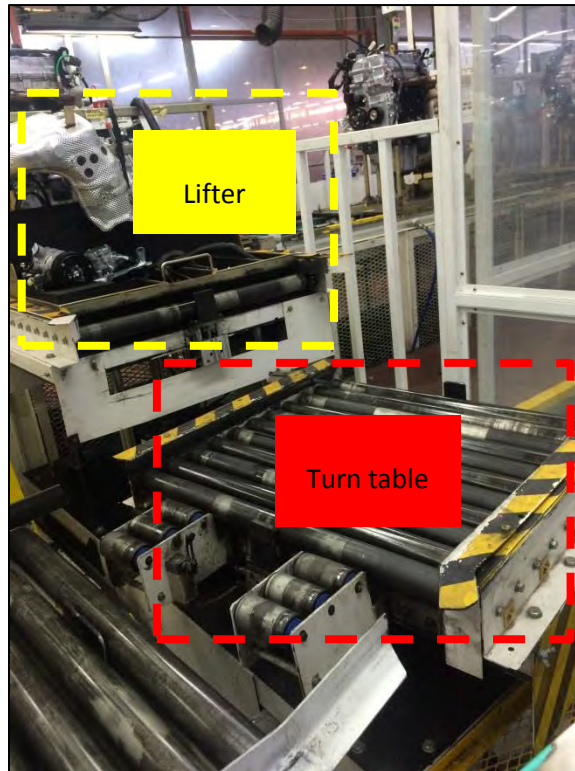


Figure 1.2: Lifter and Turn Table

1.2 Problem Statement

The current automation is not communizing the AGV, conveyor and lifter according the process tact time, efficiency and human factor. At manufacturing system, manual trolley vehicle are used to transport the parts or components from the rack and deliver it at the unloading station manually and this process is performed repeatedly. This method will affect the tact time and efficiency of the production, therefore the process become inconsistent because of the operators need to load the parts into the trolley and unloading it at the lifter and turntable station for the next process. This method will be done repeatedly and can affect the human health due to human factor because of manually parts loading it by operator. It can cause the operator to have a back pain and this can influence the efficiency of the process.

Therefore, for loading, unloading, moving or transporting horizontally any kind of raw materials, products or parts in assembly lines or manufacturing lines should be

developed. Utilization of components such as sensors, vision guided, conveyor, lifter and others will be used in this study by combining the electrical, mechanical and design as countermeasure in this case.

1.3 Objective

The main objectives for this study are:

- To design and develop a height adjustable mechanism for conveyor platform on AGV with camera attached.
- To program and control the AGV
- To test and analyse the performance of the AGV.

1.4 Scope

The scopes for this study are:

- The AGV will only be programmed to move in straight line with guided line or navigation system.
- It will use Pixycam camera with arduino microcontroller which is readily available in the lab.
- The camera is fixed and can only detect colour.