

DESIGN AND PROTOTYPE LOADING AND UNLOADING MECHANISM
FOR AUTOMATED GUIDED VEHICLE

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A report submitted in fulfilment of the requirement
for the award of Degree of
Mechanical Engineering with Automotive

Faculty of Mechanical Engineering
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NOVEMBER, 2009

SUPERVISOR'S DECLARATION

We hereby declare that we have checked this project and in our opinion this project is satisfactory in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering with Automotive.

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

Signature

Name:

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Especially for

My beloved family

And

All my friends

For their support and help

ACKNOWLEDGEMENTS

I am grateful and would like to express my sincere gratitude to my supervisor En. Wan Sharuzi b. Wan Harun for his germinal ideas, invaluable guidance, continuous encouragement and constant support in making this research possible. He has always impressed me with his outstanding professional conduct, his strong conviction for education. I appreciate his consistent support from the first day I applied to choose the project to these concluding moments. I am truly grateful for his progressive vision about my training in the development of the project, his tolerance of my naïve mistakes, and his commitment to my future career. I also would like to express very special thanks to En Nafrizuan bin Mat Yahya and En Fadhlur Rahman bin Mohd Romlay for their suggestions and co-operation throughout the study. I also sincerely thanks for the time spent proofreading and correcting my many mistakes.

My sincere thanks go to all my classmates and all of the staff of the Mechanical Engineering Department, UMP, who helped me in many ways and made my stay at UMP pleasant and unforgettable. Many special thanks go to housemates for their excellent co-operation, inspirations and supports during this study.

I acknowledge my sincere indebtedness and gratitude to my parents for their love, dream and sacrifice throughout my life. I cannot find the appropriate words that could properly describe my appreciation for their devotion, support and faith in my ability to attain my goals. I would like to acknowledge their comments and suggestions, which was crucial for the successful completion of this study.

ABSTRACT

Automated Guided Vehicle or AGV is one of material handling equipment that has been used widely in most manufacturing industry today as it provides more flexibility to the system. The basic concept of the AGV incorporates battery-powered and driverless vehicles with programming capabilities for path selection and positioning. They are equipped to navigate a flexible guide path network that can be easily modified and expanded. This project is focusing on the prototype the loading and unloading mechanism for the AGV, the AGV are needed to specify certain criteria that is lightweight, automatic operated and able to transport the acrylic. This loading and unloading mechanism operated using ballscrew as the movement mechanism and suction cup with vacuum pump as the adhering mechanism. The frame and main material to fabricate this AGV prototype are using the aluminium to minimize weight of the AGV. The application of the AGV in the real world application will help human and reducing cost in repetitive movement transportation activities.

ABSTRAK

Kenderaan panduan automatik adalah salah satu daripada kelengkapan pengendalian barang yang telah digunakan secara meluas di dalam sektor perindustrian kerana ianya menyediakan lebih kemudahan kepada sistem. Konsep asas kenderaan panduan automatik merangkumi bateri, dan kenderaan tanpa pemandu dengan kepayaan perisian untuk pemilihan jalan dan kedudukan. Kenderaan ini dilengkapi untuk mengemudi jalan yang diarahkan dan ianya mudah diubah dan dipanjangkan. Projek ini mengfokuskan di dalam penghasilan mekanisma mengangkut dan memunggah untuk kenderaan panduan automatik, kenderaan panduan automatik ini hendaklah memenuhi beberapa kriteria iaitu, ringan, beroperasi secara automatik dan kebolehan mengangkut akrilik. Mekanisma mengangkut dan memunggah ini beroperasi dengan menggunakan skru bebola sebagai mekanisma pergerakan dan pad sedutan yang dihubungkan dengan pam vakum untuk mekanisma melekap. Rangka dan bahan utama untuk menghasilkan kenderaan panduan automatik ini menggunakan aluminium sebagai bahan untuk mengurangkan berat kenderaan ini. Aplikasi kenderaan panduan automatik ini di dalam kehidupan sebenar boleh membantu manusia dan mengurangkan kos dalam aktiviti penghantaran yang berulang-ulang.

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CHAPTER 1

INTRODUCTION

1.1 Project background

Automated guided vehicles (AGVs) are commonly used in facilities such as manufacturing plants, warehouses, distribution centers and transshipment terminals. AGV can be referred as mobile robots owing to their reprogrammability. The purpose of AGV is to help reduce costs of manufacturing and increase efficiency in a manufacturing system. It also involved the movement of tools, raw material and work in process between station or into the storage. These movements must be safely, accurately, efficiently and without any damage to the materials. It is an important system and in element to integrate manufacturing facilities

In this project to build an AGV to transport the acralyte during laser cutting process, project team have been divided into three different specialize which is, loading and unloading mechanism, AGV control system and mechanical part of AGV. The essential capability of this AGV is ability transfer loads (load and unload) to location through path under computer control by programming.

1.1.1 Loading and unloading mechanism.

The loading and unloading mechanism for this agv includes the vacuum sucking unit for lifting the acralyte by vacuum sucking the acralyte corresponding to a position of working place, a loading mechanism for moving, move the sucking unit which has vacuum sucked the acralyte to the laser cut machine and an unloader for carrying another acralyte.

1.2 Project Objectives

The objectives of the project that need to be achieved are:

- 1.2.1 To study basic requirements of loading unloading mechanism for AGV application..
- 1.2.2 To design a loading unloading mechanism for AGV application.
- 1.2.3 To fabricate a loading unloading mechanism for AGV application.
- 1.2.4 To assemble loading unloading mechanism into AGV main body.

1.3 Problem statement

This AGV is designed to avoid the operator from expose with the fume that produce during laser cutting operation , according to material safety data sheet(MSDS) the fume is dangerous to health if it expose directly to the operator besides that there are many practical engineering problems for which we can not obtain exact solutions to get a better result in daily operation. Either in industry,studying or manufacturing field,all need efficient material handling system. Material handling is an integral part of any manufacturing activity.

Given the high costs involved in the equipment and the safety issues, it is imperative to design a good material handling system. The automated guided vehicle system is an important element in the computer integrated manufacturing facility. Automated guided vehicles provide considerable advantages as compared to other material handling equipment. Design concerns involve issues regarding the flow path design and the number of vehicles in the fleet. There are several ways to avoid the problem:-

- 1.3.1 By doing the cutting process remotely outside room.
- 1.3.2 Improve room ventilation system.
- 1.3.3 Anytime during and immediately after cutting there is no operators are allowed to enter the room.
- 1.3.4 Operator must wear PPE during operate the machine

1.4 Scope of project

In order to achieve the project objective, the following scopes are identified:

- 1.4.1 Design AGV cad model using SOLIDWORKS 2006.
- 1.4.2 Analysis the design using ALGOR.
- 1.4.3 Fabricate prototype of AGV
- 1.4.4 Assemble the mechanism into AGV main body
- 1.4.5 Transport acrylic (500x500) 0.85kg weight

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter is discussing on some literature that give information about automated guided vehicle (AGV) and show how this AGV have been fabricated.

2.2 Material handling

There are many solution in material handling process in industry that applied handling system in order to reduce and optimization in time handling. In Material Handling Systems, Designing for Safety and Health book, state that the handling of all types of materials may manifest itself in the individual worker's effort to lift and move material using large industrial crane[1]. Almost every industrial sector has to address material issues, especially workplaces moving material in and products out on a just-in-time schedule. improper handling and storage of materials can result in costly injuries.

Material include many things such as boxes, parts or equipment of steel beams etc. The efficient handling and storage of material in vital to the function of industry. MH provides for the continuous flow of raw material, parts and products throughout the workplace and assure that materials and products are there when they are needed. Handling equipment in modern container terminals is increasingly becoming automated. As the equipment is unmanned and operator intervention is normally not available, efficient scheduling is crucial to

achieve satisfactory performance[1]. If this is done properly, the resulting productivity gains can result in large cost savings for the terminal operators, an important consideration in view of the large financial investment required in terminal equipment.

Material handling does not add value to the product but only cost. Thus the objective of material handling is the efficient movement of goods for the on-time delivery of correct parts in exact quantities to desired locations in order to minimize associated handling costs. Material handling equipment can be classified according to the movement mode: above-floor transportation (e.g., belt conveyors, trucks, etc.), on-floor transportation (e.g., chain conveyors), and overhead transportation (e.g., cranes)[2]. In the following sections, we will review industrial trucks (including automated guided vehicles), conveyors, and industrial robots as the primary mechanized or automated material handling equipment. Material handling is an integral part of any manufacturing activity. The material handling is a variety of advanced technologies are now emerging to expand the capabilities of computer controls into the creation of automated factories[3]. The automatic guided vehicle system is an important element in the computer integrated manufacturing facility.

2.3 Review on automated guided vehicle (AGV)

Automated guided vehicle (AGV) is a driverless vehicle for repetitive movements for transportation. This mobile transport unit is battery powered and typically used in factories and warehouse. The first AGV was developed by Barrett Electronics, U.S.A., in the early 1950s and installed at Mercury Motor Freight in 1954. These towing vehicles received poor acceptance by the manufacturing industry owing to their limited controllers and difficulty in their reprogrammability[4]. The subsequent period of 1960 to 1980, however, was marked by the introduction of a large number of AGVs in Europe, which was further accelerated during the following decade because of better (compact and reliable) onboard computers and electronics. As expected, the automotive

industry such as Volvo, Fiat was the leader in the use of AGVs (more than 50% of over 10,000 installations)[4].

There are many benefits by using AGV as a material handling equipment, such as it can reduce product damage because AGV is design to transport the product safely by follow the programmable path, it also is a user friendly because the path and system can be modified or expand easily according to user will. Besides that, AGV also will improve plant logistic by deliver the product upon demand and improve response time, and last but not least, by using AGV aisle traffic will reduce and this will cause an improvement to the plant safety[5].

The AGV system component is, vehicle(AGV), software, batteries/charging unit and integration. AGV can be divided into 3 standard type, forked, tugger/tow and unit load, but AGV can be design according to needs of specific industries and unique material handling challenge.

2.3.1 Forked vehicle.

Forked vehicle is very popular type of AGV because of their versatility and flexibility, it can handle many type of load such as pallet, racks, trays and cart because of that ability forked vehicle are an excellent solution for applications where changes to the facility are expected during the life of the AGV system. These AGVs can easily be reconfigured to handle new and/or additional tasks[6] . This type of vehicle is best when interfacing with a few different type of pick and drop point for example, conveyor, floor and racking stand.



Figure 2.1: Forked vehicle.

2.3.2 Tow vehicle.

Tow AGV is designed to pull wheeled cart and dollies. This vehicle is the most productive form of AGV because it hauls more loads per trip than others AGV types[6]. Many tow types do not operate in reverse and instead operate in either a loop or they have turnaround loops at any end points of the AGV road system. The carts can be loaded automatically or manually. Tow vehicle AGVs are available in several different towing capacities and can even be equipped with an operator station for cases where customers may desire occasional man-aboard operation.



Figure 2.2: Tow AGV

2.3.3 Unit load vehicles

Sometimes these vehicles are also known as a 'top carrier', where the load rests on top of the vehicles. Unit load applications in the Food and Beverage, as well as the Pharmaceutical industry, provide timely and controlled transportation coupled with product identification and tracking of key ingredients necessary for a fully integrated and automated material delivery system[6]. Unit load vehicles are usually divided into two decks: a lift deck design provides an ideal solution for applications where a large number of pickup and deposit stations are utilized. Here the vehicle will drive into a station and either lift the load from that station or deposit the load to that station, and the other deck is a conveyor deck, which is generally used when all load transfers are to or from a stationary conveyor.



Figure 2.3: Unit load vehicle.

2.4 AGV Classification

Modern AGV systems differ from the classic ones. Rather than using fixed paths, many modern AGV are free ranging, which means the path of the vehicle are software programmed and can be change relatively easy when new stations or even flows are added. Modern technology also allows the vehicle to make decisions on its own compare to the past when control was perform by the central controllers. This leads to adaptive, self-learning system of the AGV (Tuan Le-Anh and De Koster). In this section, AGVS classification according to the journal by Peters et al will be described. According to the journal, the automated guided vehicle system can be divided into three basic levels such as below:

1. Guidepath determination
 - a) Static path
 - i. Unidirectional
 - ii. Bidirectional
 - b) Dynamic path
2. Vehicle capacity -
 - a) Single unit load
 - b) Multiple loads
3. Vehicle addressing mechanism
 - a) Direct address
 - b) Indirect address

2.4.1 Guidepath Determination

AGVS guidepaths can be determined in two ways, which are static or dynamic determination. Static guidepath system, it can be further divided into unidirectional and bidirectional systems. In static guidepath, the vehicles use a set of predetermined paths between possible origins and destinations. Variety of guidance mechanisms can be used such as wires embedded in the floor, chemical or optical sensors, dead reckoning and mapping of the paths by using software.

In unidirectional system, the vehicle will only travel in single direction following single predetermined lane. If many vehicles are used, each of them will have its own lane or path and each of the lanes is controlled independently even though the directions are different. This type of system is easier to control as deadlocking and collision problems can be avoided. In bidirectional system, vehicles can travel in forward and backward movement using the same guide path. In order to do so, a turning or turnaround point is specified for the vehicle. Although this type of system can bring improvement in productivity and less vehicle usage, however, the control system is complex since multiple vehicle share the same guidepath and must be able to avoid deadlock' situations.

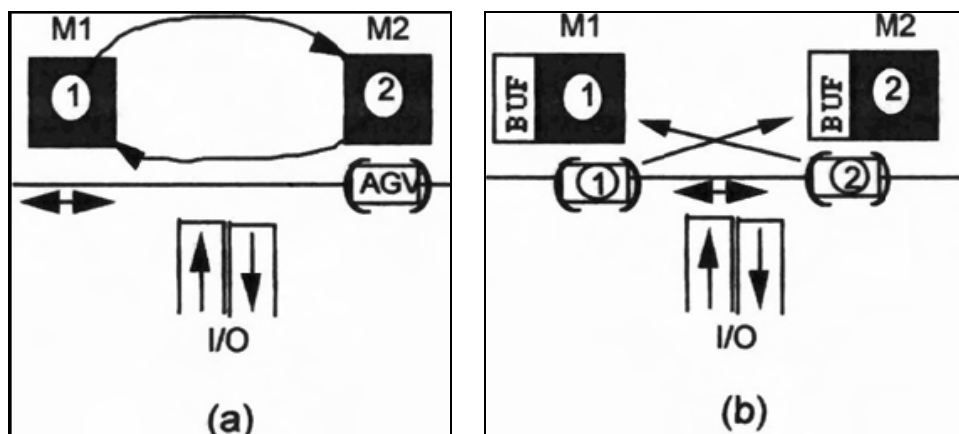


Figure 2.4: Deadlock Situations in Manufacturing Systems: (a) Part Routing Deadlock;(b) AGV Deadlock (Peters *et al*)

Dynamic guide path system use fully autonomous vehicles, which are capable of determining its path through obstacle detection and avoidance systems. In this system, the vehicle is given the destination, a location that the vehicle knows through coordinate system. The vehicle then determines its path from its current position to the desired position through its internal navigation scheme (Peters *et al*).

2.4.2 Vehicle Capacity

In automated guided vehicle system, the vehicle can be classified based on its load capacity, which is either single load or multiple load vehicles. System that use single load vehicle is known as single load system and if multiple load vehicles are used, it is known as the multiple load system. In a single load system, an empty vehicle will be assigned for a task for example taking a load and deliver it. From its current position; it will then travel to a station to pick up the load and then travel to the desired position to drop off the load. During performing its task, it is not interrupted with another assignment and will only move in path to pick up and drop off the load. In multiple load system, the task of the vehicle is more complicated where the vehicle may be interrupted while