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BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **DESIGN OF AUTOMATED GUIDED VEHICLE (AGV) FOR WORKPIECES TRANSPORTATION IN MANUFACTURING PLANT**

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirement for the degree of Bachelor of Manufacturing Engineering (Robotic and Automation) (Hons.). The member of the supervisory is as follow:

…….

(Project Supervisor)

(Prof. Dr. Bashir Mohamad Bin Bali Mohamad)

ABSTRAK

Laporan projek ini membentangkan kerja-kerja yang dilakukan pada rekabentuk dan permodelan mudah kenderaan berpandu automatik. AGV yang merupakan salah satu system yang mengendalikan peralatan yang telah digunakan secara meluas dalam industri pembuatan kebanyakan hari. Ini adalah kerana ia memberi lebih banyak kemudahan sistem pengendalian. Konsep asas AGV yang menggabungkan kenderaan berkuasa bateri dan tidak memerlukan dengan pengaturcaraan keupayaan untuk pemilihan laluan dan kedudukan. Ia dilengkapi untuk menavigasi dalam rangkaian laluan panduan fleksibel yang boleh diubahsuai dengan mudah dan berkembang. Perisian untuk mereka bentuk AGV yang dipilih berdasarkan pengetahuan penulis. Beberapa idea-idea rekabentuk telah dihasilkan dan dibahagikan kepada dua komponen utama iaitu kenderaan badan dan rangka struktur. Dari idea-idea ini direka bentuk, perbandingan telah dibuat untuk memilih idea Reka bentuk yang terbaik dari mereka bentuk AGV itu. Bahagian penting AGV direka berdasarkan spesifikasi dan keperluan bahagian-bahagian yang perlu dipasangkan padanya. Senarai semua bahagian perlu direka dan bahagian-bahagian yang standard dibentangkan dalam laporan ini. Bahagian-bahagian terperinci dan spesifikasi dibentangkan dalam solid model dengan dimensi yang memenuhi keperluan pembangunan masa hadapan. Analisis unsur terhingga (FEA) telah digunakan untuk menganalisis rekabentuk struktur AGV. Tekanan, anjakan, perubahan bentuk dan faktor keselamatan adalah diperolehi dari analisis dan dibentangkan. Untuk pembangunan masa depan, ia dicadangkan untuk fabrikasi dan menguji rekabentuk AGV. Daripada keputusan ujian, tindakan perlu diambil (jika perlu) untuk penambahbaikan Reka bentuk AGV.

ABSTRACT

This project report presents the work done on the design and soft modeling of automated guided vehicle. An AGV is one of a material handling equipment that has been used widely in most manufacturing industry today. This is because it provides more flexibility to the material handling 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. The software for designing the AGV is chosen based on the author knowledge. Several design ideas have been generated and divided into two major components which are the body vehicle and the structure frame. From these designed ideas, a comparison has been made to choose the best design idea from designing the AGV. The AGV important parts are designed based on the specification and requirement of the parts to be attached to it. The list of all parts needs to be fabricated and the standard parts are presented in this report. The detail of the parts and their specifications are presented in solid model with the dimensions which fulfills the requirement for future development. Finite element analysis (FEA) has been used to analyse the design of the AGV structure. The stress, displacement, deformation and factor of safety are obtained from the analysis and presented. For future development, it was suggested to fabricate and test the designed AGV. From the test result, action should be taken (if necessary) for further improvement of the designed AGV design.

DEDICATION

My special dedication to my beloved mother, Che Embun Binti Yaacob, for their loves and supports which never end and with the loves and supports given to me, I managed to go through 4 years of my study which full with challenges and hunches. To beloved friends of 4BMFA who have been with me through my journey in education. Also thank you for all the motivation and their beliefs towards me.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

AGV	-	Automated Guided Vehicle
CNC	-	Computer Numerical Control
CAD	-	Computer-Aided Design
CAM	-	Computer-Aided Manufacturing
CPU	-	Central Unit Processing
DC	-	Direct Current
FEA	-	Finite Element Analysis
GPS	-	Global Positioning System
RPM	-	Revolution per Minutes
PC	-	Personal Computer
3D	-	Three Dimensional
2D	-	Two Dimensional

CHAPTER 1

INTRODUCTION

1.1 Background of study

Basic Automated Guided Vehicle (AGV) technology is not a new technology. Fifty years ago when AGVs were first entered the market and industry were called driverless systems. Going through the years of development, advances in electronics have led to improvement in automated guided vehicles. Nowadays, the technology of AGV is widely used in environment to perform variety of task that involves automation. (Groover, 2000)

Figure 1.1: AGV application for warehousing industry
(Source: http://www.seegrid.com/industries/warehousing)

The automated guided vehicle is highlighted as a flexible transport vehicle for existing lines in variety industrial fields. An automated guided vehicle (AGV) is a vehicle that is equipped with automatic guidance system either electromagnetic or optically. This vehicle is capable of transportation of material, sorting and material handling work also handling dangerous materials. An AGV consist of one or more computer controller wheel based load carriers that run on the plant floor without the need for an onboard operator or driver. As it names was automated, this vehicle is programmed to handle operation on its own. (Junemann and Schmidt, 2000)

1.2 Problem statement

The problem on the manufacturing plant at Faculty of Manufacturing Engineering UTeM is that there is no automated guided vehicle (AGV) system to transport raw material from cutting process station using bandsaw machine to milling, turning, CNC and welding station. Figure 1.2 showed the condition of cutting process station and nearby stations.

Figure 1.2: The present condition between bandsaw machine and CNC machine at Faculty of Manufacturing Engineering (Source: AMC laboratory UTeM)

1.2 Project objective

1. To design an automated guided vehicle (AGV) for work-pieces transportation in manufacturing plant.
2. To develop a soft prototype of the above designed AGV.

1.4 Scope of the project

This project will cover the following scope:

1. The design an automated guided vehicle is limited to the maximum load that can be transport. The maximum load for this design is about 200N.
2. The application of this AGV is limited to the laboratory area of the block PFI-B, Faculty of Manufacturing Engineering Universiti Teknikal Malaysia Melaka.

CHAPTER 2

LITERATURE REVIEW

In this chapter, we will discuss more about Automated Guided Vehicle System, its classification, the vehicle load capacity, the vehicle itself and the application of the vehicle in material handling and industry. The reference sources and information are obtained from website, books, journals, articles, conference and magazine. This chapter is to enhance the knowledge of student about the project.

2.1 AGVs Classification

Modern AGV system differs from the classic one as described for instance in the book of Junemann and Schmidt (2000) and Tompkins et al. (2003) in several respect. 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 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 Peter et *al* will describe.

According to the journal, the automated guided vehicle system can be divided into three basic levels such as below:

i. Guided path determination
    a) Static path
        i. Unidirectional
        ii. Bidirectional
    b) Dynamic path

ii. Vehicle capacity

a) Single unit load
b) Multiple loads

iii. Vehicle addressing mechanism

a) Direct address
b) Indirect address

2.1.1 Guide path Determination

Automated Guided Vehicle (AGVs) guide paths can be determined in two ways, which are static or dynamic determination. Static guide paths system, it can be further divided into unidirectional and bidirectional systems. In static guide path, the vehicles use a set of predetermined paths between possible origin 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 predetermined lane. If many vehicle are used, each of them will have its own lane or path and each of the lane is controlled independently even through 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 guide path and must be able to avoid deadlock situation.

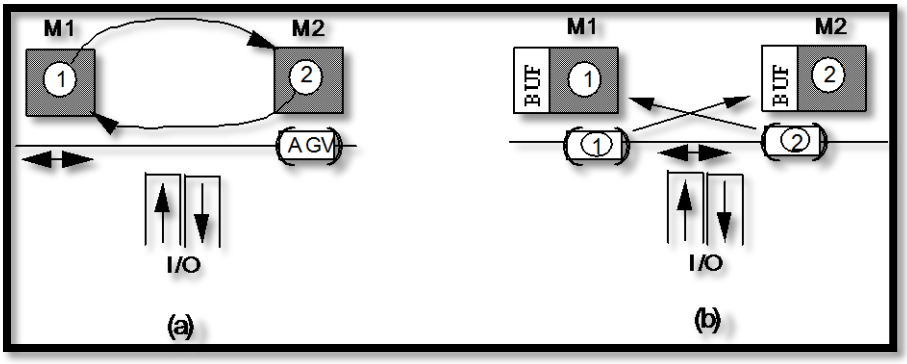

Figure 2.1: Deadlock situation in manufacturing systems: a) Part routing deadlock; b) AGV deadlock (Peter et al)

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

2.1.2 Vehicle Load 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, 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.

Figure 2.2: Single load vehicle
(Source: http://www.jbtc-agv.com/en/Solutions/Products/Unit-Load-Automatic-Guided-Vehicles-AGVs)

During performing its task, it is not in tempted 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 performing its task. It may stop to another station to pick up another load. In this type of system, the planning and scheduling functions of controller might be difficult as the plan and schedule must integrate the new task into previously assigned tasks. (Peter et al 1991)

2.1.3 Vehicle Addressing Mechanism

Vehicle addressing system in AGVs can be grouped into two, which are direct or indirect address system. In direct address system, any vehicle is allowed to visit any stations available in the same system. This system is much alike the taxi service. The planning function for this system routes vehicle from its current location to its destination considering the current status of the system. In other words the routes are not determined in advanced. Vehicles must be assigned to tasks since vehicle are not restricted to serve any particular station. The planning function might be complicated since the location of the vehicle is not known initially but only changes upon system changes.

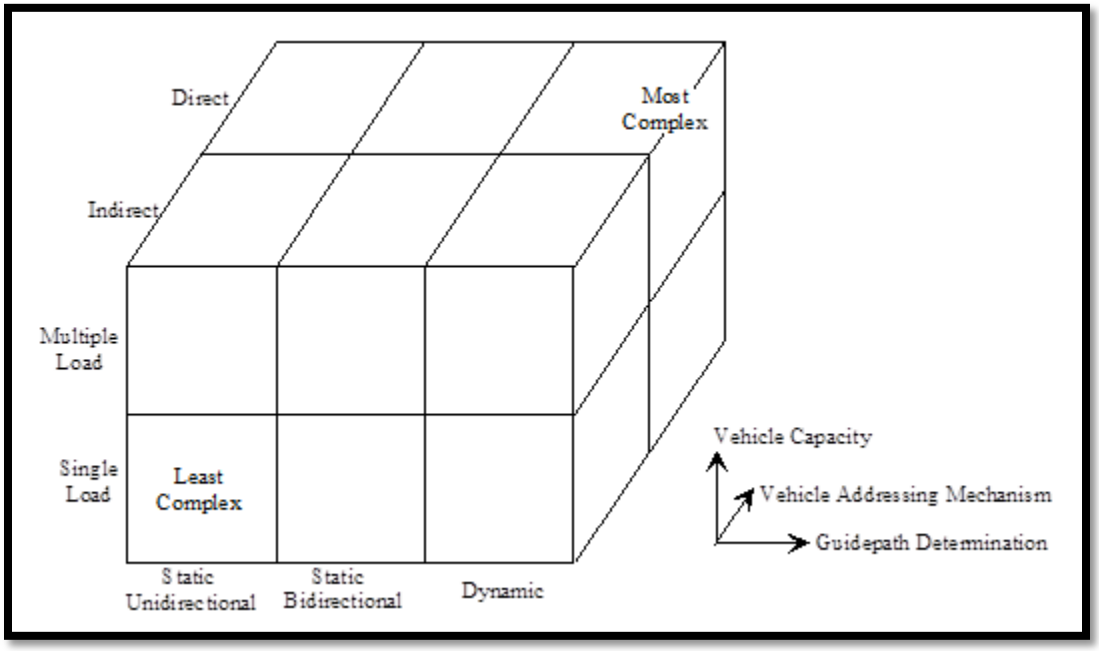

Figure 2.3: AGVS Classification Scheme (Peter et al)

In indirect address system, vehicles will stop at stations in a fixed sequence, which is more likely a bus service. The routes are predetermined as part of the system design, not one of

the controller planning function. Compare to direct address system, the dispatching in this system is straight forward. As the route of the vehicle is predetermined, it will pick up and drop off loads when it reach each stations in its route (Peter et al).

2.2 Automated Guided Vehicle (AGV)

According to (Groover, 1987), Automated Guided Vehicles (AGV) can be grouped into three categories as below:

1. Driverless train
2. Pallet trucks
3. Unit load carriers

2.2.1 Driverless Train

Driverless train basically consists of towing vehicle, which is the AGV that pull or more trailers forming a train. This type of AGV is used when heavy payloads involve and loads need to be travel in large distances like in a warehouse. The task usually involves intermediate pick up and drop off points along its path. (Groover, 2001)