UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN DEVELOPMENT OF LOAD CARRIER TYPE AGV

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Robotics & Automation) (Hons.)

by

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ABSTRAK

Sistem pengendalian bahan telah diperkenalkan dengan luasnya kepada industri pembuatan kerana keperluan fleksibiliti dan kualiti. Kenderaan berpandu automatik akan memainkan peranan penting untuk mencapai keperluan ini kerana ketepatan yang tinggi dan fungsi kebolehulangannya. Ia boleh menggantikan buruh manusia bekerja untuk tempoh masa yang lama tanpa mengetahui keletihan. Projek ini akan mencadangkan tentang bagaimana untuk memperbaiki reka bentuk pada mekanikal untuk kenderaan berpandu automatik dan menilainya. Jadual kualiti pengaturan fungsi telah digunakan untuk membuat keputusan kepada pemilihan reka bentuk. Dengan keperluan dari pelanggan dan ujikaji kejuruteraan, reka bentuk yang sesuai dan jenis kenderaan akan dipilih. Hasil dari jadual tersebut telah menunjukkan bahawa kenderaan pembawa beban adalah pilihan yang sesuai untuk diteruskan kekajian. Kemudian, projek ini akan memberi tumpuan pada kenderaan pembawa beban sebagai jenis kenderaan baru yang sesuai untuk reka bentuk kenderaan berpandu automatik kerana kelebihannya. Model trolley akan dibina dengan menggunakan 3D reka bentuk perisian. Akhirnya, ia akan disimulasi dengan satu simulasi yang bernama daya statik untuk menguji keadaan kekuatan and cara ubah bentuk.

ABSTRACT

Material handling system has been widely introduced to manufacturing industries due to the requirement of flexibility and quality. An automated guided vehicle will play an important role to achieve the requirement for the material handling system because of the high accuracy and repeatability function. It can replace the human labour working for a long time period without getting fatigue. This project is about how to improve the mechanical design for AGV and evaluate it. Quality function deployment has been used to decide the design selection. With the customer requirement and engineering voice in QFD, the suitable design and type of AGV will be selected. The result from QFD has showed that the unit load carriers are the suitable choice to be continued develops. Then, this project is focused on using unit load AGV carriers for the new type of AGV design due to the advantage of this type of AGV. The model preparation of AGT is designed by using SolidWorks 3D drawing software and performed simple static force simulation on it.

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LIST OF ABBREVIATIONS

CAD	-	Computer Aided Design
UTeM	-	University Technical Malaysia Melaka
AGV	-	Automated Guided Vehicle
LGV	-	Laser guided vehicles
SGV	-	Self-guided vehicles
P&D	-	Pick-up and deposit
SCR	-	Silicon Controlled Rectifier
QFD	-	Quality Function Deployment
U.S.A	-	United State of American
JIT	-	Just In Time
AS/RS	-	Automated Storage/ Retrieval System
FM	-	Facility Management
DC	-	Direct Current
AGT	-	Automated Guided Trolley
FEA	-	Finite Element Analysis

CHAPTER 1
INTRODUCTION

1.1 Background

Nowadays material handling system has become important due to the requirement of quality and quantity. Because of that, the creation of Automated Guided Vehicle (AGV) has been introduced to the industries for the purpose of increase the product handling speed and decrease the human labor cost. Based on the definition from Wikipedia, it defines the AGV as a mobile robot that follows markers or wires in the floor, or uses vision or lasers.

The first AGV was created by Berrett Electronics in 1953 (Wikipedia foundation, 2012). This AGV is able to tow objects behind them in trailers to which they can autonomously attach. The trailers can be used to transfer the material and finished product. This is also the idea from the company to the UTeM. The first idea for the trolley-towing AGV is under towing function. It was uses to tow the trolley from one point to another point without any human intersection.

In a traditional company system, human labor is very important for the productivity. But, the AGV can safely achieve this requirement with an intelligent computer. AGV is easy to be control and able to communicate with other autonomous vehicles to provide a seamless operation. In case to design an AGV, the engineer designer requires considering trade-offs between product attributes in the areas of cost, weight, manufacturability, quality, and performance. Difficult challenge of determining how to arrive at the best overall design need to be faced, making the right compromises, and not sacrificing in critical attributes like safety.

1.2 Problem Statement

The reason to create an Automated Guided Vehicle is mainly to solve the logistic problem that often occurred in the workplaces and reduce the risks of personal injury. It is widely uses in factories, offices, houses, hospitals and some other place that cannot be noticed.

The AGV can perform many tasks with a higher accuracy and repeatability. There are some works such as to tow a trolley from one place to another place by repeatedly, etc. AGV is more efficient when compared to the human labor that will simply get tired after working for a whole day. By using a suitable power and drive system, it can carry and lifting a trolley far more than human workers can be. Robots will not get tired and their movement is easy to be control at all times. Their movement will be set up by the programming device to move around and do the job like collecting and feeding materials.

Besides that, there is a lot of worker need to spend their energy and time to tow the trolley from loading bay to the conveyor for transferring the seat frame. By using AGV, it can avoid the worker from getting fatigue and the factories system would be more systematic. AGV also able to repeatedly doing the same job without any mistake that may be happen on human workers.

Based on the expectation, the environment of the factories need to be analyze first before do the designing of a suitable AGV towing robot to prevent any unknown error. This is the main fact to design and improve the robot.

1.3 Objectives

The objectives of this project:

- To design the model preparation of the AGT prototype using computer software
- To perform analysis based on the design automated guided trolley

1.4 Scope of the Project

The first design model is a four-wheeled mobile robot that has the ability to follow line on floor. There are four-wheels including two driving wheels controlled by the motor and two free wheel in front which are for steering purpose. With four wheels, the wheels are always in contact with the surface because there is a higher driving force to tow the trolley. In this case, the final decision is to modify the simple trolley prototype to operate in AGV function. The model of this idea is same type as the unit load AGV carries. By using SolidWorks CAD software, it can design and show the AGV model is solid state drawing. The work in this project is focusing more on the development on the mechanical design of the AGV.

1.5 Project Limitation

The main problem to be considered is how to modify the trolley becomes a unit load carriers to add in the extra equipment without increase the load. It is also important to know the actual working environment either the factory have enough area to let the robot operated or not.

1.6 Report Structure

Chapter one is discussing about the introduction of the report that first start with background of the AGV, problem statement, objectives, scope of the project, project limitation.

Chapter two is start with literature review. This chapter have describe the material handling system, Automated guided vehicle, AGV system, guidance system, addressing mechanism, type of vehicle, comparison between three type of AGV and current existing AGV in industry.

Chapter three is related to methodology of project. It describes the current design of AGV, type of company trolley, the reason for new design, design concept and overall method.

Chapter four is result and discussion for the project. It shows the result of concept drawing and actual drawing of AGT. Lastly, it shows the result from the static force simulation that related to stress, strain and displacement.

Chapter five is the conclusion of the project. It conclude the research and finding from this project. It also includes future study suggestion.

CHAPTER 2
LITERATURE REVIEW

2.1 Material Handling

Material handling is loading, moving and unloading of material. To do it safely and economically, different types of tackles, gadgets and equipment are used when the materials handling is referred to as mechanical handling systems. A definition from Texas A&M Industrial Engineering, material handling uses the right method to provide the right amount of the right material at the right place, at the right time, in the right sequence, in the right position, in the right condition, and at the right cost.

In any industry, no matter it is big or small, involving manufacturing or construction type work, materials have to be handle as raw materials intermediate goods or finished products from the point of receipt and storage of raw materials, through production processes and up to finished goods storage and dispatch points.

Even the material handling did not add value to the product and not a production cost. It cost a lot of money for the company, so it should be eliminated or at least reduced as much as possible. Another definition from American Materials Handling Society, material handling is the art and science involving the moving, packaging and storing of substance in any form. (New Age International, http://www.newagepublishers.com/samplechapter/001455.pdf)

Based on that, this means that material handling is very important and should be concerned about it. The foremost importance of materials handling is that it helps productivity and increase the profitability of an industry. A well design material handling system can provide high efficiency of a production system by ensuring the right quantity of materials delivered at the right place at the right time most

economically. Besides that, it can cut down the labor cost and reduce the damage of materials during storage and movement.

AGV can achieves those goals and bring the biggest profit to the industries that are widely using it.

2.2 Automated Guided Vehicle

Automated guided vehicle normally explained as a robot with material handling system that uses independently operated, self-propelled vehicles guide along defined pathways. An AGV can also be called a laser guided vehicles (LGV) or self-guided vehicles (SGV). AGV can carry loads or tow objects behind them in trailers. The trailers can be used to move raw materials or finished product. AGV are employed in nearly every industry, including paper, metals, newspaper and general manufacturing. AGV suitable used on when there is high transferring requirement with a stable repeatable movement and without human labor decision making (Arvin, Sooraj, Ankitha, Alka, Vishnu, 2011).

AGV has been installed with a driverless computer controlled that is programmed to transport materials through desirable routine in a certain area like 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. At the start, it poor efficiency was been accepted by the manufacturing industry because ofits limited controller and cannot be reprogrammable. Because of this, a lot of researchers are very interested to develop and improve it flexibility and efficiency. The performance of AGV can affect the materials handling system that directly related to the whole factory operation. (Wikipedia foundation, 2012)

Nowadays, AGV have been played an important role in industry because it has become one of the fastest drowning classes of equipment in the materials handling industry (H. Huzairi, 2009). AGV can be used from the process start until the end such as deliver the raw material from all the way through the loading bay and unloading it.

Over the year the technology has become more sophisticated and today automated vehicles are mainly lasering navigated (LGV). In an automated process, LGV are

programmed to communicate with other robots to ensure product is moved smoothly through the warehouse, whether it is stored for future use or send directly to shipping areas. A typical AGV consists of the frame, batteries, electrical system, drive unit, steering, precision stop unit, on-board controller, communication unit, safety system, and work platform. (Arvin, Sooraj, Ankitha, Alka, Vishnu, 2011).

2.2.1 AGV System

According to statistic in 1989, AGV systems installation with respect to their application types were profiled as following: JIT delivery systems (56%), FM transfer system (13%), storage load transfer, non-AR/RS (12%), AS/RS interface (8%), progressive assembly (7%), mini-load AS/RS interface (1%), and others (3%). Other application of AGV in non-manufacturing environment such as delivering mail, messages, and package in office and delivering laundry in hospitals. AGV can be used in two different ways. The first approach is attach a workpiece to the AGV having all manufacturing processes done while the AGV carries the workpiece from station to station. In this approach, the AGV is freed only after all the processes for the workpieces are completed. The second approach is to use vehicles only for moving the workpieces from one station to another. Vehicles are assigned to the workpieces only for a single trip. In the former, number of vehicles required is significantly greater than in a normal AGV system (Bulent CELINE, 2003).

2.2.2 AGV Guidance Technique

AGV guidance system can be classified as three main types:

- Wire guide path
- Optical guide path
- Off-wire guidance

In the wire guide path technique, wires with varying frequencies are buried in the floor. AGV select a path at a control point according to the assigned frequency. In the optical guide path techniques, an AGV focuses a beam of light on a reflective

tape or a painted strip and follows the path by measuring the amplitude of the reflected light. The disadvantage of the wire guide path and optical guide path have caused the development of off-wire guidance techniques such as laser triangulation, floor-grid referencing, and gyroscopic guidance. The advantage of these techniques that, there is no need for floor cutting or painting, and the guide path is easily modified. (Wikipedia foundation, 2012)

2.2.3 AGV Addressing Mechanism

The system in AGV can be grouped into two types. There is direct or indirect address system. In direct system, the AGV is moving like the taxi because the vehicle is allowed to visit any station in the same system. By considering the current status of the system, the planning function will routes vehicle from its current location to its destination. This mean the routes of vehicle are not determined in advanced. The vehicles must first be assigned to tasks since vehicles are not planning to serve any particular station. This situation has make the planning function become complicated since the location of the vehicle is unknown and only change when the system changes.

For the indirect address system, the vehicles will stop at each station by a fixed sequence which is like a bus system. The routes are predetermined as part of the system design and not one of the controller planning function. Compare to the direct address system, the dispatching in this system is straightforward. As the route of the vehicle is predetermined, it will pick up and drop off loads when it reach each station in its routes (Nurulhuda, 2006).

2.2.4 AGV Vehicles Types

Types of AGV can be categorized as:

- Towing vehicles
- Pallet trucks
- Unit-load carries

2.2.4.1 Towing Vehicle

Figure 2.1: (a) Example of towing vehicle

Figure 2.1: (b) Example of towing vehicle

Towing vehicles pull a series of trailers that are attached to the vehicles. The trailers are attached to and detached from the vehicles manually at the stations. The vehicle does not have lofting capabilities nor a transfer mechanism. It can be used for any type of load (Bulent CELINE, 2003). It will be earliest variety to be introduced in the industry. It has a design similar to standard tow tractors. Interface between the AGV and load is made through a coupling device. Pick-up and deposit (P&D) points can be designated parking location on the floor or a staged location adjacent to a P&D stand for automated transfer. Different types of loading equipment used for loading and unloading the trailer include an AGV-pulled train, hand pallet truck, cranes, manual labour, shuttle transfer and others (David Dziwis, St. Onge Company, 2005).

2.2.4.2 Pallet Truck

Figure 2.2: (a) Example of pallet truck

Figure 2.2: (b) Example of pallet truck