UNIVERSITI TEKNIKAL MALAYSIA MELAKA

STRUCTURAL DESIGN AND ANALYSIS OF AUTONOMOUS GUIDED VEHICLE (AGV) FOR PARTS SUPPLY

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree in Mechanical Engineering Technology (Automotive Technology) (Hons.)

by

KHAIRUL HAZWAN BIN MOHD RASIT

B071110332

921106-04-5343

FACULTY OF ENGINEERING TECHNOLOGY

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DECLARATION

I hereby, declare that this report entitled “Structural Design And Analysis of Autonomous Guided Vehicle (AGV) For Parts Supply” is the result of my own research except as cited in the references.

Signature : .....

Author’s Name : .....

Date : .....

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the Bachelor's Degree in Mechanical Engineering Technology (Automotive Technology) (Hons.). The member of the supervisory is as follow:

…….

(Project Supervisor)

ABSTRACT

For the last 10 years, the world economic growth rapidly and have been becomes the battle stage between the industrial companies. Autonomous Guided Vehicle is introduced to support the supply system however the initial investment is very high and it cannot convince a certain company to invest such amount of money for the system. In this project, the focus research is more on a low cost lightweight AGV development. Lightweight design leads to less energy consume to carry its body. The purpose of this study is design a low cost, light body AGV that to be used in parts supply using polyboxes. On top of that, the structural strength analyses are performed through computer aided engineering (CAE) simulation. The structure of the AGV also put into consideration of the vehicle architecture, material properties and product maintainability in innovative approach.

ABSTRAK

Sejak 10 tahun kebelakangan ini, pertumbuhan ekonomi dunia semakin cepat dan telah menjadi pentas pertempuran di antara syarikat-syarikat industri. Kenderaan autonomi berpandu diperkenalkan untuk menyokong sistem bekalan bagaimanapun pelaburan awal adalah sangat tinggi dan sukar untuk meyakinkan syarikat tertentu untuk melabur jumlah wang untuk sistem itu. Dalam projek ini, penyelidikan tumpuan adalah lebih kepada kos rendah serta rangka AGV yang ringan. Reka bentuk yang ringan membawa kepada tenaga yang kurang untuk menjalankan badannya . Tujuan kajian ini adalah untuk reka bentuk AGV yang akan digunakan di bahagian-bahagian bekalan alatan yang menggunakan polyboxes. Selain itu, reka bentuk kekuatan struktur akan diuji dan dianalisis melalui bantuan komputer simulasi kejuruteraan. Struktur AGV juga sudah dimasukkan ke dalam pertimbangan seni bina kenderaan, sifat bahan dan penyelenggaraan produk dalam pendekatan inovatif .

DEDICATION

Dedicated to my father, Mohd Rasit bin Mohd Hassan and my mother, Norkiah binti Hashim. To my supervisor, Ir. Mazlan bin Ahmad Mansor, co-supervisor, Mr. Mohd Suffian bin Ab Razak, lecturers and friends for all of their help and friendship.

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TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATION

AGV	-	Autonomous Guided Vehicle
AGVS	-	Autonomous Guided Vehicle System
BOM	-	Bill of Materials
CAE	-	Computer Aided Engineering
CAD	-	Computer Aided Design
JIT	-	Just In Time
WIP	-	Work In Progress
STI	-	solidThinking Inspired

CHAPTER 1

1.0 INTRODUCTION

1.1 Background of the Study

For the last 10 years, the world economic growth rapidly and have been becomes the battle stage between the industrial companies. Because of this particular phenomenon, most companies lower their price by increasing their production quantity increase their sales in order to get the same profit margin. At this point, the situations affect the workers. When the production increases, the quantity parts supply also increase. The increasing of workload workers makes themselves stress and fatigue. This lead to the increasing of worker turnover rate for operating the production. This situation leads to the autonomous guided vehicle (AGV) implementation to support part supply operation.

30 to 80 percent of the total cost of production efficient material handling is critical to a manufacturing facilities success. According to Jones et al. (1998) Autonomous guided vehicle systems (AGVS) have become a key component for factory modernization and increased productivity with the recent advances in microprocessor and control system.

The main concept of an autonomous guided vehicle (AGV) grasps all transport systems which are capable of functioning without driver assistance. When first introduced to industry, the AGV was in competition with driver operated material handling system such as pallet carts, fork lifts and tow tractors. However, since microprocessor technology has evolved, the capabilities and types of AGV system improved from time to time. Nowadays AGV is now in direct competition with other

forms of industrial transportation such as roller conveyors, belt conveyors and chain conveyors.

According to Ali et al. (2010), AGV applications within the United States have grown remarkably during the last decade and are currently expanding at a 30% annual rate. AGVs can be found in nearly every sectors of industry. AGVs implementations are limited only by their operational applications and economic activity.

AGV is introduced to support the supply system however the initial investment is very high and it cannot convince a certain company to invest such amount of money for the system. In this project, the focus research is more on a low cost of AGV with more energy efficient. Energy consumed is more on carrying the load, not for carrying its heavy body. This project is inspired by the ability of the ants, which can lift up to 5000 times of their own body weight as viewed in Your Universe Online website at <http://www.redorbit.com/news/science/1113068168/ant-neck-joint-helps-lift-weight-021114/>.

1.2 Problem Statement

Generally in Malaysia, there is no Autonomous Guided Vehicle (AGV) that integrated with automated part racking system, which use automatic roller for easy to dispatch item to the workstation. Few AGV have been introduced in the market in few recent years such as TransCar Automated Guided Vehicle, INTELLICART-Automated Guided Vehicle, and Toyota's Automated Guided Vehicles (AGVs) that can carry extra load is available at http://www.toyotaforklift.com/category/otherproducts.aspx but most of the AGV design are heavy and bulky and the application is only focused on carry the parts from point A to point B. The price range is also quite expensive which can reach around RM 300k to RM 500k for the development of an AGV system.

Figure 1.1: Example of AGV in the market (http://www.swisslog.com)

1.3 Objective

It is known that the late modern technology, there have been changes in industrial sector in terms of increased number of production, heavier supply material, introduction of new machine and techniques. Because these changes are far beyond the company experience, prevailing design method of AGV for industrial sector seem to have very limited success.

In this project, the objective is focus on:

1) Design of economic lightweight AGV. The research is focused mainly on parts supply using polyboxes.

2) Analyse the structural strength through CAE simulation.

1.4 Scope

The scope of this project starts from designing the structure of the AGV and testing of the AGV system. There are two main parts which must achieve to ensure the AGV can work well. The first part is the AGV body design and the second part is the total load that the AGV can hold. Overall scopes of project are as stated below:

1) Design the model of the AGV by using CATIA and SpaceClaim.

2) Optimize the design to withstand desire load.

CHAPTER 2

2.0 LITERATURE REVIEW

2.1 Introduction

This section will discuss about the fundamentals, theories and concepts of this project in detail. Besides that, it also explains about the perspective, components and method that will be used in this project. The concept of the AGV that will be discussed is more about design and comparison.

2.2 Material Handling Equipment – Automated Guided Vehicle

In the early 1950s, the material handling industry was still growing due to the increase in manufacturing caused by World War II. In an attempt to make good business even better, a group of material handling distributors gathered and discovered many of them were facing similar difficulties. These companies decided to join forces and form an association as a way of mutually benefitting all members. In 1954, a meeting was held between eight distributors at the Morrison Hotel in Chicago, IL. That meeting marked the certain topics referring to the material handling industry, including industrial trucks, engineered systems and conveyors, storage and handling equipment, warehousing, storage rack, logistics and other related industry sectors.

2.2.1 Introduction to Material Handling Equipment Technology

Material Handling Institute define material handling as the movement of bulk packaged and individual goods, as well as their in process and post process storage, by means of manual labor or machine within the boundaries of a facility.

The objective of material handling is the efficient movement of goods for on-time delivery of correct parts in exact quantities to desired locations in order to minimize handling costs. It is not uncommon to have parts moving around a factory several kilometers before proceed to their shipment. Manufacturing factories must eliminate all unnecessary parts movements, as well as in process section, for just-in-time (JIT) production. There are several types of material handling equipment according to the movement mode such as above-floor transportation, on-floor transportation and overhead transportation.

2.2.2 Automated Guided Vehicle (AGV) system

Material handling is an important factor of any production system. Material handling systems have been extensive since the beginning of mass production, either as mechanical system, manual system, or in more recent years as fully automated system. Technology advances every day and need for flexibility and reliability to increase attention on automated material handling systems. The use of AGV systems are becoming accepted in today's industries. AGVs have become increasingly popular in terms of horizontal material handling transportation system. They are particularly useful where products need to handled carefully or the environment is potentially dangerous to workers such as IC chips, voltage cables, flammable and radioactive materials.

Figure 2.1: Autonomous guided vehicle system in a factory (www.bluebotics.com)

2.2.3 Description of an AGV system

AGV system is an advanced material handling system that involves one or more driverless vehicle each following a guide path and controlled by an-off board microprocessor or computer. AGV are typically used to carry parts supply in production and assembly operations. The advantages of AGVs include reliable, flexibility in adapting to changes in material flow, improved position accuracy, easily expandable layout and system capacity, reduced handling damage and automated interfaces with other system. An AGV reduce in the labor force because it allows automation of a certain portion of material handling which is also results in an increase in the efficiency of the material handling operation, thus resulting in better utilization of the work force and processing equipment.

The efficient of material handling system also helps in improving quality and reducing mistakes. The improved system results in increased worker satisfaction as it change the material time arrival rate to suit the workers pace. Sezen (2003) gives out main advantage of an AGV system is real-time control of material handling. This helps

in identification of the parts, the path they travel and the vehicles they travel in, resulting in lower Work in Progress (WIP) storage, lower inventory costs, reduce delay and better response to demands.

The main disadvantage of an AGV based on material handling system is its price tag. The high cost of the control software, development and the number of vehicles required in a single system cut back the wide usage of AGVs as material handling systems. Other limitations of an AGV include necessity for polished floor surfaces for smooth operation of the AGVs. A guide path has stability problems and restriction such as height of metal floors that must be crossed. Obstacles in the facility layout and slope gradients are other restriction the need to be overcome when designing the guide path for the AGVs. It can be seen from above that though the AGV has a number of advantages, it also has its share of disadvantages and may not be applicable in all cases.

Figure 2.2: Guide path of an AGV (www.news.thomasnet.com)

2.3 AGV Structure Design

Designing and drawing parts is an important part of AGV development. To design the structure of AGV there are several patterns need to refer. Each of the design