UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AN AUTOMATED GUIDED VEHICLE (AGV) POINT TO POINT MOTION CONTROL

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Engineering Technology (Robotic and Industrial Automation) (Hons.)

By

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Engineering Technology (Industrial Automation & Robotics) (Hons.). The member of the supervisory is as follow:

…….

(Project Supervisor)

ABSTRACT

Automated Guided Vehicle (AGV) is the widely used transport system in industry that can manage many type of loading raw material and finished product in manufacturing process. AGV is mobile robots that navigate automatically by follow the markers or line that created on or in floor. The main purpose of Automated Guided Vehicle in industry is to improve the transport time of manufacturing process, can reduce human labor and manage to handle heavy load. The control system of an AGV is the main part that reacts as a brain to the AGV navigation system. In industry, an AGV is commonly controlled by Computer Integrated Manufacturing System (CIMS) in manufacturing process. Computer Integrated Manufacturing (CIM) is the manufacturing approach that the entire production process was controlled using computers. This project is a basic design and development of an AGV and develops the control system point to point motion control of the AGV. The mechanical part of the AGV was built as the same minimum size of a standard AGV in industry and the control system of this AGV was using the Arduino and line follower type for navigation of the AGV. The developments of this project also want to improve the motion of AGV line following by implementing some controller. Lastly, to analyze the difference of AGV motion with and without the controller effect then troubleshooting the AGV and make the improvement.

ABSTRAK

Automated Guided Vehicle (AGV) adalah satu sistem pengangkutan yang terbesar di dalam industri dimana ianya dapat mengangkut bahan mentah dan produk yang selesai dari sesi pembuatan. AGV merupakan robot pengangkutan yang bergerak secara automatik berpandukan pada penanda mahupun garis yang terdapat pada lantai permukaan. Fungsi utama *Automated Guided Vehicle* di dalam industri adalah untuk menaik taraf masa pengangkutan di dalam sesi pembuatan , dapat mengurangkan tenaga kerja manusia dan dapat menyelesaikan masalah pengangkutan barang berat. Sistem kawalan AGV merupakan penggerak utama yang terpenting dan berfungsi sebagai otak kepada AGV dalam melakukan sistem pergerakan. Di dalam industri, AGV selalunya dikawal oleh *Computer Integrated Manufacturing System (CIMS)* semasa proses sesi pembuatan. *Computer Integrated Manufacturing* ialah sesi pembuatan produksi yang dikawal sepenuhnya menggunakan komputer. Projek yang dilakukan ini adalah membuat reka bentuk asas AGV, membangunkan sebuah AGV dan menghasilkan sistem kawalan tersendiri kepada AGV berkenaan. Reka bentuk mekanikal AGV tersebut dibina mengikut saiz minima yang sama seperti di dalam industri dan sistem kawalan AGV berkenaan dibuat menggunakan *Arduino* dan jenis kawalan panduan digunakan ialah berpandukan garis pada lantai. Projek ini juga dilakukan untuk membaik pulih pergerakan pada AGV dengan menetapkan sistem kawalan tersendiri. Akhir sekali, untuk menganalisis perubahan apabila sistem kawalan diadaptasikan mahupun tidak kepada AGV berkenaan dan membuat perubahan baik pulih pada AGV.

DEDICATION

Special dedications to my family that give an opportunity for me to gain knowledge and further study until this level. For all their love and support given to me, I manage to get through four year of study which full with challenges. Also thanks to all that motivate me and beliefs toward me.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

AGV	-	Automated Guided Vehicle
AGC	-	Automated Guided Cart
DC	-	Direct Current
4W2WD	-	Four-Wheel Two-Wheel Drive
PID	-	Proportional, Integral, Derivative
A	-	Ampere
IR	-	Infrared Sensor

CHAPTER 1
INTRODUCTION

1.0 Introduction

An automated guided vehicle or automatic guided vehicle (AGV) is a mobile robot that follows markers or wires in the floor, or uses vision, magnets or laser for navigation. They are most often used in industrial application to move materials around a manufacturing facility or warehouse. Application of the automated guided vehicle has broadened during the late 20th century.

Automation has become the main of modern manufacturing; no company is able to survive in a competitive market without automating its operations. In fact the term automation basically refers to the use of computer and other automated machinery for the execution of tasks that human labor would otherwise perform. Automation is used to manage systems and to control processes, thus leading to reduce the necessity of human intervention.

Nowadays, manufacturers seek to implement methods of automation appropriate to their needs and purposes. Companies automate their activities for a variety of reasons. Increasing productivity is normally the main aim for companies desiring competitive advantages. Automation reduces human errors and improves the quality of output. Other reasons of automation include the presence of hazardous working environments and the high cost of human labor in such areas (Bijanrostami 2011).

An automated guided vehicle are now becoming in attraction for an automated production line. Nowadays, many factories confront with labor shortage and expensive; consequently, any operation without human expertise requirement is most likely to be replaced by an automated operation. Material handling system is also a prime area for automation. Thus, an automated guided vehicle is designed to replace conventional system. To efficiently implement AGV system is not easy. It requires perfect combination of good hardware technology and well management. In the past decades, much work has been done in hardware areas such as controller, path and guidance technology and made considerable progress in AGV technology (Prombanpong et al. 2012).

Modern AGV systems differ from the classic ones as described for instance in the books of Jünemann and Schmidt (2000) and Tompkins et al. (2003) in several respects. Rather than using fixed paths, many modern AGVs are free-ranging, which means their preferred tracks are software programmed, and can be changed relatively easy when new stations or flows are added. A second difference is in the way they can be controlled. Agent technology allows decisions to be taken by these smart vehicles that in the past were taken by central controllers. This leads to adaptive, self-learning systems and is particularly appropriate for large, complex systems with many vehicles and much potential vehicle interference (Le-Anh & Koster 2006).

1.1 Background

This project is about to create and develop the Automated Guided Vehicle (AGV) which is by considering three major parts that is design and build a prototype of an AGV, develop the control system for AGV and improve the motion of the AGV by using a suitable controller and improving the design that may occurring problem to the motion of AGV. This project involves of parts from sketching, drawing, measuring each dimension to the control system part which involves computing wiring system and software application to ensure the AGV can run perfectly. This project is proposed to design an Automated Guided Vehicle point-to-point motion control. An AGV is fabricated by using DC motor and a basic controller is designed to control the motion. The controller is implemented for a line following robot to analyze the controller robustness.

1.2 Problem Statement

Classical line following AGV is slow response to the error occur will easily leave its track that drawn on the floor. This problem will result the motion of the robot to be unsmooth and sometimes robot tends to move out of the track. Although the line following AGV can follow the black line, its motion still needs to be improved, so to overcome that problem, we need a better controller to make AGV follow the line smoothly and make less error. The motion of line following AGV can be improved by using feedback mechanism which forms an effective closed loop system. In this project, we are using PID controller because of easy implementation on the AGV (Engineering 2013). A failure of an AGV system can occur due to several reasons, such as: a breakdown of a vehicle, objects on the lanes of the road network or manual intervention of the AGV system. Implementing safety sensor can prevent from this failure (Adriaansen 2011).

1.3 Objective

The main objectives of this project are:

(a) To design and develop one complete Automated Guided Vehicle (AGV).
(b) To develop the control system for the Automated Guided Vehicle (AGV).
(c) To improve the Automated Guided Vehicle (AGV) motion.

1.4 Scope of Project

This project is based on the application of the AGV from one point to another point performing the operation of motion in line. The main part of this project is to improve motion of the AGV control system by using suitable controller and the command software to guide the AGV movement .(Anon n.d.) Equip a sensor to AGV as a mechanism with some fault-tolerant so that is can still run smoothly and safely with unexpected disturbances.(Li & Adriaansen 2011)

1.5 Conclusion

This chapter describing about the goals of this project by listing the main criteria from the introduction, project background, problem statement and scope limitation of this project. In addition, it shows the detail about how this project will be conducted.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

The main focus on this chapter is the review of Automated Guided Vehicle's development, including type of designing AGV, type of navigation system, drive system, chosen component used and variable type of controller that been used to control AGV. The source of information that had been stated before are taken from journals, articles and websites as reference. Source taken are chosen accordingly by the specific studies that been carried out that is about AGV.

Reviewing different kind of method applied in term of designing and controlling method. Identifying the suitable method and most likely to the project from the previous project as a reference to make a new development to this project.

2.1 Summarize Literature Review

This topic will show the summarize literature review by using K-chart. From the chart, the flows of this study are shown in the red boxes by selecting the most suitable method by studies from the previous project. The k-chart is shown in the figure above:

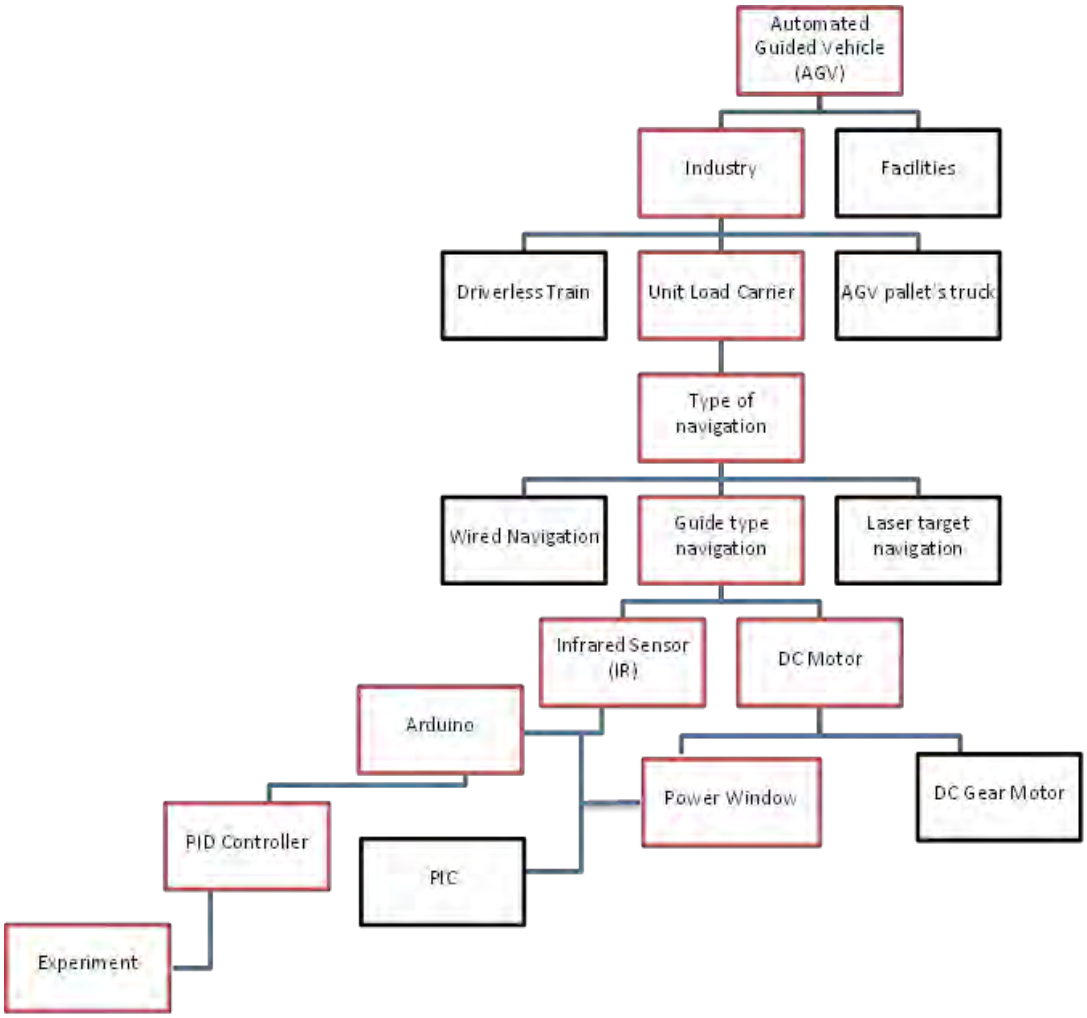

Figure 2.1: K-Chart of Literature Review

2.2 Automated Guided Vehicle (AGV) field

There are two major field that AGV is commonly implemented, the main part in industry as the material handling equipment, transferring load in warehouse, production line and loading unloading that need repeat process. Automated Guided Vehicle (AGV) now days not just been implemented in industry, there are also had been used in facilities like distributing medicine in hospital, in military as ground covering vehicle and so on. The main focus on these studies is the implementation of AGV in industry. There is several type of field in industry that needed the implementation of AGV. For example the transportation of containers, the volume of goods transported by containers through sea ports has been rapidly increasing during the last decade. Therefore automated container terminals (ACTs) have become an interesting research topic in order to increase the productivity and efficiency as well as to decrease the cost of container terminals. ACTs are equipped with automated container transshipment systems consisting of automated cranes and automated guided vehicles (AGV) (Adriaansen 2011). There are also research that been done by developing an AGV in warehouse, an intelligent forklift Automatic Guided Vehicle (AGV) been developed to perform various transporting tasks in factories and warehouses for improving the quality and efficiency as well as saving the manpower in manufacturing and service industries (Li et al. 2015). Automate Guided Vehicles (AGV) has been applied for the flexible manufacturing system. Many factories were adopted it into assembly line or production line such as automobile, food processing, wood working, and other factories. Many researchers developed and designed in order to suite with their applications which are related to the main problem of factory (Butdee et al. 2008).

2.3 Type of Automated Guided Vehicle (AGV)

2.3.1 Driverless Train

Automatic Guided Vehicles (AGVs) have played a vital role in moving material and product for more than 50 years. The first AGV system was built and introduced in 1953. It was a modified towing tractor like train that was used to pull a trailer and follow an overhead wire in a grocery warehouse. By the late 1950's and early 1960's, towing AGVs were in operation in many types of factories and warehouses (Bijanrostami 2011).

2.3.2 Unit-Load Carrier

The first big development for the AGV industry was the introduction of a unit load vehicle in the mid-1970s. This unit load AGVs gained widespread acceptance in the material handling marketplace because of their ability to serve several functions; a work platform, a transportation device and a link in the control and information system for the factory (Bijanrostami 2011).

2.3.3 AGV's Pallet Truck

Automatic guided vehicle (AGV) pallets type typically requires the location of the pallets be known a priori and that the pallets are accurate positioned. To perform pallet handling also when the pallet position is not precisely known in advance, e.g. when the loads are handled and placed by a human driver, only a few solutions have been presented (Lecking et al. 2006).

2.4 Design of Automated Guided Vehicle (AGV)

There are many roles to be considered while designing an AGV from the type needed to the specific field. Referring to the task of the AGV and which kind of suitable design needed to be done. Type of drive with suitable cost is important to build an AGV. There are many type of drive in mobile robot, for example the four-wheel steering and four-wheel drive (4WS4WD) mobile robot. The 4WS4WD possesses the benefits of the 4WD structure and the advantages of a 4WS system, has the better performance of lateral dynamics in comparison with traditional mobile robots(Lin et al. 2013). But this kind of drive might be high cost for implementing an AGV. The most suitable drive that preferred to AGV is by using differential drive, four-wheel and two-wheel drive (4W2WD). In this type of wheeled mobile robot, the front side consists of right and left wheels performing differential-wheel motion and working as the drive and the steering mechanics. Two fixed wheels are attached at the rear side. The kinematic class of the wheeled mobile robot is new in the field of wheeled mobile robot. The traction and steering of mobile robot are controlled by implementing a well-known technique in the differential-wheel type mobile robot and the motion of the mobile robot performs as in the car-like mobile robot (Drive et al. 2015).

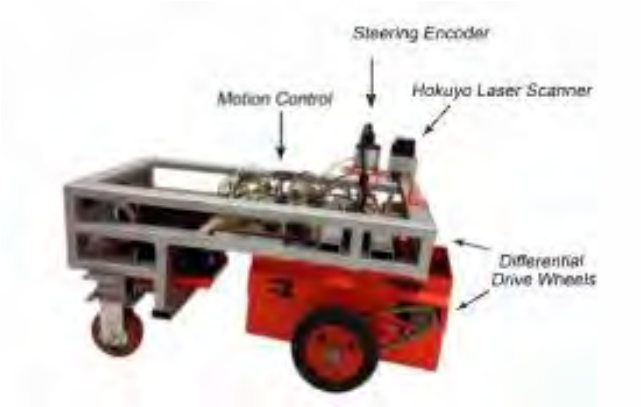

Figure 2.2: Differential drive wheels type