DESIGN OF AUTOMATED GUIDED VEHICLE USING PROGRAMMABLE LOGIC CONTROLLER

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"I hereby declare that I have read through this report entitle "Design of Automated Guided Vehicle Using Programmable Logic Controller" and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Control, Instrumentation and Automation)"

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Date : 21st June 2016

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I declare that this report entitle “Design of Automated Guided Vehicle Using Programmable Logic Controller” is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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ABSTRACT

Automated Guided Vehicle (AGV) is a robot that is used to transport material and goods from one place to another. Design of Automated Guided Vehicle using Programmable Logic Controller is to investigate the parameters required in order to operate the AGV, to design the controller algorithm and to construct the physical model of AGV so that the performance can be analyzed. The controller used for the AGV is the Programmable Logic Controller (PLC). The AGV integrated with the DC motor for the movement of the AGV and infrared sensor act as the navigation system of the AGV. The AGV is designed to carry load from one point to another point and the performance parameters were recorded without the load and with the load. The performance parameters includes the time taken to complete a path, the speed of the AGV according to the load given and how the different in load affect the power supply of the AGV. The AGV through testing process manage to carry maximum load given which is 25 kg in speed of 46 rpm and minimum load given which is 10 kg in the speed of 69 rpm. The amount of load given affected the speed of the AGV and the performance through the operation.

ABSTRAK

"Automated Guided Vehicle (AGV)" adalah sebuah robot yang digunakan untuk mengangkut bahan dan barang-barang dari satu tempat ke tempat lain. "Design of Automated Guided Vehicle using Programmable Logic Controller" adalah untuk menyiasat parameter yang diperlukan untuk mengendalikan AGV, mereka bentuk algoritma pengawal dan membina model fizikal AGV supaya prestasi AGV itu boleh dianalisis. Alat kawalan yang digunakan ialah "Programmable Logic Controller (PLC) ". AGV itu menggunakan motor aliran terus untuk pergerakan dan sensor inframerah sebagai navigasi untuk AGV. AGV direka untuk membawa beban dari satu tempat ke tempat yang lain dan parameter prestasi direkod dengan meletakkan beban dan tanpa beban. Parameter prestasi termasuk masa yang diambil untuk menyelesaikan jalan yang ditetapkan, kelajuan AGV mengikut beban yang diberikan dan bagaimana perbezaan dalam beban menjejaskan bekalan kuasa daripada AGV. AGV melalui proses ujian berjaya membawa beban maksimum yang diberikan iaitu 25 kg dengan kelajuan 46 rpm dan beban 10 kg dengan kelajuan 69 rpm. Beban yang diberikan kepada AGV mempengaruhi kelajuan AGV dan dan prestasi AGV semasa beroperasi.

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AGV	Automated Guided Vehicle
PLC	Programmable Logic Controller
DC	Direct Current
CPU	Central Processing Unit

CHAPTER 1

INTRODUCTION

1.0 Introduction

Automated Guided Vehicles (AGVs) are vehicle based robot that are used in industry application. AGV is traditionally used to move works part or load from one place to another place around the industry facilities. However, with the rapid improvement in technology, the AGV has been used in many other industries such as transporting goods in warehouse and transporting foods and medicines in hospitals [1]. The movement of the AGV are fully controlled by either microprocessor or Programmable Logic Controller (PLC) that are already programed to do a certain task and following a special route made using white or black line or any coloured strips [2]-[3].

The first AGV was built in the year of 1953. It was a modified towing tractor with trailer that follow an overhead wire as its path. Towing AGVs were in operation in many types of warehouses and factories by the late of 1950's and early 1960's. The introduction of a unit load vehicle in the mid 1970's was the first major development for the AGV system industry. Since then, the AGV system were accepted for the transportation system in many industries and evolve to become more complex system [4].

In this modern technology era, AGV system are well known across the globe. AGV's system become more advance from time to time. Nowadays, many types of AGV emerge and are programmed to do a certain task in a certain environment. One of the most advance AGV types is the AGVs assembly-line vehicle. This type of AGVs commonly use in a manufacturing industry such as manufacturing of engines. Its use a complex computer control and extend planning to implement the system. The use of AGV in the industry make the work done more efficient and saving time. The AGV system is not only can be use in the big industry, it also can be use in more other small industries and facilities such as groceries shops, hospitals and offices.

This project is focusing on the integration of Programmable Logic Controller (PLC) as the control system for the AGV, sensors for sensing and giving feedback data, servo motor for steering system and the Direct Current (DC) motor as the drive system. Sensing is an important part in AGV on how the robot will detect the route, the destination, any obstacle during the path and its own state such as the battery level and operating status. Control of AGV is about the functionality of the AGV during the run on how it will react to the surroundings, forward movement, backward movement, driving and steering. The motor selection is based on the weight of the load, torque and the speed of the AGV [3].

Design of Automated Guided Vehicle using PLC is the title of this project. A prototype of AGV that can be used in indoor application such as warehouse, supermarkets and hospitals is to be developed in this project. The project is to implement the hardware of an Automated Guided Vehicle (AGV) and also the control algorithm for the AGV. The project consist two different part which are mechanical and electrical parts. Mechanical part involve the construction of the AGV's hardware. The electrical part involve the electrical drawing, electrical wiring and programming of the AGV's algorithm.

1.1 Objectives of The Project

The project objective is to build a prototype of AGV that function as the transportation system for loads. The specific objectives are as follow:

1. To investigate the AGV system parameter required in order to navigate the AGV and carry the loads.
2. To design the AGV controller algorithm using the Programmable Logic Controller (PLC).
3. To develop the physical component of AGV and the programming to control the movement of the AGV's system.

1.2 Motivation

The rapid increase of technology encourage people to develop a system that make peoples do an easier job. As an examples, from wired communication to wireless communication, from 2D printing to 3D printing, and robots are used in all types of industries around the world to do a man job. The AGV system makes the transportation process become easier and more efficient. A Design of Robust Control Algorithm for Automated Guided Vehicle represent the use of the AGV system in industry. This project is develop so that the AGV system can be use not only in heavy industry but also the need for development of low cost AGV for small and medium industry (SME) so that the use of this AGV system can be further expand.

1.3 Problem Statements

The implementation of AGV in industry is widening especially for heavy industry, establish company and big manufacturers. Thus, AGV is design to make the system can be used for many other industry involving retail industry such as in supermarkets. AGV can carry loads and bring the loads to another place automatically without using any man power or manually using forklift. The conventional way of transporting goods usually can cause some random errors and this will be affect the production time.

The AGV system that are already used in industry produced an efficient work output. The speed of the AGV suitable according to the situation and it will be programmed either make it faster or slower. The productivity of the works can be increased and it can save energy and time because it can be used in multi-shift environment or 24-hour operation.

The existing AGV are always used in multinational company and has an expensive market price. This project is meant to develop an AGV system that has a lower operating cost and able to be use in various application. The product from this development can be potentially commercialized in transporting goods system where the AGV is using in warehouse and supermarkets.

1.4 Project Scope

The project are developed to design a robust control algorithm for the AGV to be use in various application and can choose the correct path to carry the loads. Hence, the scope for this project are been identified and focus on.

Design and develop an automated guided vehicle that is use to carry loads that are about more than 25kg and transport it to another place. This project expect to be use in retail industry, so that the average weight for goods that always to be transport are about 25kg.

The AGV system is controlled by using the Programmable Logic Controller (PLC). The PLC will act as the brain for the AGV to make sure it will functioning well. The PLC is robust, reliable, flexible and easier to command to do a specific task. It can maintain the control system function in challenging environment.

Essential sensitivity sensor will be use as the navigation system for the AGV. The sensors is used for the steering left and right purpose. The steering system will be controlled using the sensors that detect the path for the AGV and send the data to the controller.

The DC motor is implemented for moving forward and reverse .The DC motor that use is selected based on the weight and torque of the AGV including the weight of the loads. Based on those parameters, the DC motor is chosen and it is use to move the AGV forward and reverse. The DC motor also used for the steering by using the data collected from the input sensor.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

Automated Guided Vehicle (AGV) is an unmanned mobile vehicle that are used for transportation system. The AGV is design to carry loads from one station to other station. AGVs are commonly used in manufacturing factories, warehouses and terminals. In this modern technology, some AGV also been used in hospitals to carry foods and medicines [1]-[3].

AGV can be differentiated with many types, the sensors that the AGV use, the control system and the motor that moves the AGV. Each of the types of AGV has different function, operation, and the environment where the AGV is use. There were also some development project on the AGV technology so that the AGV technology will continue to develop.

With the increasing of AGV technology, the transportation process become easier and more efficient. This project is develop is to make the AGV technology can be use more widely not only in multinational and heavy industry but also for the retail industry. In order to complete this project, there are several important information that need to be study which are the types of AGV, the guidance system, the sensors used in AGV, the controller in AGV and the selection of the motor.

2.2 Types of AGVs

There are several types of AGV that are used. Some of the popular modern AGVs are AGVs forklift truck, AGVs towing vehicle, AGVs unit load carriers, AGVs pallet trucks, AGVs light-load transporter, and AGVs assembly-line vehicle. The different of the AGVs types shows how the AGV operate [1]-[5].

Figure 2.1: AGVs forklift truck [6]

AGVs forklift truck is highly adaptable automated vehicle as shown in Figure 2.1. It's an AGV that can pick up and drop load at different height which is it will adjust the position of its fork according to the place of load must be pick up or drop. This type of AGV also can pick up and drop load either the AGVs in on the stands or drop the load on the floor level. Because of its versatile operation, the AGVs is very expensive and only be used in complete automated operations.

Figure 2.2: AGVs towing vehicle [7]

AGVs towing vehicle is the first type of AGV that had been developed in the year of 1953. It is also can be called automated guided tractor because the similarity to tractor towing system. The AGV will tow the load behind by using trailers of pallet trucks. Normally, this type of AGV is use for large volumes of load (>1000 lb) and far moving distances (>1000 feet). The example of this type of AGV as shown in Figure 2.2.

Figure 2.3: AGVs unit load carrier [7]

AGVs unit load carrier is another types of AGV as shown in Figure 2.3. This type of AGV carry the load on-board the AGV. The deck for the AGVs is equipped by powered or non-powered roller, chain or belt, and custom. This AGV normally integrated with lift and conveyor or it is loaded with either manual or automatic equipment such as forklift trucks, pallet trucks or cranes.

Figure 2.4: AGVs pallet truck [8]

The AGVs pallet trucks types as shown in Figure 2.4 is quite similar to the AGVs forklift vehicle. The differences of the AGVs pallet trucks and forklift are the loading and unloading for the AGVs pallet trucks must be on the floor level and the load must palletized. This type of AGV is commonly use in distribution process.

Figure 2.5: AGVs light-load transporter [9]

Next is the AGVs light-load transporter as shown in Figure 2.5. As the name of the AGVs, this type of AGV carry small volume of load like parts on a tray or basket. The distance of the AGVs operate also moderate and it operate in areas with restricted and tight space. It is always been use in electronic fabrication and small assembly manufacturing.

Figure 2.6: AGVs assembly-line vehicle [10]

Another type of AGVs is the AGVs assembly-line vehicle as shown in Figure 2.6. This types of AGVs is a modification of the light load AGVs that are brought to the assembly line. The vehicle is use to carry part from one station to another in a serial assembly line. When the assembler finished the work, the vehicle will moves to another station until the process is complete. When the assemble process is complete, it will start again from the first station and this process will continue. The manufacturing process become more flexible by using this type of AGVs system in the process. Above all, this system use complex computer control and extensive planning to integrate this system into the manufacturing process.

2.3 Guidance System of AGV

AGVs also can be differentiated by its guidance system. AGVs can be classified into wired-guided, tape-guided, laser-guided, inertial-guided and vision-guided types. The most widely used type of AGV is the tape-guided AGV because of its reliability and simplicity in terms of installation and operation of the system [11]-[13].

Wire-guided AGVs use an energized wire that have been fixed along the guide path. The AGV is equipped with an antenna that will follow the energized wire. For this type of guidance system, changes and expansion of the system is not flexible because the wire is already embedded and fixed on the floor [12].

Tape-guided AGVs use tape that are placed on the floor of the AGV's path. It is either magnetic tape or black/white tape and the AGV is programmed so that it will follow the tape path. The magnetic tape guidance system is commonly used with the magnetic

guide sensor. The black/white tape commonly used with the optical sensors such as infrared sensors. The magnetic tape guidance system is more reliable than the black/white tape because the magnetic tape is not affected by many harsh condition such as dirt and lighting condition. But, the magnetic tape is more expensive due to the magnetic system use compare with the normal tape. The similarity for the tape-guidance system is easy to lay and can be changes easily due to the use of tape concept [11]-[12].

Laser-guided AGVs are equipped with laser beam that are used to scan wall-mounted bar-coded reflectors. When the laser beam scan the bar-coded it will give accurate positioning for the AGV to move. As in [12], the laser-guidance system can correct its own path in real-time and this system is not depend on any floor/surface quality to function well.

For the inertial-guided AGVs, the AGV's guided path is programmed to the AGV's control system. This guided path is fixed for the AGV and the AGV will move according to it. Gyroscope is commonly use in this type of AGV as stated in [13]. Lastly, for the vision-guided AGVs, it use Photo sensors. These photo sensors will detect colourless florescent particles that had been painted on the floor. It is also use infrared sensor to detect the route of the AGV [11].

This project will be use the tape-guidance system. This is because the simplicity and stability of this system. It is also easier to make any changes and the implementation cost is cheaper than the laser-guidance, inertial-guidance and vision-guidance. In [11], the AGV development use this tape-guidance system in their project because of the simplicity and stability.