UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF AUTOMATED-GUIDED VEHICLE FOR 300KG TROLLEY TOWING APPLICATION

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

by

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ABSTRACT

The aim of this project is to study and developed a mobile robot that can tow a trolley automatically. It focus on a warehouse area at Johnson Controls Automotive Seating (M) Sdn. Bhd. Usually in the warehouse area, all the towing trolley activities were conducted by the operator from warehouse to the assembly line, approximately 40 meters per direction and the total weight of trolley estimated at 300 kg per trolley. So, this project is focusing on design and development of an AGV where the AGV will be tested for it's performance after the development complete. SolidWorks 20011 is the main software that is used to design the AGV in this project. Two mecanum wheels with 120W DC brush motor are used to move the robot and the AGV will use line following technique to perform the navigation task by using Advance Auto-Calibration Line Sensor which is placed at the front and back side of the AGV. For the assessment performance, the AGV will be tested in two types of experiments, where the first experiment is to identify the capability of the AGV to detect different size of lining tape. The second experiment will be a test to identify the performance of the robot to navigate along a given path by performing the line following task.

DEDICATION

My special dedication to my beloved parents, Che Man B. Che Mat and Che Liah Bt. Ahmad, for their loves and supports which never end and with the loves and supports given to me, I managed to go through the 4 years of my study which full with challenges and hunches. To my supervisor, En Mohd Nazrin B. Muhammad, Dr. Fairul Azni B. Jafar, lectures especially to Encik Mahasan Bin Mat Ali and all my friends for their help, support and friendship. Not to forget Mr. Muhamad Asari Bin Abdul Rahim which always understand and willing to help me in any works at the laboratory.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

AGV	-	Automatic Guided Vehicle
DC	-	Direct Current
JIRA	-	Japanese Industrial Robot Association
LED	-	Light-emitting Diode
PIC	-	Programmable Interface Controller
RIA	-	Robotics Institute of America
RISC	-	Reduce Instruction Set Computer
RPM	-	Rotation per Minutes
SLA	-	Seal Lead Acid battery

CHAPTER 1

INTRODUCTION

1.1 Background

Advances in manufacturing technology enables companies to make a quickly produce the products. This has given rise of trend to reduce an inventory in the short term bulk supply. Hence, this allows the company more financial freedom, it needs to accommodate temporary warehouse, and storage selected. So, to be better in production handling and speed it can be achieved with the implementation of Automatic Guided Vehicle (AGV). Figure 1.1 shows an example of AGV.

Figure 1.1: The mobile robot (Roland Siegwart and Illah R. Nourbakhsh, 2004).

Usually in a warehouse, men are the main to maintain productivity. With the help of smart computer, AGV are safe and easy to operate. A precision change allows it to navigate with precision in tight spaces. The AGV is very flexible as a result of remote in communication. Its ability to communicate with other autonomous vehicles provide in smooth operation and continuous coordination between vehicles delivering efficiency savings.

There have been several types in AGV technology that is AGV Towing Vehicles, AGV Unit load Carriers, AGV Pallet Trucks, AGV Forklift Trucks, Light Load AGV, and AGV Assembly-Line Vehicles. AGV Towing Vehicle is the first type introduces in 1953. It was a modified tractor towing that was used to pull a trailer. Towing vehicle also called an automated guided tractor. Figure 1.2 shows a few types of AGV applications.

(a) AGV towing vehicles.

(b) AGV unit load carriers.

(c) AGV forklift trucks.

Figure 1.2: AGV applications, (a) AGV towing vehicles, (b) AGV unit load carriers, and (c) AGV forklift trucks.

The goal of an AGV guidance system is to keep the AGV on track/predefined path. Easy in modification of guidance system is the major advantage of changing the guide path at lower cost compared to chain, conveyors and etc. Usually AGV navigation is by wired, guide tape, laser target navigation, steering control or vision guide.

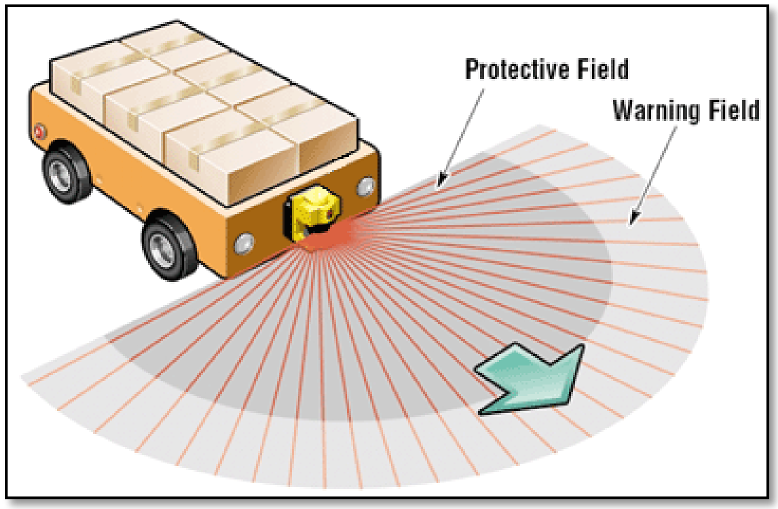

Figure 1.3: Obstacle Detection of Automated Guided Vehicle (AGV), (http://www.omron-ap.co.in).

1.2 Problem Statement

Currently, trolleys on production line especially in warehouse area are being pushed by workers irregular intervals. In fact workers lead to unproductive time and cost. Therefore AGV are used out to solve the problem situation.

1.3 Objective

The aim objectives of this project are:

i. To investigate the AGV technology.
ii. To develop the AGV.
iii. To assess the performance of AGV.

1.4 Scope

The scope of this project consists of three which is the AGV able to tow a trolley with a maximum load of 300Kg, the AGV operated in specific condition floor and the speed of AGV is not importance criteria but should able to complete the task given.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Autonomous Mobile Robot is an automated vehicle that is not required to operate from the operator to navigate the robot. Basically autonomous mobile robot is built with reference by physical movement of animals and human, with using simulated of software. All movements are determined in advance before the operation and the mobile robot will navigate accordingly. An autonomous mobile robot can be divided into three types of areas which is air, ground and submarine. Implementation of autonomous mobile robots such as the agriculture purpose, surveillance, military, and other applications can reduce the risk of injury and time consuming (Hamid et al., 2009). Figure 2.1 shows an example of mobile robot.

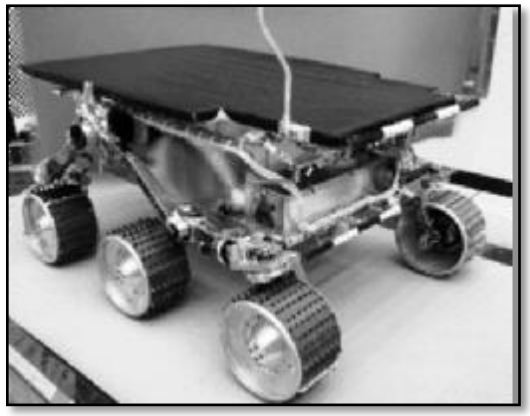

Figure 2.1: The mobile robot sojourners that explore mars in summer 1997
(Siegwart and Nourbakhsh, 2004).

In the general terms the mobile robot can be defined as mobile systems equipped with sensors to interact with the external environment and navigate with it when trying to achieve several objectives. There are several mobile robots that can change their location through movements such as Automatic Guided Vehicles (AGV). Figure 2.2 shows an AVG that are used to transport a motor blocks from the assembly station to another (Roland Siegwart and Illah R. Nourbakhsh, 2004).

Figure 2.2: An Automated Guided Vehicle (AGV) (Siegwart and Nourbakhsh, 2004).

Refer to the American scientist and author Isaac Asimov wrote a novel that titled "Run-around" where the word "Robotics" was used for the first time in 1942. He tried to describe the technology of robots, and also to protect people and limit the impact that the robot will result in a future society.

Hence, Asimov defined three laws:

i. A robot may not injure a human, or allow a human being to be injured.
ii. A robot must follow any order given by a human being that does not conflict with the first law.
iii. A robot must protect itself unless such protection conflicts with the first or second laws.

According to the *Robot Institute of America* (1979), a robot is defined as a reprogrammable, multifunctional manipulator designed to move material, parts, tools, or specialized devices through various programmed motions for the performance of a variety of tasks. For the *Japanese Industrial Robot Association* (JIRA), robots are divided into the following six classes, which are:

Class 1: Manual handling device: a device with several degrees of freedom actuated by the operator;

Class 2: Fixed sequence robot: handling device which performs the successive stages of a task according to a predetermined, unchanging method, which is difficult to modify;

Class 3: Variable sequence robot: the same type of handling device as in class 2, but the stages can be modified easily;

Class 4: Playback robot: the human operator performs the task manually by leading or controlling the robot, which records the trajectories. The information is recalled when necessary, and the robot can perform the task in the automatic mode;

Class 5: Numerical control robot: the human operator supplies the robot with a movement program rather than teaching it the task manually;

Class 6: Intelligent robot: a robot with means to understand its environment, and the ability to successfully complete a task despite changes in the surrounding conditions under which it is to be performed.

However, it is different with *Robotics Institute of America* (RIA) view. The only considers the machines which are at least in class 3 as robots. They define “robot is a re-programmable, multifunctional manipulator (or device) designed to move material, parts, tools, or specialized devices through variable programmed motions for the performance of a variety of tasks.

2.2 Application Of Mobile Robots

Mobile Robot is an automatic machine that is capable of movement given by environment from one position to another. Mobile robot has the ability to move around in their environment and not fixed to one physical location. In contrast, industrial robots usually consist of articulated arm assembly (various related manipulator) and gripper (or end effectors) that attached to a fixed surface. Mobile robots are the focus of a great deal of time research and almost every major university has one or more labs that focus on mobile robot research. Mobile robots are also found in industry, military and security environment. They also appear as consumer products, for entertainment or to perform certain tasks like vacuum.

2.3 Research Study on AGV

Automated Guided Vehicle (AGV) to improve efficiency and reduce costs by helping to automate a manufacturing facility or warehouse. The first AGV was created by Berrett Electronics in 1953. AGV can tow objects behind them in trailers that they can autonomously attach. Trailers can be used to move raw materials or finished products. Objects can be placed on a set of motorized rollers (conveyor) and then refused to reverse them. Some AGVs use a forklift to lift objects for storage. AGV employed in virtually every industry, including, pulp, paper, metal, newspaper, and general manufacturing. It is also used in transporting a material such as food, linen or medicine in hospitals.

In addition to choosing the right vehicle for the right job, there are also choices to be made when it comes to AGV guidance, also referred to as navigation systems. Navigation systems can be closed path or open path. Bellow it a list part of AGV guidance. Figure 2.3 shows the picture example of navigation system.

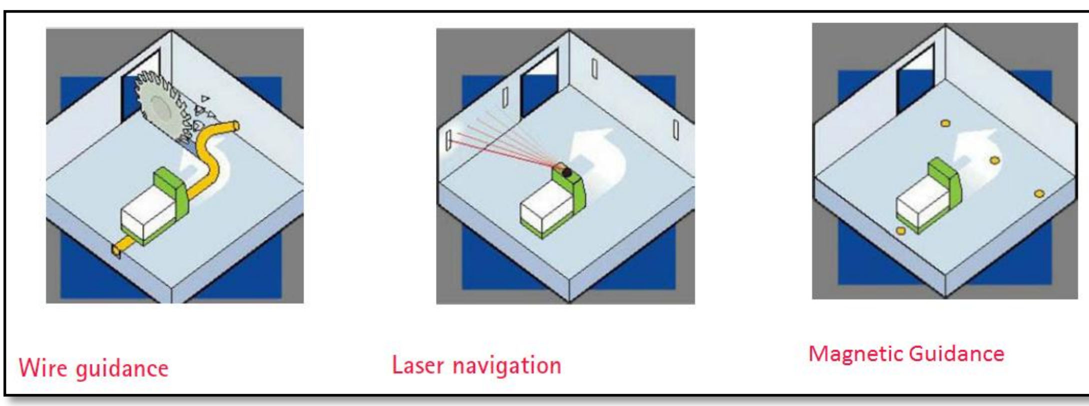

Figure 2.3: Example of navigation system (Lorie King Rogers, 2011).

2.3.1 Line Following

A line follower consists of an infrared light sensor and an infrared LED. It works by illuminating a surface with infrared light, the sensor then picks up the reflected infrared radiation and based on its intensity, determines the reflectivity of the surface in question. Light-colored surfaces will reflect more light than dark surfaces, resulting in their appearing brighter to the sensor. This allows the sensor to detect a dark line on a pale surface, or a pale line on a dark surface. Figure 2.4 shows the picture of line tracking navigation principle on the line follower robot.

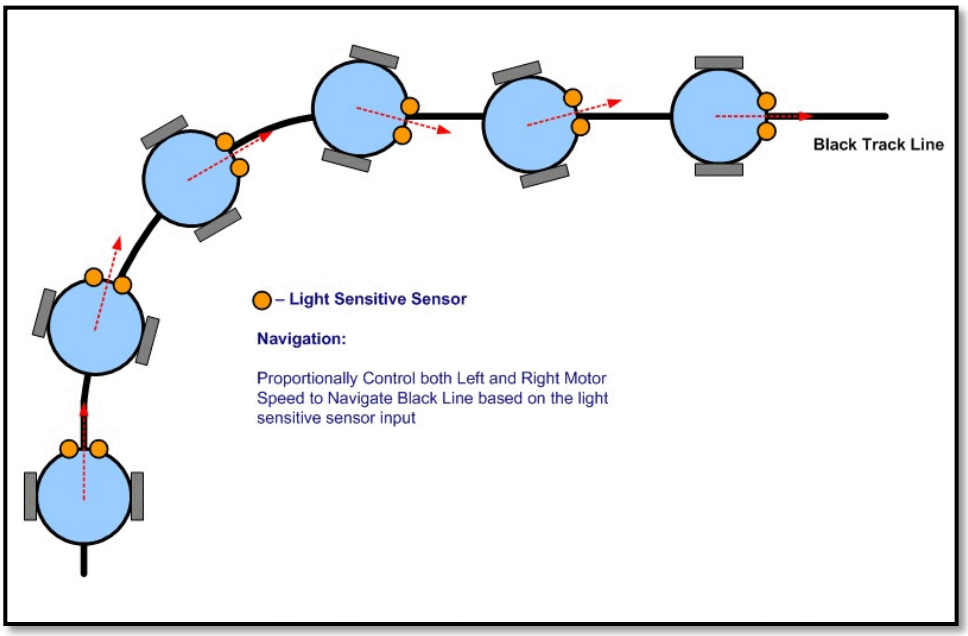

Figure 2.4: Line tracking navigation principle on the line follower robot (http://www.ermicro.com).

2.3.2 Wire Guidance

Wire-guidance is the simplest form of navigation, designed for a set, predictable path. Torrens likens wire-guidance to a hound dog following a scent trail that has verifications along the way. An RF signal is transmitted from the wire that's buried in a slot below the floor to a sensor under the vehicle. The sensor detects the signal and adjusts the position of the vehicle to keep it on the path. Because the slot must be cut into the floor, wire-guided systems are most commonly used in applications that require a high degree of accuracy on the path, like an AGV traveling back and forth between two workstations in a congested area (Lorie King Rogers, 2011).

2.3.3 Magnetic Guidance

Magnetic tape and magnetic paint are used to guide vehicles in applications that are relatively simple and where flexibility is paramount. "Magnetic tape allows customers to easily change their guide paths by simply pulling up and reapplying the tape," says Daifuku Webb's Carlson. Customers who change the layout of their processes frequently can quickly and easily reconfigure routes because tape and paint are not permanent. They are also less expensive than other guidance systems (Lorie King Rogers, 2011).

2.3.4 Vision Guidance

Camera-based imaging is the newest guidance technology, and according to JBT's Longacre, is becoming increasingly popular. The main reason for its growing popularity isn't so much for obstacle detection, as for load recognition. For example, a pallet stored by a manual lift truck might not be perfectly aligned in its position, but the AGV's camera can see the pallet fork pockets and adjust accordingly. Camera-based imaging is used in several mobile robotic applications. While camera-based imaging requires a lot of processing power for its dynamic route planning, there are no rules. "A mobile robot sees what it sees and can evaluate its environment in real time," explains Torrens. "It looks for the ability to go around obstacles and can change its mind in a moment's notice." (Lorie King Rogers, 2011). Figure above shows systems of navigate by vision guidance.

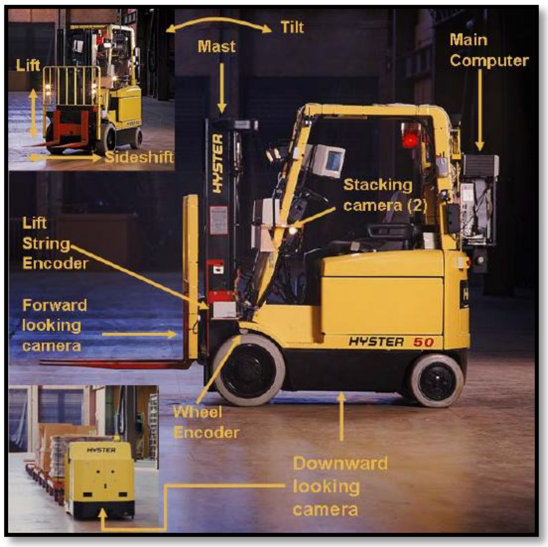

Figure 2.5: Structure in AGV system (Arkin, 1989).

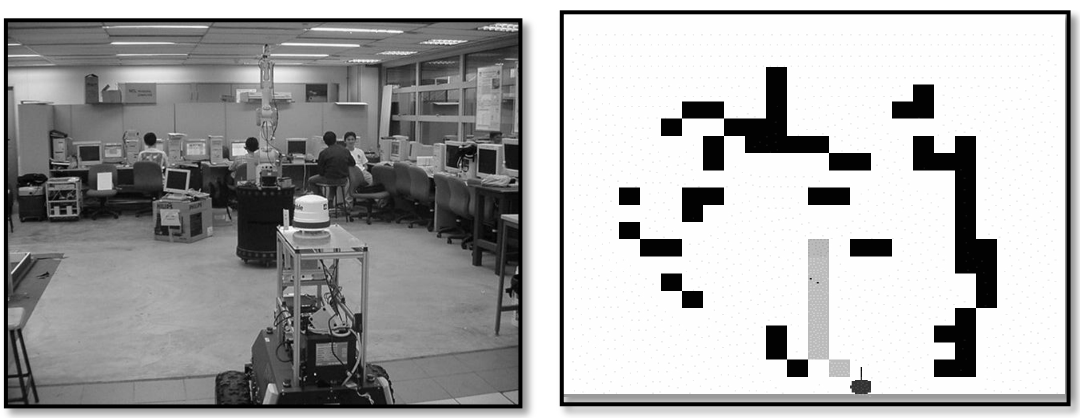

Figure 2.6: Indoor environment (Yew Tuck Chin, 2001).