OMNI DIRECTIONAL LOGISTIC TRANSPORTATION VEHICLE

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Faculty of Electronic and Computer Engineering
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To my beloved father, mother, brother, supervisor, friends, lecturers and fellow colleagues
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ABSTRACT

An Automatic Guided Vehicle (AGV) is a mobile robot used in industrial applications to move materials from point to point. It does not require human intervention, thus making it autonomous. Most of these robots operated a simple algorithm which the robot will keep a designated line in the centre through its sensor. Therefore, infrared sensors are used to enable the line following function, to detect obstructions and, to detect the loading and unloading station. The AGV in this project is a mobile robot driven using servo motors to control the wheels. The significance of this project would be the implementation of omni wheel. The omni wheel is able to maneuver in omni directions, thus producing holonomic drive which enables the AGV to maneuver easily in really tight places. The controllable degrees of freedom of the AGV are equal to the total degrees of freedom; hence, it is referred as a holonomic vehicle.
ABSTRAK

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LIST OF ABBREVIATIONS

RIA - Robotics Institute of America
AGV - Automatic Guided Vehicle
PIC - Programmable Integrated Circuit
RC - Radio Control
PWM - Pulse-width modulation
DC - Direct Current
IR - Infrared
LED - Light Emitting Diode
Hz - Hertz
RAM - Random Access Memory
EEPROM - Electrically Erasable Programmable Read Only Memory
A/D - Analog to Digital
ICSP - In-Circuit Serial Programming
BASIC - Beginner’s All-purpose Symbolic Instruction Code
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CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter will discuss the brief history of robot, the definition of robot, modern usage of robot, mobile robot, autonomous robot and automatic guided vehicle. Besides that, problem statement, objectives of the project, scope of work and report structure of this project will be covered in this chapter as well.

1.1.1 History of Robot

A Robot is a representative of a mechanical artificial agent which appearance suggests that it has intent of itself and serves a special purpose. The word “robot” stems from a play from 1921 called “Rossum’s Universal Robots” or “R.U.R.” by Czech playwright Karel Capek. The word “robot” was derived from the Czech word “robota” which means “forced labour”. The same case goes to the word “robotics” which appeared in the novel entitled “Run-around” written by the American scientist and writer
Isaac Asimov. In his novel, he stated The Three Laws of Robotics which almost all positronic robots appearing in his fiction must obey. The three laws are:

i. A robot may not injure a human being or, through inaction, allow a human being to come to harm.

ii. A robot must obey orders given to it by human beings except where such orders would conflict with the First Law.

iii. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

1.1.2 Definition of Robot

The Robotics Institute of America (RIA) considers machines as robot if the machine fits the requirement as stated below:

A robot is a re-programmable, multi-functional manipulator (or device) designed to move material, parts, tools, or specialized devices through variable programmed motions for the performance of a variety of tasks.

1.1.3 Modern Usage of Robots

Robots are capable of performing almost all kind of tasks that the designers could think off. If the designer is able to build and program the robot, then the robot is definitely capable of performing the desired task. Hence, robots are used in all kind of sectors due to their capabilities and their near limitless possibilities.

Robots are used most in the industrial sector. Robots are considered useful due to their ability to perform tasks without stopping and not needing rest unlike humans. Their main attribute is that robot can perform repetitive tasks without any complains and they
do not go on strike like humans do when they are not satisfied. On the other hand, robots can perform task with more precision and accuracy compared to their human counterparts.

Warehouse robots are AGV used in the warehouses to perform loading and unloading of materials. The purpose of warehouse robot is to reduce costs of manufacturing and increase efficiency in a manufacturing system as well as to improve the efficiency of logistics operations in a warehouse. A warehouse robot can drastically reduce the workforce required to run a facility, with human input required only for a few tasks, such as picking units of product from a bulk packed case.

1.2 Problem Statement

The previous or existing transportation vehicle type AGV lack the flexibility in movement. These AGV was unable to maneuver in really tight place or the warehouse. While there have been transportation vehicle which is able to maneuver omni-directionally, but it requires human to operate it. However, requiring human workforce will increase operation cost. This procedure is not reliable, dependable nor productive since human does not work 24 hours a day and 365 days in a year.

1.3 Objectives

The objectives of this project are to:

i. Design and develop a transportation vehicle AGV system transportation vehicle using PIC Microcontroller.
ii. Design and develop the maneuvering system using servo motors.
iii. Design and program omni-directional movement using omni-wheel.
1.4 Scope of work

The scope of work in this project is stated as given:

i. PIC16F877A microcontroller and its programming commands using programming language.

ii. The AGV transportation vehicle will able to follow the line.

iii. The AGV transportation vehicle is able to maneuver in omni-directions.

iv. Capable of transporting payload up to 2 kilograms.

1.5 Report Structure

This thesis is a documented report of the ideas generated, the theories and concepts applied, the activities performed and the final product of this project produced. The thesis consists of five chapters and each chapter is described as below:

Chapter 1 discusses on the history of robot, definition of robot and the modern usage of robot. Pictures are included along with the information. In addition, problem statement, objectives of the project and the report structure is included as well.

Chapter 2 consists of the background study of the project along with the literature review, which is performed and documented about the theoretical concept applied in constructing the robot. Background study on the AGV and the line following robot shows how the line following concept works. Reviews are done on the materials that are suitable to be used for this project. Microcontrollers, sensors and motors are explained in this chapter.

Chapter 3 explains on the introduction of methodology of the project, design flow and construction of the project. Brief description is given about each procedure in
the completion of the project. The list of tools and approaches used in this project are included.

Chapters 4 cover the result of all the designing, testing and troubleshooting processes. It contains the overview development of the project hardware and includes the construction and design of the entire robot as well as the microcontroller circuit board, the sensor circuit board, the track for line following and the pickup mechanism. Testing and troubleshooting of these circuit boards are mentioned. Analysis of the problems encountered during the development of the project and the solutions performed in order to overcome the problems are discussed.

Chapter 5 is the final part of the thesis which concludes the Final Year Project. This chapter includes the application of the project and the recommendation that can be implemented for future references.
CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

With various amount of microcontrollers, sensors, motors and omni-wheels in the market, it is rather complicated to find the suitable components and not to mention the vast number of specification which varies according to their manufacturers. Hence, a literature review is performed in this chapter to make a review on the various types of microcontrollers, sensors, motors and omni-wheels that are available on the market. This is imperative step as a guide to choose the most suitable components which are going to be used for this project.

2.2 Robots

A robot is a reprogrammable multifunctional manipulator designed to move materials, parts, tools, or specialized devices through variable programmed motions for the performance of a variety of tasks (Rehg, 1985). The robot is also defined as a software-controllable man-made device that uses sensors to guide itself and/or its end-effectors through deterministic motions in order to manipulate physical objects.
Robot can be categories into 2 classes which are the industrial robot (manipulator) or the mobile robot.

2.2.1 Automated Guided Vehicle (AGV)

AGV is a mobile robot used in industrial applications to move materials from point to point (refer Figure 2.1). AGVs operate in specially modified environments (typically containing induction loops, beacons, or other markers) and carry out transportation tasks along fixed routes [2]. Most of these robots operated a simple algorithm which the robot will keep the line in the centre through its sensor. The AGV can work in various environments ranging from harbour dockside areas to normal warehouse. Loading and unloading handling of the AGV are automatic, thus the AGV does not requires an operator to handle it. The pickup mechanism uses fork attachments, conveyers, shafts and etc. but depends on the loading and unloading units that it handles. Modern or current AGVs are controlled by computers using on-board microprocessor and are equipped with robotic arms and gripper to perform load and unload handling.

Figure 2.1: Automatic Guided Vehicle (AGV)
2.3 Drive System

Motor is the heart of the drive system if not the body. Motor is used in order to convert electrical signal (energy) to mechanical energy, thus enabling the vehicle to move according to the desired direction. Most electric motors work by electromagnetism which is based on the fundamental where any current-carrying wire contained within a magnetic field will produce a mechanical force.

2.3.1 Servo Motor

Servomechanism is a device used to provide control of desired operation through the use of feedback. Servo motor is a motor that implements the servomechanism which the motor is capable of provide control of the motor movement through the use of feedback. It measures its own position and compensate for external loads when responding to a signal. A servo motor consists of a DC motor, a position feedback potentiometer, reduction gear and an actuator arm.

![Disassembled servo motor](image)

Figure 2.2: Disassembled servo motor

Servo motors are commonly used for radio control (RC) applications. RC servos are servos typically employed in industrial robotics, automation, and radio-controlled models. RC servos are comprised of a DC motor mechanically linked to a potentiometer. Pulse-width modulation (PWM) signals from the microcontroller sent to the servo are
translated into position commands by electronics inside the servo. Once the servo received its command, the DC motor is powered until the potentiometer reaches the value corresponding to the commanded position that it's ordered.

Servo motor has a control circuit and potentiometer (also known as pot) that is connected to the output shaft. The pot allows the control circuit to monitor the current angle of the servo motor. Once the shaft reaches or is at the correct angle, the motor will shut off. However, if the angle is not according to the control circuit, the motor will turn in the correction direction till it reaches the desired angle. The output shaft of the servo is capable to traveling to approximate 180 degrees. However, there are those which can go even further to somewhere around 210 degrees. There are even those specially designed which is capable of rotating continuously. A conventional servo is used to control at an angular motion of 0 to 180 degrees due to the mechanical gear built, except the continuous servo. The amount of power supplied to the motor is proportional to the distance traveled. Thus, this is called a proportional control.

The control wire is used to communicate the angle. The angle is determined by the duration of a pulse that is applied to the control wire. This is called Pulse Coded Modulation. The servo expects to see a pulse every 20 milliseconds. The length of the pulse will determine how far the motor turns. A 1.5 millisecond pulse, for example, will make the motor turn to the 90 degree position (called the neutral position). If the pulse is shorter than 1.5 ms, then the motor will turn the shaft to closer to 0 degrees. If the pulse is longer than 1.5ms, the shaft turns closer to 180 degrees.