**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

## BORANG PENGESAHAN STATUS LAPORAN PSM

TAJUK: **Automated Guided Cart**

SESI PENGAJIAN: **2008/2009 Semester 2**

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Disahkan oleh:

(TANDATANGAN PENULIS)

(TANDATANGAN PENYELIA)

Alamat Tetap:
24, Evergreen Cresent,
Bunga Raya Garden,
31650, Ipoh, Perak

Cop Rasmi:

NUR AIDAWATY BTE RAFAN
*Pensyarah*
Fakulti Kejuruteraan Pembuatan
Universiti Teknikal Malaysia Melaka
Karung Berkunci 1200, Hang Tuah Jaya,
Ayer Keroh 75450 Melaka

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# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## AUTOMATIC GUIDED CART

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bechelor Degree of Manufacturing Engineering (Robotic and Automation) with Honours.

by

**THAM WAI FOONG**

FACULTY OF MANUFACTURING ENGINEERING

2009

# DECLARATION

I hereby, declared this report entitled "Automatic Guided Cart" is the results of my own research except as cited in references.

Signature : .....

Author's Name : THAM WAI POONG

Date : 22/05/09

# APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotic and Automation) with Honours. The member of the supervisory committee is as follow:

(Signature of Principle Supervisor)

.....

(Official Stamp of Principle Supervisor)

NUR AIDAWATY BTE RAFAN
*Pensyarah*
Fakulti Kejuruteraan Pembuatan
Universiti Teknikal Malaysia Melaka
Karung Berkunci 1200, Hang Tuah Jaya,
Ayer Keroh 75450 Melaka

(Signature of Co-Supervisor)

.....

(Official Stamp of Co-Supervisor)

SILAH HAYATI BINTI KAMSANI
*Pensyarah*
Fakulti Kejuruteraan Pembuatan
Universiti Teknikal Malaysia Melaka
Karung Berkunci 1200, Hang Tuah Jaya,
Ayer Keroh, 75450 Melaka.

# ABSTRACT

The present invention related to automated guided cart (AGC) particularly to cost-effectiveness, light duty vehicle, which is specifically adapted for use in light manufacturing shop floor. This AGC followed a magnetic guide taped on floor to move goods or material from one point to another under PIC control. The AGC system employ specifically designed carts, which are configured particularly to carry components such as automobile chassis or assembly components in an automobile assembly operation. Generally, the method to achieve the objectives, it consists of designation stage, procurement preparation stage, material preparation stage, fabrication stage, and examination stage. This project involved design and development of the AGC system through the engineering skills via mechanical calculation and analysis, material selection, electrical circuit design, and programming of the PIC controller. In the implementation stage, a light duty AGC produce and applicable to industrial environment to accomplished the project.

# ABSTRAK

Ciptaan projek berautomatik panduan kereta (Automated Guided Cart) terutamanya untuk keberkesanan kos, kenderaan tugas ringan dan khususnya disesuaikan oleh penggunaan dalam tingkat pembuatan ringan. AGC ini diikuti satu panduan yang magnetik merakamkan di atas lantai untuk bergerak barangan atau bahan di sepanjang lorong yang ditentukan. Ia dikawalkan oleh PIC mengawal untuk bergerak dan pelbagai fungsi. Sistem AGC reka bentukan mengatur corak yang tatarajah terutamanya untuk melaksanakan komponen-komponen ibarat casis kereta atau komponen-komponen pemasangan dalam operasi automobil pemasangan. Umumnya, kaedah untuk mencapai matlamat-matlamat, ia mengandungi peringkat gelaran, ia itu, tahap persiapan pemerolehan, tahap persiapan bahan, peringkat pembuatan, dan peringkat peperiksaan. Rekabentuk dan pembangunan AGC terlibat dalam projek ini melalui kemahiran-kemahiran kejuruteraan adalah pengiraan dan analisis mekanikal, pemilihan bahan, rekabentuk litar elektrik,dan pengaturcaraan PIC mengawal. Untuk mencapaikan matlamat projek ini, dalam peringkat pelaksanaan, AGC yang bertugasan ringan menghasilkan dan bersedia digunakan untuk persekitaran perindustrian dicipta.

# ACKNOWLEDGEMENT

I would like to express my gratitude to all those who gave me the possibility to accomplish this project of manufacturing engineering bachelor's degree entitled automated guided cart. I want to thank the Department Managemtnt Faculty of Manufacturing of Universiti Teknikal Malaysia Melaka (UTeM), Prof. Dr. Mohd. Razali b. Muhamad and giving me permission to commence this project in the first instance, approved the title of project proposed. I have furthermore to thank the Management of Project Sarjana Muda, Sivarao a/l Subramonian, and Head of Department of Robotic and Automation, Dr. Zamberi bin Jamaludin who gave and confirmed this permission and supported me to progressing with my project.

I am deeply indebted to my supervisor, Puan Nur Aidawaty bt. Rafan and principle co-supervisor, Puan Silah Hayati bt. Kamsani from the Department of Robotic and Automation of UTeM whose help, stimulating suggestions, technical information, and encouragement helped me in all the time of project and writing of this report.

My colleagues from 4BMFA of UTeM supported me in my research work. I want to thank them for all their help, support, interest and valuable hints. Especially I am obliged to Mr. Lim, Lee Wai Keong, Tan Sia Peng for the great help in difficult times and suggestions for improvement.

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# LIST OF ABBREVIATIONS

| | | |
|---|---|---|
| AC | - | Alternative Current |
| ADC | - | Analog Digital Convertor |
| AGC | - | Automated Guided Cart |
| AGV | - | Automated Guided Vehicle |
| AGVS | - | Automated Guided Vehicle System |
| AISI | - | American Iron and Steel Institute |
| CAD | - | Computer Aided Drawing |
| CCP | - | Capture and Compare Module |
| CPU | - | Central Processing Unit |
| DC | - | Direct Current |
| DIP | - | Dual Interchange Pin |
| EEPROM | - | Electrically Erasable Programmable Read-only Memory |
| FMS | - | Flexible Manufacturing System |
| GND | - | Ground |
| I/O | - | Input / Output |
| IC | - | Integrated Circuit |
| IDE | - | Integrated Development Environment |
| IR | - | Infra-Red |
| JIT | - | Just In Time |
| LED | - | Light Emitting Diode |
| NEMA | - | National Electrical Manufacturers Association |

| | | |
|---|---|---|
| PIC | - | Programmable Intelligent Computer |
| PWM | - | Pulse Width Modulation |
| R | - | Resistor |
| RAM | - | Random Access Memory |
| RPM | - | Radius per Minute |
| SCR | - | Silicon Controlled Rectifier |
| UNS | - | Unified Numbering System |
| USART | - | Universal Asynchronous Receiver / Transmitter |
| USB | - | Universal Serial Bus |

# CHAPTER 1
# INTRODUCTION

This chapter introduced the general information regarding to this title of project and problem statement to state reason to develop the research and implementation of Automated Guided Cart. Brief declaration of Automated Guided Cart discussed.

## 1.1 Introduction

Automated guided vehicle system (AGVS) is a material handling system that uses independently operated, self-propelled vehicles guided along defined pathways (Groover, 2008). The vehicles are powered by on-board batteries that allow many hours of operation. An AGV is suitable applies on automating material handling in batch production and flexible manufacturing system.

In this project, automated guided cart (AGC) developed in the application of material handling to light duty industry as assembly line applications, storage and distribution and logistics. There are three main tasks to carry out the project, which are mechanical structure, controlling electronic circuit components and comments programming. From designation, material selection, implementation and evaluation stages, discussed.

## 1.2 Problem Statement

Material handling equipment is usually assembled into a system. The system must be specified and configured to satisfy the requirement of a particular application. It depends on the materials to be handled, quantities and distance to be move, type of production facility served by the handling system, and other factors, included available budget.

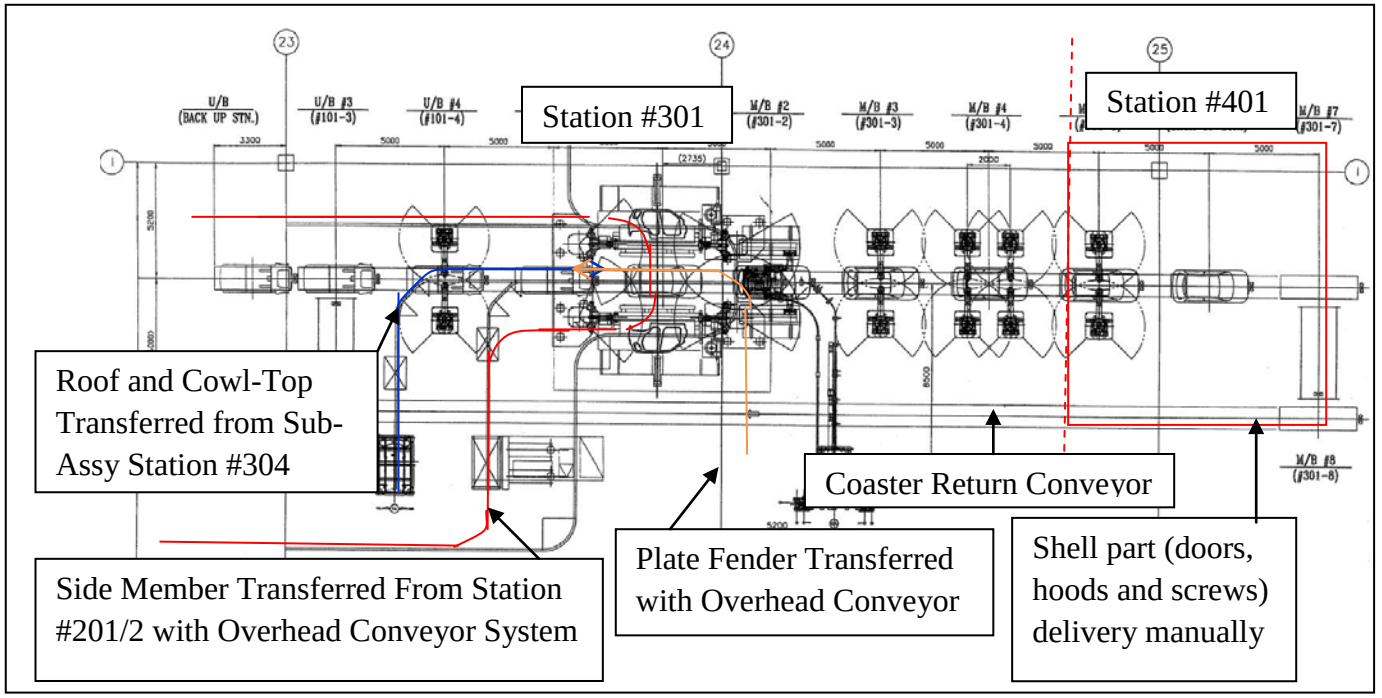



**Figure 1.1**: Production layout illustrated material handling system in present practice (Perodua, 2007)

In current practice, progress of welding to form a Main Body of KENARI (station #301) presently is perform in a completely automated process line as shown in Figure 1.4. In the #301 process, it involved robot welding and the main body delivery automatically by the conveyor. When the main bodies proceed to the station #401, which is assembles of the doors and hood. Screws and nuts, doors and hoods are delivery manually by the tow tractor from the storage. Due to the tow tractor delivery not in time, downtime of the operation occurred. Furthermore, extra cost of man power and diesel needed to perform delivery process.

Every point affects the manufacturing cost. Especially man power operated required labor costs and petrol and diesel consumption due to prices crisis increment. Therefore, a reasonable adjustment and development required to encounter these circumstances.

There are several alternatives to modification from manual supply to automated supply to the station #401, which are automated guided cart system and conveyor system.

**Table 1.1**: Comparison of material handling methods

| | **Automated Guided Cart** | **Manual Transport** | **Conventional Conveyor System** |
|---|---|---|---|
| Initial Investment Cost | Cart & Magnetic / Wire Tape Installation | Fork Lifter / Towing Truck | Building Construction and Modification |
| Labor, Maintenance and Power Consumption Costs | Labor Cost = 0 Maintenance = Average A Month Once Power Consumption = Electrical Powered | Labor Cost = Each per Transports Maintenance = Average 6 Month Once Power Consumption = Fuel Consumption | Labor Cost = 0 Maintenance = Average 2 Month Once Power Consumption = Electrical Powered |
| Productivity & efficiency | High | Medium | High |
| Material Flow (JIT System & FMS) | Point to Point | Point to Point | Station to Station |

To implement automation to a process, several facts and consideration stated as following based on the problems indicated, summarized of the AGC system responded to its problems are:

- Cost effectiveness and Labor Free: Automated Guided Carts are in fact, required no labor other than periodic and remedial maintenance. They can operate 24 hours a day without supervision, injuries, pensions, vacations or sick days. Furthermore, electrical power drives the movement of AGC is much more environment friendly and zero fuel consumption needed depend to fork lifter and towing truck.

- Space Efficient: AGC require little more space than the material they are carrying and since they are mobile and equipped with on-board safety equipment, they can co-exist with people, manual material handling and processes such as assembly.

- Increase productivity while reduce costs: A prime for cost saving in manufacturing is through in-process inventory reduction and facilities investment. Simply by adding or removing the AGC from the line, assembly production rate can be adjustable. This fits to company which applied Just-In-Time System and Flexible Manufacturing System. In an addition, the load handling is easy to modify to fits the materials or products needed to carries. Therefore, it protecting the initial investment of the product.

## 1.3 Objectives

(a) To develop and produce a cost-effectiveness and flexible autonomous Automated Guided Cart (AGC).
(b) To develop and produce an Automated Guided Cart which is controlled by Programmable Intelligent Computer (PIC) Microcontroller.
(c) To develop and produce an Automated Guided Cart, which is, could be applied into industrial environment included safety aspects.

## 1.4 Scope

(a) Design and fabricate the structure of the Automated Guided Cart.

When the materials selected to be used for the frame fabrication, dimensions design and draw through computer aided design (CAD) drawing or technical drawing prepared for the assisting to the fabrication stage. There is also needed to inspect the function of the frame is supportable.

(b) Design and develop the controller of the Automated Guided Cart PIC microcontroller.

In electrical construction, PIC microcontroller is the main component to control the function of the AGC. In the programming stage, several hardware needed to be prepared, they are: (1) burning circuit that transferring the source codes to computer and convert to machine codes and load into the PIC microchip, (2) programming software used to complies the source code, (3) computer used as the input and output module between the microchip and the designed source code.

(c) Design the electrical circuit of the motor driver circuit board and magnetic circuit board.

For the electrical circuit, it required to design and develops a workable electronic circuit board that is able to interface to the microprocessor circuit board. Selection to the magnetic sensors that meet to the microprocessor as input devices needed.

# CHAPTER 2
# LITERATURE REVIEW

In this chapter, the review of information is to support the knowledge and skills before started the project. There are two major section contained, which are mechanical section, and electrical section. Due to the information, it ensure the research and development of the project accomplish.

## 2.1 Vehicle Guided Technology

The guidance system is the method by which AGC pathway is defined and cart is controlled to follow the pathways. In this section, it discusses three technologies that are common used for the vehicle guidance: (1) imbedded guided wires, (2) paint strips, and self-guided, and (3) self-guided vehicles.

### 2.1.1 Imbedded Guided Wires

A guided system for a self-guided vehicle features an electrical conductor and permanent magnets embedded together in an elongate groove formed in a vehicle supporting surface such as a factory or warehouse floor. The electrical conductor provides steering guidance while the permanent magnets embedded with the conductor provide other information without distorting the magnetic field of the electrical conductor. To prevent such distortion, the permanent magnets are selected for their low magnetic permeability and high electrical resistivity. Magnetic field sensors are provided on the vehicle for determining exact position of the vehicle

along its path of travel by sensing deviation, or lack thereof, with respect to such permanent magnets. (Laid, 1987)

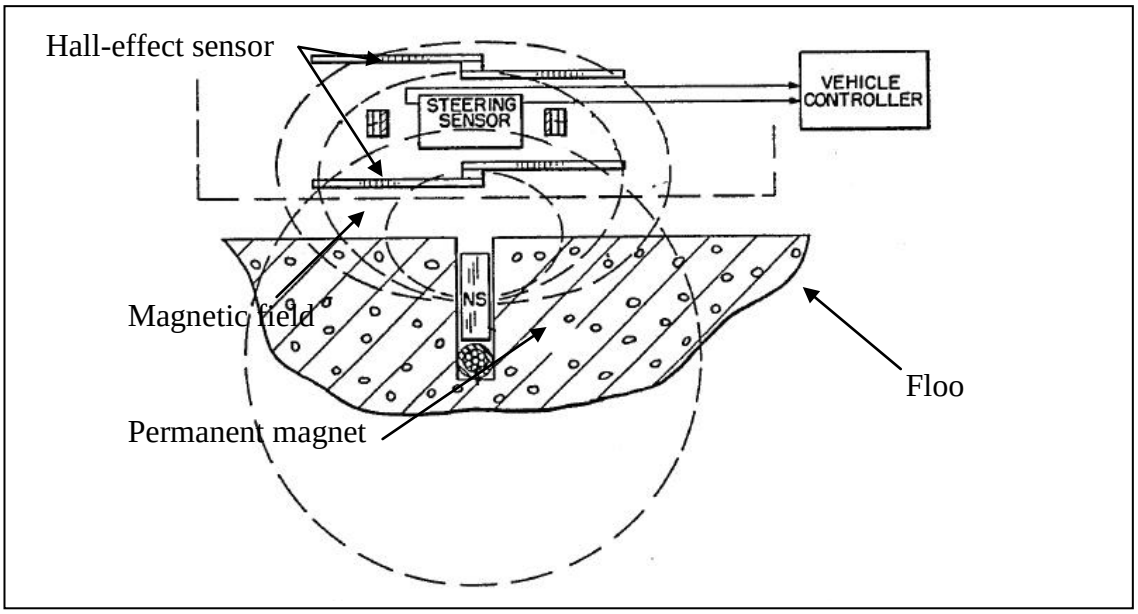



**Figure 2.1**: Plan view of an exemplary embodiment of the information sensing portion of the guided system. (Laib, 1987)

### 2.1.2 Paint Strips Guidance

The self-propelling vehicle is adapted to carry a load and has steering-wheels and a central driving-wheel as well as optical detectors designed to read an optical track laid out on the ground and furnishing passive driving signals, the vehicle also being provided with an ultrasonic emitter-receiver assembly working as a radar and operative to detect obstacles along the path of movement of the vehicle. (Deplante, 1982)

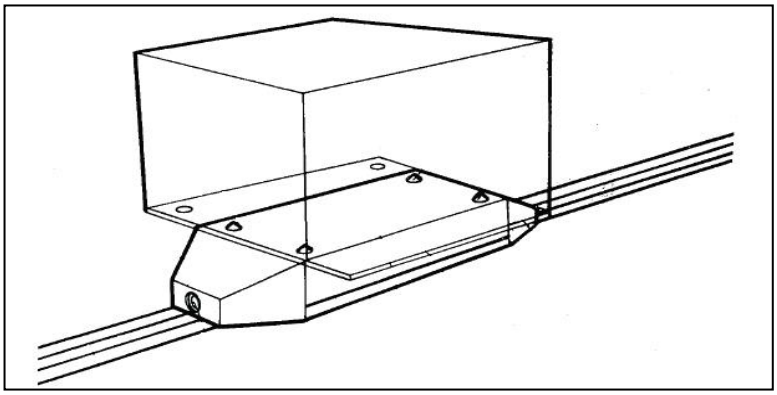


**Figure 2.2**: The diagrammatical perspective view of the AGV adapted to move automatically along an optically defined path for carrying a load from a starting point to an arrival point. (Deplante, 1982)

### 2.1.3 Self Guided Vehicle

A navigation system for use in a self-guided material handling vehicle provides guidance during operation in areas having densely stacked rows of containers and reduces the potential of deviation of the self-guided vehicle from the desired path travel. A laser-signaling device is mounted on the vehicle and rotatable about an axis of the rotation extending generally perpendicularly to the longitudinal axis of the self-guided vehicle. The laser-signaling device is adapted to delivery a light beam signal at the first preselected angle relative to the axis of rotation of the laser-signaling device, at a second different preselected angle relative to the axis of rotation. Receiving devices a reflection of the light beam signal and delivers a position signal in response to the light beam signal received. The navigation system is particularly suited for use in automation storage and retrieval systems. (Wible, 1990)

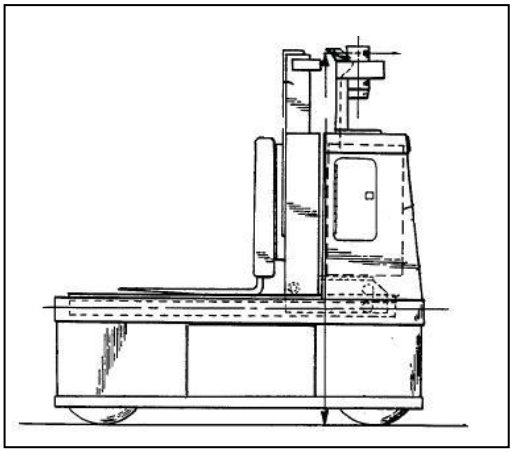


**Figure 2.3**: A diagrammatic side elevation view of a self guided vehicle (Wible, 1990)

## 2.2 Mechanical Review

Design of automated machine always consists of two major elements, which is mechanical and electrical element. In mechanical design, it creates device or system to satisfy specific needs. Mechanical devices typically involve moving parts that transmit power and accomplish specific pattern of motion. Mechanical systems are composed of several mechanical devices.

### 2.2.1 Material in Mechanical Design

It needed to specify suitable material for each component of a mechanical device before further designation. The initial efforts in specifying a material for a particular component of a mechanical design should be directed to the basic kind of material to be used. Function of the component, kinds and magnitudes of loads it will carry, and the environment in which it will operate should be specified. (Mott, 2002)

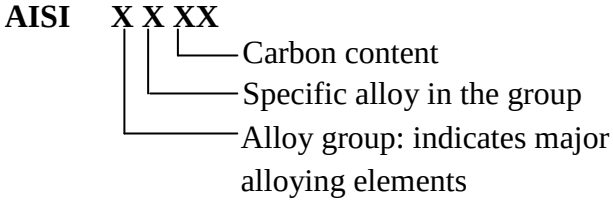
Machine elements are often made from one of the metals or metal alloys such as steel, aluminum, cast iron, zinc, titanium or bronze. Strength, elastic, and ductility properties for metals usually determined and considered in the stage of design.

**(a) Carbon and Alloy Steel**

Steel is possibly the most widely used material for machine elements because of its properties of high strength, high stiffness, durability and relative ease of fabrication. Many types of steel are available.

The term steel refer to an alloy of iron, carbon, manganese, and one more other significant elements. Carbon has very strong effect on the strength, hardness, and ductility of any steel alloy. The other elements affect hardenability, toughness, corrosion resistance, machinability, and strength retention at high temperature. The primary alloying element present in the various alloy steels are sulfur, phosphorus, silicon, nikel, chromium, molybdenum, and vanadium. (Mott, 2002)

General Form of Designation




The AISI uses a four-digit designation system for carbon and alloy steel as shown above. The first two digits indicate the specific alloy group that indentified the primary alloying element other than carbon in steel. The last two digits indicate the amount of carbon in the steel (Mott, 2002).