DESIGNING AND METHODOLOGY OF AUTOMATED GUIDED VEHICLE ROBOTS/ SELF GUIDED VEHICLES SYSTEMS, FUTURE TRENDS

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ABSTRACT

Automated Guided Vehicles (AGVs) have been operating effectively in factories for decades. These vehicles have successfully used strategies of deliberately structuring the environment and adapting the process to the automation. The objective of this project is to develop automated guided vehicles systems that autonomously transport material from loading to unloading stations but our teams have been designing new AGVs with more maximizing productivity across industry. The potential of robot technology to increase the intelligence and adaptability of AGVs is largely unexploited in contemporary commercially-available vehicles. AGVs are increasingly becoming the popular mode of container transport and factories. These unmanned vehicles are used to transfer containers between two or more destination. The efficiency of a container terminal is directly related to the amount of the time each vessel spends in the port. Advanced technologies, and in particular automated guided vehicle systems, have been recently proposed as possible candidates for improving the terminal's efficiency not only due to their abilities of significantly improving the performance but also to the repetitive nature of operations in container terminals. To our knowledge, this is the first instance of an AGV that has operated successfully in a relevant environment for an extended period of time without relying on any expensive systems. These vehicles have successfully used strategies of deliberately structuring the environment and adapting the process to the automation.

Keywords: *Automated Guided Vehicle (AGV), Robots, Industry, Automation*

1. INTRODUCTION

The first AGV system was built and introduced in 1953. It was a modified towing tractor that was used to pull a trailer and follow an overhead wire in a grocery warehouse. By the late 50's and early 60's towing AGVs were in operation in many types of factories and warehouses. AGVs have evolved into complex material handling transport vehicles ranging from mail handling AGVs to highly automated automatic trailer loading AGVs using laser and natural target navigation technologies.

The market for AGVs (automated guided vehicles) is the oldest established market for mobile robots. This market was valued at $566 million globally in 1998 and it was projected to reach $900 million by 2005 [4]. The largest consumer of AGVs is the automotive industry although many other industries including warehousing and distribution, paper, printing, textiles, and steel also use these vehicles. Even large 65 ton material handling vehicles in the shipyards of Rotterdam and Brisbane [2] have been successfully automated. While there are many specialized forms of AGVs, three main types of vehicle are in use today:

- *Tug or Tractor:* These pull several passive loads placed on wheeled platforms behind them.
- *Unit Load*: This type carries a single load placed on a platform on the vehicle.
- *Forked:* These carry a single load but also pick it up and place it using fork implements.

In part, the historical success of these vehicles has been based on a strategy of exploiting the valid assumptions of structured indoor environments. Such assumptions include mostly flat floors and the assumed availability of infrastructure that is provided to support vehicle guidance. System design elements include reducing speeds to very safe levels, centralizing movement authority, and confining the vehicles to dedicated pathways, known as *guidepaths*, which are kept clear of obstacles to the highest degree possible. Of course, such risk reduction comes at the cost of limitations in performance and adaptability. Contemporary AGVs rely heavily on specially installed infrastructure to determine their position in the facility. Such infrastructure is costly to install and modify.

What is AGV?

AGV is one type of Material Handling Equipment (MHE) like conveyors, cranes & hoists, elevator & lifts, automatic storage & retrieval system and so on which are focuses on process of transferring something from one place to another places especially in industrial sector or industrial warehouse. Actually, the goals to maintain or improve product quality reduce damage and provide protection of materials, promote safety and improve working condition, promote productivity, control inventory and so on. For further information, AGV is a driverless vehicle capable of moving along predetermined paths and performing certain prescribed duties. AGVs have become increasingly popular as a means of horizontal material handling transportation system. They are used wherever there is a need for an autonomous transportation system. AGVs are particularly useful where products need to be handled carefully or the environment is potentially dangerous to humans. Examples include handling of telecommunication products, IC chips, voltage cables and radioactive materials. In the automotive manufacturing industry, AGVs have been combined with robots to perform welding and painting operation.

Figure 1: AGV Systems

Guidance

Different guidance methods can be chosen depending on varying factors such as the customer's requirements, frequency of transportation, existing facilities, cost of installation and future expansion. A combination of guidance systems is also possible. The three most common systems are laser, wire and tape guidance described below.

- **Laser guidance:** The laser technique provides the customer with extensive freedom because the automated guided vehicle does not need any tracks, wires or rails, but can be easily programmed for both indoor and outdoor driving. The driving routes can easily be changed within the software.
- **Wire guidance:** Wire guidance is a well-proven navigation system where the vehicle follows a wire laid in the floor. Information is transferred via the wire, radio or defined information points to a host computer. Wire guidance can be applied to both indoor and outdoor use.
- **Tape guidance:** The vehicle follows a taped or painted line on the floor via a camera. Information is transferred via radio communication. Tape guidance is only suitable for indoor use.

Types of AGVs

- **Unit load vehicles** feature rugged steel frames and onboard conveyance, making them suitable for industrial environments with automated processes.
- **Cart vehicles** popular in the automotive and electronics industries, are used for material transportation and assembly line tasks. Typically featuring low capacity and complexity, these systems are less expensive than

conventional AGVs and also more flexible. Most cart vehicles follow a magnetic tape on the floor, so changing the path is quick and inexpensive.

- **Fork vehicles** are designed for applications in which automated load pickup or delivery is required from various heights. Fork vehicles are most often used for trailer loading and unloading and floor-to-floor delivery.
- **Pallet Trucks** are designed to transport palletized loads to and form floor level; eliminating the need for fixed load stands.
- **Light Load vehicles** are vehicles which have capacities in the neighborhood of 500 pounds or less and are used to transport small parts, baskets, or other light loads though a light manufacturing environment. They are designed to operate in areas with limited space.
- **Towing Vehicles** were the first type introduced and are still a very popular type today. Towing vehicles can pull a multitude of trailer types and have capacities ranging from 8,000 pounds to 60,000 pounds.

Components of an AGV System

- **Vehicles:** The vehicle or the AGV consists of the frame, batteries, on-board charging unit, and electrical system, drive unit, steering, precision stop unit, communication unit, safety system and work platform. The components mentioned above can each be further classified into different categories based on their capabilities and features.
- **Guide path and guidance systems:** The guide path techniques used are known as passive or active tracking. Passive tracking occurs when optical or metal detection principles (wireless) are used for vehicle guidance whereas active tracking involves inductive principles (for example, guide wire is used to help tracking).
- **Floor and system control**s: The controller is the brain of the whole system, tying the vehicle and the guide path together and integrating the system. The AGVs contains three levels of control architecture: vehicle control system, floor control unit and vehicle on-board processor.

How do AGV control systems differ?
The centralized controller approach utilizes a PC or other computer device to manage the movement of vehicles along the path. Often, this is called the smart central approach. Either or both the routing or traffic control functions would be performed by the central controller. The AGVs would take appropriate direction from the central controller via a communications link.
The decentralized control approach does not require a central controller device for basic vehicle movement. Instead, the vehicles perform their own routing and traffic control functions. This is often referred to as the smart vehicle approach. The AGVs would use their onboard intelligence to select their route to a destination and they would avoid running into other AGVs operating on the path by communicating directly between AGVs.

Features of AGV systems
AGV system can easily be interfaced with other modules of FMS, such as robots, automatic storage and retrieval system (AS/RS), CNC machines, etc.
AGV system offers considerable flexibility, as it is adaptable to change in product as well as production.
AGV material handling system is very suited to computer integrated manufacturing system (CIMS). This is due to on-board controller of the AGV.
The integrated material handling system facilitates the optimization in the efficiency of the manufacturing systems and improved productivity.
AGV system has the ability to handle variability in the production rate or changes in product routing.
Compared to conventional material handling systems, it has the flexibility to adapt to changes in machines layout and product design without major capital investment.
It has ability to transport low to medium volume unit load material to a reasonable large distance in the factory without many problems.
There is low noise and disturbance level with AGV system.
Operational safety is more due to non-involvement of labour.

Figure 2: AGV System

Why use guided vehicles?
Automating the routine movement of goods frees up truck drivers for more demanding and flexible work, while reducing errors and accidents and rendering operations transparent. The greatest benefits are gained in multi-shift work.

What is an AGV?
AGV (Automated Guided Vehicle) is an automatically controlled truck typically performing repetitive and predefined logistic tasks in industry or warehouses. AGV can free human capacity for more challenging tasks. AGV performs constantly 24h / 7days.

Motivation
AGV guidance systems have been evolving for about 50 years. Some of the more significant guidance technologies include:
• *Wire Guidance:* Wires embedded in the floor are sensed inductively in order to determine vehicle lateral position with respect to the wire. This is an earlier technology which is not used much today.
• *Inertial Guidance*: Gyroscopes and wheel *odometry* (measurements of distance traveled*)* are used to implement very accurate dead reckoning. Magnets are placed in the floor at regular intervals to be used to reset the inevitable drift of the dead reckoning system.
• *Laser Guidance*: A spinning laser emitter-receiver is mounted on the vehicle. It senses the bearings to retro reflective landmarks placed carefully in the facility and then it triangulates an accurate solution. Available on the market today.
It has long been a goal of the AGV industry to reduce dependence on guidance infrastructure – the wires, magnets and reflectors mentioned above. The need to preserve visibility of infrastructure limits the capacity of vehicles to deviate from pathways that were specified when the system was installed. Wire guided vehicles must stay very close to the wire, laser guided vehicles must avoid interrupting their line of sight to specially-mounted retro reflectors, and inertially guided vehicles must drive over floor magnets at regular intervals.
Systems which are able to deviate significantly from their guide paths are known as *free-ranging*. When vehicles are not free-ranging, a single failed vehicle can temporarily block a main thoroughfare and shut down all automated traffic. Infrastructure dependence often prevents AGVs from operating in environments where infrastructure is difficult to employ. For example, weather conditions make outdoor environments more challenging, although radar guidance has been used successfully outdoors. For applications that involve operations in semi trailers, it is normally not feasible to place adequate infrastructure in the trailer. The trailers are not usually owned by the facility and they are not dedicated to any particular shipping route or customer. A second limitation of contemporary AGVs is that they are essentially blind. With some exceptions, contemporary systems rely on precise positioning of loads because the systems cannot determine if the loads are imprecisely positioned. These vehicles may not be able to interface with loads placed by human-driven vehicles because humans do not usually position loads with the required precision.

CONCLUSION AND RESULTS

This paper describes the design and development of the AGVs, a low-cost, modular, and flexible AGV system. Low cost was achieved by using simple, off-the shelf components and by avoiding large software and hardware development costs. The vehicle navigation system is very flexible in that it is capable of either line-following or free navigation. In addition, the guide path in the line-following mode is a simple reflective tape that can be installed, removed, and changed easily.

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BIBLOGRAPHY

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