APPLICATION OF AGV IN INTELLIGENT LOGISTICS SYSTEM

B.Y. QI, Q.L. YANG, Y.Y. ZHOU

The 28th Research Institute of China Electronics Technology Group Corporation, Nanjing 210007, China

qby0825@163.com

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Abstract

AGV, a flexible and intelligent logistics handling robot, as intelligent logistics equipment, has been widely used in material handling, assembly lines and other occasions. The components, communication and guiding principle of the AGV system, were introduced, and the logistics distribution model of AGV was analyzed, which provided a reference on the applications for AGV in discrete manufacturing process.

1 Introduction

AGV (Automated Guided Vehicle) is a flexible and intelligent logistics handling robot, which is equipped with an electromagnetic or optical means, such as automatic steering apparatus capable of guiding along a predetermined path of travel, with security and a variety of transfer functions chariot. The first automatic truck, 1913 Ford Motor Company for the chassis assembly, reflecting the use of the automatic guided vehicle then called superiority. By the mid-1950s, the British adopted under floor embedding, formed to guide electromagnetic induction simple AGVS. 1960s computer technology applied to the management and control AGV systems, AGV system from automated warehouses into a flexible manufacturing system (FMS) and production systems, so that AGV has been rapid development. Since the efficiency and flexibility of the AGV, making AGV systems in advanced industrial countries that have been widely used the manufacturing and assembly process to become a popular material handling equipment [1-3].

Modern automatic production lines for the production of efficient operation, flexible logistics system requires higher and higher, product replacement types, multiple product mix production line synchronous operation, the adjustment of product yield, production lines and other aspects of regrouping, AGV itself unique superiority will the rapid development and universal application. Especially in discrete manufacturing many varieties, small quantities of product features, the workshop venues, roads and space constraints, the actual production of flexible demand, AGV is more suitable for discrete manufacturing features. AGV work areas without laying track, bearing frame and other ancillary equipment, are not subject to site constraints, road and space, the flexibility to set up smart logistics system, adequately reflect their unmanned production process flexibility for efficient and economical production management[[4-6].

This paper describes the adaptation range of the AGV, system components, communication and guiding principle, and analyses the AGV logistics and distribution model which provides a reference for AGV applications in discrete manufacturing process.

2 Scope of AGV

2.1 Material handling

In modern material handling, the AGV will be naturally accepted by the market when the total cost of human and handling tools is roughly equal with the cost of using AGV. High labour costs in developed countries of Europe, America and Japan, so the application of AGV is more popular and across the board. Such as chemical raw materials and finished products; instrumentation industry components; electronics industry chips, computers; household appliances industry; automotive parts.

2.2 Flexible assembly line/production line

Traditional production lines are generally formed by continuous transmission equipment consisting of rigid, as short as a few meters, as long as several kilometres, such as automotive assembly, cylinder processing lines. The outstanding problems are:(1)requirements every step of the beat unity, otherwise it will stop any one process because delays and affect the course of the entire production line, such as the lack of material, missing parts, scrap or unexpected problems. (2)continuous production line cut off the channels, resulting in long supply lines, people and vehicles passing convenient. (3)continuous production line requires a lot of equipment investment and costs higher. (4)some work can’t be synchronized for rigid production line.

AGV is used not only as unmanned automated guided vehicles, but also as a movable assembly station, processing station. It works both free and independent operations, but also accurate and orderly combination of convergence, forming no physical barrier, but it can play a dynamic regulation, highly flexible production lines. Such as car assembly line, engine assembly line, machining line, cabinet production lines.

2.3 Special occasions

AGV has the advantage with unmanned automatic handling, which can be used in the particular environment, such as nuclear materials, dangerous (toxic substances, corrosive materials, biological materials, flammable and explosive materials) and so on.

3 Composition of AGV system

AGV control system has three main techniques: the navigation of AGV, the layout designing of AGV, the guidance of AGV. In order to solve these problems, constitution of the AGV systems are bound complex.

AGV control system is divided into the ground (upper) control systems, vehicle (single computer) control systems and navigation/guidance system. Ground control system refers to fixed equipment of AGV system, which is responsible for task allocation, vehicle scheduling, path (line) management, traffic management, automatic charging function; the vehicle control system after receiving the instruction of the upper system, is responsible for navigation calculations of AGV, guide implementation, vehicle travel, loading and unloading operations and other functions; navigation/guidance system provides absolute or relative position and heading for AGV.

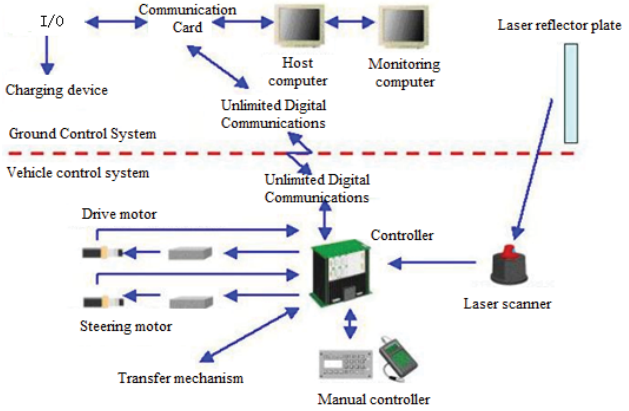


Figure 1. Hardware structure of AGV system

4 Communication of AGV

(1)Wired communication

The guide wire can be used to achieve carrier communication, wiring hidden and difficult to offset. It is mainly used for electromagnetic guidance, simple path and small area.

(2)Infrared light communication

Infrared light communication has no frequency licensing issues, high-speed communication, easy control; communications zone should be in clearly visible range, and need mechanical protection for dust-sensitive, interference from light and the other same wavelength infrared. It is for simple path without cover and small area and used for electromagnetic guidance, tape guide, optical guided AGV.

(3)Radio communication

Radio communications has good spatial coverage, and no insensitive in general interrupting; simple to install, easy protection; better results outdoor. The disadvantage is that the use frequency must be licensed and all the AGV and ground stations within the same system must be unified with a frequency, vulnerable to interference from other radio devices. It is for a variety of paths, a variety of guided mode, the more complex environment, large area.

(4)Wireless LAN

In addition to the basic characteristics of radio communications, but also the various features of network communications, fast, easy expansion, good compatibility, easy to connect with other systems, and low cost. It is for a variety of paths, a variety of guided mode, the more complex environment, large area.

5 Guiding principle of AGV

AGV can accurately calculated the position based on the sensor located in the work area, guide van autonomous driving between stations and warehouses, without any manual intervention during operation. It can automatically accept workers call instructions, automatically arrive at call position, automatically operation along the design line, automatic detection of obstacles articles and stops, and automatically detect the battery charge and automatically charging as necessary. In all functions, the core technology is the guided technology.

The guidance technologies of AGV include electromagnetic guidance, magnetic guidance, laser guidance, visual (image) guidance, inertial guidance, point guide, GPS guidance.

5.1 Electromagnetic guidance technology

The metal wire is embedded in AGV travel paths and low-frequency, low-voltage current is loaded, so that a magnetic field is created around the wire. The induction coil on the AGV achieves the guide by identification and tracking of the magnetic field strength. Its main advantages are the lead hidden and difficult to pollution and damage, guiding principle is simple, reliable, and easy to control and communications, silent light interference, lower manufacturing costs. Its main disadvantages are the flexibility to change the path of the poor; a lot of trouble adjusting, induction coil is more sensitive surrounding a ferromagnetic material and limited speed guide. It is suitable for less complex path, the operating point fixed applications, such as the engine, rear axle, dashboard delivery in car assembly.

The AGV pilot line is embedded under the ground at the working area, as shown in Figure 2.

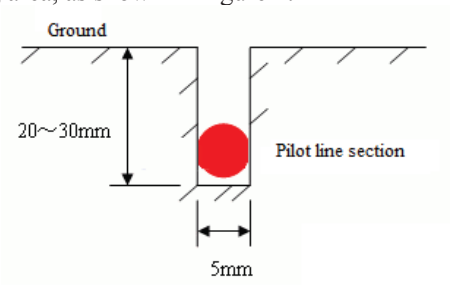


Figure 2. Embedded AGV electromagnetic pilot line

Design a pilot signal generator, an electromagnetic signal is applied to a particular exchange ends of the wire, as shown in Figure 3. Two sensors are installed on the left and right stations of AGV, and detect the alternating electromagnetic field signals that are emitted from underground wire. The deviation may be calculated between the wires and the AGV by comparing the differences of strength and frequency of two sensor signal, and it is controlled that AGV travels along the guide wire.

Electromagnetic guide is one of the more traditional way of AGV guidance, the main advantage is that the guide wire is subtle and difficult to pollution and damage, guiding principle is simple, reliable, easy to control, and communications, to fight against sound and light interference, lower manufacturing cost. The disadvantage is that the path is difficult to change the extension, the large limitations of the complex path.

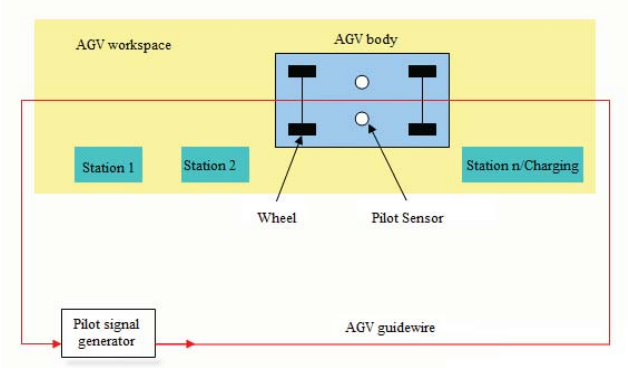
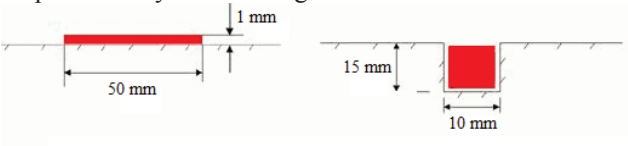


Figure 3. Electromagnetic guided AGV working schematic

5.2 Magnetic guide technology

It is similar with the electromagnetic guide. The tape is attached to the pavement, replacing metal wire buried under the ground, and the guide is achieved by magnetic induction signal. Its flexibility is better than the wire guide, and it is easier to change or expand the path, tape laying is simple, but this guide way is susceptible to interference around the loop metal species, because the tape is exposed, vulnerable to wear and tear, mechanical damage and pollution, greater guided stability affected by the environment. It is suitable for simple path, the little line, relatively clean environment applications. Such as the production line of the electronics industry, material handling of pharmaceutical companies, food companies and so on.

Magnetic pilot is constant, and strong magnetic strip can be laid on or under the ground, as shown in Figure 4. Because the short-range magnetic field signals, magnetic stripe is usually laid on the ground.



(a)Affixed to the ground (b)Buried underground

Figure 4. Magnetic guide

Magnetic stripe has the constant magnetic field signal itself, and no additional signal generator. two magnetic field sensors are installed on each side of AGV vehicle and detect the magnetic signal of magnetic stripe. The deviation and the distance are calculated between the magnetic stripe and AGV by comparing the difference of magnetic signals from the two sensors, and it is controlled that AGV travels along the magnetic lines, as shown in Figure 5.

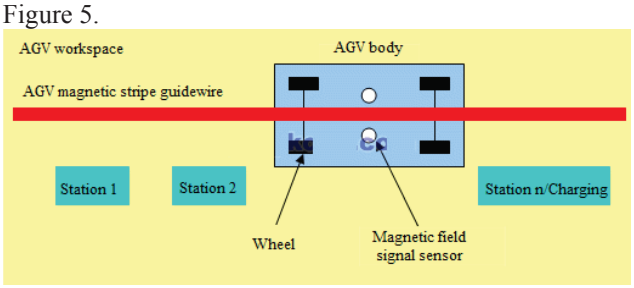


Figure 5. Magnetic Guiding AGV working schematic

The magnetic guide is one of the traditional AGV guided ways, and the main advantages are that no additional signal source, guiding principle is simple and reliable, and can fight audible interference, lower manufacturing costs. The disadvantages are easy to demagnetization, easy to wear, large limitations on the complex path.

5.3 Laser guidance technology

Laser guided is that laser reflector plates are installed around the accurate location path of AGV traveling, and then the exact coordinates of each reflector plate are measured, which are stored in AGV board computer. AGV emits laser beam by the laser head and collects the laser beam reflected the reflector plate. The length and angle of each reflected light can be measured and the AGV current position and direction will be calculated. Thus position and motion of AGV is obtained and corrective traveling is controlled.

The main advantages of laser guidance are: accurate positioning; without additional ground positioning facilities; flexible travel paths, able to adapt to the complex path conditions and working environment. The disadvantages are first that the body structure need to meet view requirements of laser scanner field, the resistance to light interference correction capability has some limitations, and high cost.

5.4 Vision-guided technology

The CCD cameras and sensors are equipped on the AGV, and the environment image database is set that the AGV will travel around the path in the vehicle computer. In AGV moving process, the camera, like the human eye, dynamic access to the information on the vehicle surroundings image which is compared with the image database, the current location will be determined and decision making for the next step, and can observe the obstacles ahead, automatically change the path bypass. This AGV don't need set any human physical path, so has the best flexible guide in theory, which will be the future mainstream guide technology.

5.5 Inertial guidance

Inertial navigation is that the gyroscope is mounted on the AGV and the positioning block is mounted on the ground. AGV can determine its position and orientation by the gyroscope bias signals and ground positioning block signals and achieve the guide. Its main advantages are advanced technology, high positioning accuracy, flexibility, easy to mix and compatible with a wide field of application. The disadvantages are that the gyroscope is sensitive to vibrations; ground conditions greatly affect the reliability of the AGV, high maintenance costs, and the need to correct positioning. It is suitable for the occasions that better ground conditions, more prominent advantages for handling large and heavy objects, such as car body, chassis, sheet metal, and container and so on.

6 Logistics mode of AGV

Modern AGV technology has the features of the most intelligent. The hardware and software functions of vehicle computer are increasingly powerful and constantly upgrading, so that the AGV and AGV system have the functions that received the instructions from the host computer or customer by network, wireless or infrared and, automatic guided, automatic driving, route optimization, automatic operations, traffic management, vehicle scheduling, security collision avoidance, automatic charging, automatic diagnosis.

AGV enables intelligent transfer function of components with the main transmission line and three-dimensional warehouse, and achieve JIT parts delivery of vehicle assembly process. According to a certain timing requirements, AGV communicates with the control center and receives the instructions. According to certain specified timing requirements the parts are shipped to the specified location, and will be pushed to the work station by the robot or transfer mechanism (as shown in Figure 6).

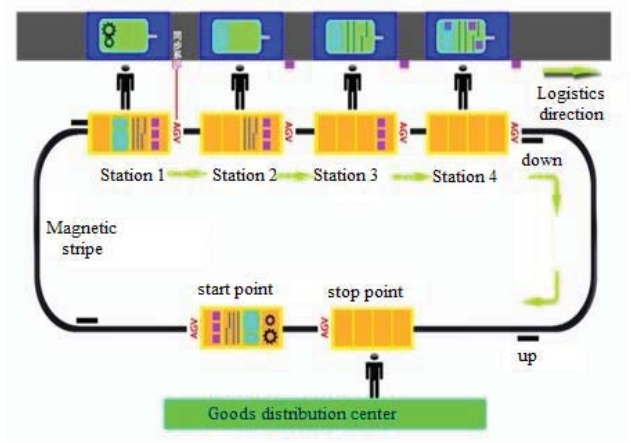


Figure 6. Distribution systems for assembly

AGV can achieve the intelligent distribution and sorting of the parts combining with electronic tags. Electronic tags are used to solve the sorting and assembly of parts, and AGV is responsible for transportation of parts. RFID system is one of the most commonly way used for computer-aided picking system.

Warehouse order picking through the electronic tag display, promptly and clearly give instructions that the inner shelf replenishment and pick up to the picking person. AGV will remove the parts to the assembly station (as shown in Figure 7).

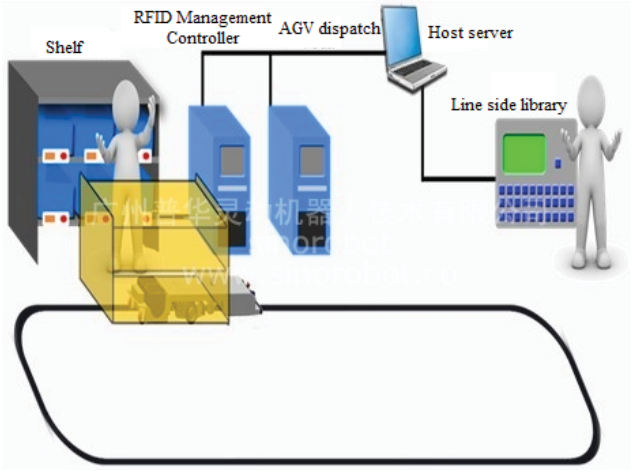


Figure 7. Parts sorting and intelligent distribution system

In addition, the AGV and MES integration, MES obtain work orders and pre-treatment from ERP, determine the production needs according to the current actual production schedule and promptly sent the relevant material requirements to the AGV dispatch centre. AGV dispatch centre is responsible for the arrangement and parking positions of AGV, which are from MES system.

The specifying AGV gets the task and automatic walk to the designated location, and the pick-up process starts. After that, the materials are directly sent to the transfer mechanism of producing areas and automatic delivered.

The application based MES-AGV system can facilitate the go and feeding process, implement the automation and intelligent of the assembly process, and realize fine production management.

7 Conclusion

AGV is more widely accepted, and has been used in material handling, assembly, distribution, and other production processes. The overall characteristics and mutual differences of AGV have a certain reference value for the practical application of the correct understanding and accurate grasp, flexible application.

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