The automated guided vehicle engineering essay

CHAPTER 2

An automated guided vehicle system (AGVS) is a material handling system that uses an independently operated, self-propelled vehicle that is guided along defined rails in the floor. The vehicle is powered by means of an AC Servo motor. The definition of pathways is generally accomplished by using wires embedded in the floor, painted stripes or by using rails to guide the vehicle.

types of agv

There are different types of AGV's each which works based on a specific principle. The types can be classified as follows:

Driverless trains

This type consists of a towing vehicle (which is an AGV) that pulls one or more trailers to form a train. It was the first type of AGVS to be introduced and is still popular. It is used in applications where heavy payloads must be moved in large distances in warehouses or factories with intermediate pickup and drop-off point along the route.

Fig 2. 1 Driverless Trains

AGV pallet trucks:

Automated guided pallet trucks are used for palletized loads along determined routes. In this typical application the vehicle is backed into the loaded pallets by human workers. The driver drives the pallet truck to the guide path, programs its destination and the vehicle proceeds automatically to the estination for unloading. The capacity of the AGVS pallet truck ranges up to6000 lb, some trucks are capable of handling two pallets rather than one. A recent introduction related to pallet trucks

AGV is the Forklift AGV. This vehicle can achieve significant vertical movement of its forks to reach loads on shelves.

Fig 2. 2 AGV Pallet trucks

AGVS Unit Load Carrier:

This type of AGVS is used to move unit loads from one station to another station. They are often equipped for automatic loading and unloading by means of powered rollers, moving belts, mechanized lift platforms, or other devices. Variations of the unit load carriers include light load AGV's. The light load AGV is a relatively small vehicle with a corresponding light load capacity. It does no require the same large aisle width as the conventional AGV. Light-load guided vehicles are designed to carry a partially completed subassembly through a sequence of assembly workstations to build the product.

AGVS technology is far from mature, and the industry is continually working to develop new systems in response to new application requirements. An example of a new and evolving AGVS design involves the placement of a robotic manipulator on an automated guided vehicle to provide a mobile robot for performing complex handling tasks at various locations of the plant. These robot vehicles are seen as being useful in clean rooms in the semi conductor industry.

Fig 2. 3 AGV Pallet trucks

applications of agv:

Automated guided vehicle systems are being used in a growing number and in a variety of applications. The application trend is parallel to the vehicle types described above. We group the applications into the following five categories:

Driverless train operations:

These applications involve the movement of large quantities of material over relatively large distances. For example, the moves are within a large warehouse or factory building, or between buildings in a large storage depot. For the movement of trains consisting of 5 to 10 trailers, this becomes an efficient handling method.

Storage/distribution systems:

Unit load carriers and pallet trucks are typically used in these applications. These storage and distribution operations involve the movement of materials in unit loads from or to other specific locations. The application always involves the interface of the AGV with some other automated handling or storage system, such as automated storage and retrieval system (AS/RS) in a distribution center. The AGVS delivers the incoming loads or unit loads from the receiving dock to the AS/RS; the AS/RS retrieves the pallet loads or items from the storage and transfers them to vehicles for delivery to the shipping dock. When the rates for the incoming loads and outgoing loads are in balance, this mode of operation permits loads to be carried in both directions by the AGVS vehicle, thereby increasing the handling the system efficiency.

This type of storage/distribution operation can also be applied in light manufacturing and assembly operations in which the work-in-progress is stored in a central storage area and distribution to individual workstations for assembly or processing. Electronics assembly is an example of these types of applications. Components are “ knitted” at the storage section and are delivered in tote pans or trays by the guided vehicle to the assembly workstations in the plant. Light load AGV systems are used in these applications.

Assembly line operations:

AGV systems are being used in a growing number of assembly line applications, based on the trend that began in Europe. In these applications the production rate is relatively low and there are a variety of different models made on the production line. Between the workstations, components are knitted and placed on the vehicle for the assembly operations that are to be performed on the partially completed product at the next station. The workstations are generally to be arranged in parallel configuration ton add to the flexibility of th1e line. Unit load carriers and light load vehicles are the types of AGVS used in these assembly lines.

Flexible manufacturing systems:

Another growing application of AGVS technology is in Flexible Manufacturing Systems (FMS). In this application, the guided vehicles are the material handling systems in FMS. The vehicles deliver work from the staging area to the individual workstation, the vehicle also moves work between stations in the manufacturing system. At a workstation, the work is transferred form the vehicle platform into the work area of the station for processing. At the completion of processing by that station a vehicle comes to pick up the work and transport it to the next area. AGVS systems provide a versatile material handling system to complement the flexibility of the FMS operation.

Miscellaneous applications:

Other applications of Automated Guided Vehicle system includes non-manufacturing and non-warehousing application, such as mail delivery in the office buildings and hospitals material handling operations. Hospital guided vehicle transport, meal trays, linen, medical and laboratory supplies and other materials between various departments in the building. These applications typically require movement of the vehicle between different floors of the hospital. AGV systems have the capability to summon and use elevators for this purpose.

VEHICLE GUIDANCE AND ROUTING

There are several functions that must be performed to operate any automated guided vehicle system successfully. These functions are:

Vehicle guidance and routing

Traffic control and safety

System management

The term guidance system refers to the methods by which the AGVS pathways are defined and the vehicle control system that follows the pathways, as indicated above, there are two principle methods currently in use to define the pathways along the floor: Embedded guide wires and paint stripes. Of the two types, the guide wire system is more common in warehouse and factory applications.

In the guide wire method, the wires are usually embedded in a small channel cut into the surface of the floor. After the guide wires are installed, the channel slot is filled so as to eliminate the discontinuity in the wire. The signal is of relatively low voltage, low current and as the frequency is in the range of 1-15 KHz. These signal levels creates a magnetic field along the pathway that is followed by sensors on-board each vehicle. Two sensors are mounted on the vehicle on either side of the guide wire. When the vehicle is moving along the course such that the guide wire is directly between the two coils, the intensity of the magnetic field measured by each coil will be equal. If the vehicle strays to one side or the other, or if the guide wire path curves, the magnetic field intensity at the two sensors will me different. This difference is used to control the steering of the motor, which make the required changes in the vehicle direction to equalize the two sensor signals, thereby tracking the defined pathway.

When paint stripes are used to define the vehicle pathways, the vehicle possesses an optical sensor system that is capable of tracking the paint. The paint can be taped sprayed, or painted on the floor. One system uses a 1-in-wide paint strip containing fluorescent particles that reflect an ultraviolet (UV) light source on the vehicle. An on board sensor detects the reflected light in the strip containing fluorescent particles that reflects an UV light source on the vehicle. An onboard sensor detects the reflected light in the strip and controls the steering mechanism to follow it. The paint guidance system id useful in environments where electrical noise would render the guide wire system unreliable or when the installation of guide wires in the floor surface would not be appropriate. One problem with the paint-strip guidance system is that the paint strip must be maintained.

A safety feature used in the operation of most guidance systems is automatic stopping of the vehicle in the event that is accidentally strays more than a few inches on the guide path. The automatic stopping feature prevents the vehicle from moving off the guide path. It is capable of locking on to the guide wires or paint strip. If moved within the same few inches of it. The distance is referred to as vehicle acquisition distance.

The use of micro process or controls on board the vehicles has led to the development of feature called dead-reckoning. This term refers to the capability of the vehicle to travel along the route that does not follow the defined pathway in the floor. The microprocessor computes the number of wheel rotations and the operation of the steering motor required to cross a steel plate in the factory floor, or to depart from the guide path for positioning at a load/unload station. At the completion of a dead-reckoning maneuver, the vehicle is programmed to return to within the acquisition distance of the guide path to resume normal guidance control.

Routing is an AGVS system which is concerned with the problem of selecting among alternative pathways available to the vehicle in its travel to a defined destination point in the system. A typical guided vehicle layout, one that exploits the capabilities of modern AGVS technology, contains features such as multiple loops, branches, side-tracks and spurs, in addition to the required pickup and drop-off stations. Vehicles in the system must decide which path to take to reach a defined destination point.

When a vehicle approaches a branching point in which a guide path splits into 2 directions, a decision must be made as to which path the vehicle should take. This is sometimes referred to as a decision point for the vehicle. There are two methods used in commercial AGV systems to permit the vehicle to decide which path to take:

Frequency select method

Path switch select method

In the frequency select method, the guide wires leading into the two separate paths have different frequencies. As the vehicle enters the decision point, it reads an identification code on the floor to identify its location. Depending on its programmed destination, the vehicle selects one of the guide paths by deciding which frequency to track this method requires a separate frequency generator for each frequency that is used in the guide path lay out . this usually means that two or three generators are needed in the system. Additional channels must often be cut into the floor with the frequency select method to provide for by pass channel where only the main channel needs to be powered for vehicle tracking.

The path switch selects using a single frequency through out the guide path layout. In order to control of a vehicle at a decision point, the power is switched off at all branches except the one on which the vehicle is to travel. To accomplish a routing by the path select switch method. The guide path layout must be divided into blocks that can be independently turned on and off by means of control mounted on the floor-mounted switching device connected to the control unit for the relevant block. The control unit activates the desired guide paths and turns off the alternatives branches or branch.

In the rail guide method, the AGV travels on rails. The rails are fitted with micro-switches at the respective positions wherever necessary and the vehicle in guided by the rails to the respective storage section, the micro-switches placed on the rails are used to detect the reach of position by the vehicle these micro-switches are connected to the PLC and trigger the reset of the pulse train output being generated by the PLC. The micro-switches also determine the distance of return travel the AGV has to go in order to reach the origin or the finished product collecting section. The routing and branching method adopted is similar to that of the embedded wire or paint strips guidance method as explained above.

traffic control and safety:

The purpose of traffic control for the AGV is to prevent collision between the vehicles traveling along the same guide path in the layout. This purpose is usually accomplished by means of a control system called the blocking system the term " blocking" suggest that a vehicle ahead of it. There are several means used in the commercial AGV system to accomplish the blocking. They are:

on board vehicle sensing

zone blocking

On-board vehicle sensing involves the use of some form of sensor system to detect the presence of vehicle and carts ahead of the same guide wire. The sensor used on commercial guided vehicle includes optical sensors and ultrasonic systems. When the on-board sensor detects an obstacle in front of it, the vehicle stops. When the obstacle is removed, the vehicle is avoided and the traffic is controlled. Unfortunately, the effectiveness of forward sensing is limited by the capabilities of the sensor system to detect vehicles in front of its guide path. Since the sensors themselves are more effective in sensing obstacles directly ahead of the vehicle, these systems are most appropriate on layouts that contain long stretches of straight pathways. They are less effective at turns and convergence points where forward vehicles may not be directly in front of the sensor.

The concept of zone control is simple. The AGV layout is divided into separate zones, and the operating rule is that no vehicle is permitted to enter a zone if that zone is already occupied by another vehicle. The length of a zone is sufficient to hold one vehicle plus an allowance safety and other considerations. These other considerations include the number of vehicle in the system, the size and complexity of the layout, and the objective of minimizing the number of separate zone controls. When one vehicle occupies a given zone, any trailing vehicle is not allowed into that particular zone. The leading vehicle must proceed into the next zone before the trailing vehicle can occupy the given zone. By controlling the forward movement of the vehicles in the separate zones, collisions are prevented and the traffic in the overall system is controlled. The concept is in its simplest form. More complicated zone control schemes separate any two vehicles by a blocked zone.

One means of implementing zone control is to use separate control units for each zone. These controls are mounted along the guided path are actuated by the vehicle in the zone. When a vehicle enters a given zone, it activates the block in the previous zone to block any trailing vehicle from moving forward and colliding with the present vehicle. As the present vehicle moves into the next zone, in effect, zones are turned on and off to control vehicle movement by the blocking system.

In addition to avoid collisions between vehicles, a related objective is the safety of human beings who might be located along the route of the vehicle traveling in the system. There are several devices that are usually included on an automated guided vehicle to achieve this safety objective. One of the safety devices is an obstacle-detection sensor located at the front of each vehicle. This is often the same on-board sensor as that used in the blocking system to detect not only other vehicles, but also people and obstacles in the path of the vehicle. These obstacle-detection systems are usually based on optical, infrared, or ultrasonic sensors. The vehicles are programmed either to stop when an obstacle is sensed ahead of it, or to slow down. The reason for slowing down is that the sensed object may be located off to the side of the vehicle part, or directly ahead of the vehicle beyond a turn in the guide path. In either of these cases, the vehicle should be permitted to proceed at a slower speed until it has passed the object or rounded the turn.

Another safety device included on virtually all commercial AGV vehicles is an emergency bumper. The bumper surrounds the front of the vehicle and protrudes ahead of it by a distance which can be a foot or more. When the bumper makes contact with an object, the vehicle is programmed to brake immediately. Depending on the speed of the vehicle, its load, and other conditions, the braking distance will vary from several inches to several feet. Most vehicles are programmed to require manual restarting after an obstacle encounter with emergency bumper.

Other safety devices on the vehicle include warning lights and/or warning bells. These devices alert people that the vehicle is present.

Finally, another safety feature that prevents runaway vehicles is the inherent operating characteristic of the guidance system: if the system strays by more than a few inches from the defined path, the vehicle is programmed to stop.

system management:

Managing the operation of an AGVS deals principally with the problem of dispatching vehicles to the points in the system where they are needed inn a timely and efficient manner. The function depends on reliable operation of other system functions discussed above. There are a number of methods generally used in combination to maximize responsiveness and effectiveness of the overall system.

The dispatch methods include:

On-board control panel

remote call stations

central computer control

Each guided vehicle is equipped with some form of control panel for the purpose of manual vehicle control, vehicle programming, and other functions. Most commercial vehicles have the capacity to be dispatched by means of this control panel to a given station in the AGV's layout. Dispatching with an on-board control panel represents the lowest level of sophistication among the possible methods. Its advantages are that it provides the AGV's with the flexibility and responsiveness to changing demands on the handling system. Its advantage is that it requires manual attention.

The use of remote call stations is another method that allows the AGVS to respond to changing demand patterns in the system. The simplest form of call station is a press button mounted near the load/unload station. This provides a signal to any passing vehicle to stop at the station in order to accomplish a load transfer operation. The vehicle might then be dispatched to the desired location by means of the on-board control panel.

More sophisticated call stations consists of control panels mounted near the various stations along the layout. This method permits the vehicle to be stopped at a given station, and its next destination to be programmed form the remote control panel. This represents a more automated approach to the dispatching function and is useful in AGV systems that are capable of automatic loading and unloading operations.

Both of the cal station methods described here involve a human interface with the AGVS at the loading/unloading station. One example is an automated production workstation that receives raw materials and sends completed parts by means of the AGVS. The workstation is interfaced with the AGVS to call for vehicles as needed to perform the loading and unloading procedures.

In large factories and ware houses systems involving a high level of automation, the AGVS servicing the factory or warehouse must also be highly automated to achieve efficient operation of the entire production-storage-handling system. Central computer control is used to accomplish automatic dispatching of vehicles according to a preplanned schedule of pickups and deliveries in the layout and/or in response to calls from various loads/unload stations in the system. In the dispatching method, the central computer issues commands to the vehicles in the system concerning their destination and operation to perform. To accomplish the dispatching function, the central computer must possess real-time information about the location of each vehicle in the system so that it can make appropriate decisions concerning with vehicles to dispatch to what locations. Hence, the vehicle must continually communicate their whereabouts to the central controller.

There are difference in the way these central computer dispatching system operate. One of the differences involves the distribution of the decision responsibilities between the central controller and the individual vehicles. At one extreme the central computer makes nearly all the decisions about the routing of vehicles and other functions. The central computer plans out the routes for each vehicle and controls the operation of guide path zones and other functions. At the opposite extreme each individual vehicle possesses substantial decision-making capabilities to make its own routing selection and to control its own operations. The central computer is still needed to control the overall scheduling and determine which vehicles should go to the various demand points in the system. However the vehicles themselves decide which route and control their own load transfer operations. Vehicles in this second category are often referred to as “ smart” vehicles.

To accomplish the system management function, it is helpful to monitor the monitor the overall operations of the AGVS by means of some form of graphics display. Even with the central computer control it is still desirable for human managers to be able to see the overall system operations, in order to monitor its general status and to spot problems. A CRT colour graphics display is often used for these purposes in modern guided vehicle systems.

Another useful tool in carrying out the systems management function is a system performance report for each shift of AGVS operation. These periodic reports of system performance provide summary information about proportion uptime, downtime, and number of transactions made during a shift, and more detailed data about each station and each vehicle in the system. Hard-copy reports containing this type of information permit the system managers to compare operations from shift to shift and month to month to maintain a high level of overall system performance.

2. 7 agv construction:

The AGV is rectangular structure. The outer frame is constructed using square pipe of size 20mm, length 40cm, width 30cm and height 20cm. the base of the AGV is attached to four PPC wheels on all four corners through and iron bush type rod which is bolted along with the frame. A horizontal shaft of 30cm in length is inserted between the two wheels attached to the bush.

At either ends of the horizontal shaft the two PPC wheels are mounted and are bolted at the ends. The horizontal shaft rod is of 12mm in diameter and an aluminum pulley of diameter 25mm is fixed in the center of the horizontal shaft. The other pulley is mounted on the servo motor shaft, which is also of diameter 25mm. Two 30 cm square pipe are taken welded at the bottom of the frame of the AGV, in order to provide support to the vehicle.

Slots are made in the two welded square pipes so as to seat the servo motor perfectly. A groove shaped setup is made with a steel plate as per the dimensions of the servo motor so that it can be seated perfectly.

With the help of a flat belt of thickness 15mm and length 50mm the two aluminium pulleys, one attached to the shaft of the servo motor and the other to the shaft in between the wheels are coupled. The belt has minimum slippage and the power transmission from the motor to the wheels is maximum with minimum percentage of power loss.

On top of the outer frame a plywood plank is placed and screwed to the bottom which acts as the base and a 50mm overall height is maintained to support the object, so that it does not fall off while moving on the vehicle.

A sensor is placed on the AGV on the plywood plank so that it can sense the objects falling into the AGV; it helps to enable the servo motor as per the logic fed into the PLC.

AGV Design Specifications:

AGV wheel:

Diameter = 100mm

Square pipe = 18 x 18mm

Length = 400mm

Width = 300mm

Height = 246mm (without wheel)

Total height = 300mm

Wheel connecting rod = 10 x 10mm

Diameter = 15mm

Coupling diameter = 50mm

Motor support rod = 20 x 20mm

Pulley support

Height = 140mm

Length = 50mm

Width = 10mm

Fig 2. 4 AGV Graphical Representation

2. 8 AGV Working:

The Automated Guided Vehicle adopts the Barcode Technology to move to the respective storage sections. An AC servo motor is used to drive the vehicle; the servo motor has a drive that controls the motor positioning and movement with the help of a built in encoder.

When ever an object travels on the conveyor the barcode label pasted on the finished product is sensed by the barcode scanner, a sensor present in the AGV also senses the presence of the object once the object comes sliding down the conveyor. The bar code scanner produces an ASCII output. This is given as an input the PLC. The PLC in turn generates a pulse train output (PTO) based on the type of product. This PTO output in turn is fed to the servo drive. The servo drive drives the servo motor based on the pulses received.

If product A is present on the AGV the PLC generates a particular amount of pulses that is enough to drive the vehicle to the respective storage section. The PLC similarly generates different types of pulse outputs for different types of products so that each product can proceed to its particular storage section.

The AGV moves along with the servo motor on rails to the respective station. The rails have micro switches attached to them at respective positions in front of each storage section, this helps in keeping track of the movement of the AGV. It also acts an input to the PLC to generate the pulses in the reverse direction for the AGV to return to the home or origin position in order to collect other finished products dispatched by the conveyor.