Practical application of an outdoor AGV system

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Summary

For the production of a new transmission, it was necessary to transport parts between separated buildings. In order to reduce logistics and transport costs, an outdoor Automated Guided Vehicle system was constructed based on a towing Automated Guided Vehicle and implemented to handle the transporting and loading/unloading of cargo fully automatically. This article describes the measures developed and adopted to deal with transport issues and safety issues so as to achieve fully automated parts supply with this new towing Automated Guided Vehicle system.

1. Introduction

Two types of Automated Guided Vehicles (AGV) are the towing type and the low-bed type. The former type transports things on a cart that the vehicle tows by means of a towing hook connection. The latter type transports things by sliding under the cart and is secured to it by a pin. The towing type is not much affected by floor distortions or undulations, but it has no record of use at JATCO for automated parts supply. In contrast, the low-bed type has an ample record of automated parts supply use, but floor distortions or undulations can make it difficult for the vehicle to travel stably.

A recent plan for a new transmission required AGV use for automated parts supply, in addition to involving travel outside the plant over a surface with many distortions and undulations. Moreover, measures had to be adopted for preventing any impact on product quality, including protection against wind and rain.

This article describes the technologies that were developed to achieve fully automated parts supply using an AGV system based on the towing type. It explains the measures implemented to deal with outdoor transport issues, to prevent parts supply delays and to ensure safe operation.

Fig. 1 Towing type AGV

2. Vehicle travel and parts supply issues

2.1 Measures supporting AGV travel on slopes

The towing type of AGV in Fig.1 is well-suited to traveling on distorted surfaces. However, there is a risk of deviating from the path when traveling on a downward slope because the vehicle is pushed by the weight of the load on the cart. It was necessary to implement measures to prevent such deviation because the outdoor path for the intended use contained a downward slope of 4° along the way.

According, a system was devised for automatically braking the cart. A mechanism was adopted for sliding the towing bar 60 mm longitudinally. An automatic braking system was built for moving the towing bar via a linkage so as to press rubber pads against the middle fixed tires of the cart. Figure 2(a) shows images of the system when traveling on a level surface. The towing bar is in the "pulled-out position" to retract the rubber pads. Figure 2(b) shows images of the system when traveling on a downward slope. The towing bar is moved to the "downward slope pushed-in position" so as to press the rubber pads against the tires via the linkage mechanism. This braking system works to brake the cart, enabling the towing AGV to travel stably on downward slopes.

2.2 Outdoor transport issues

With the previous method of transporting parts between buildings, a cover was placed over the cart to keep out wind

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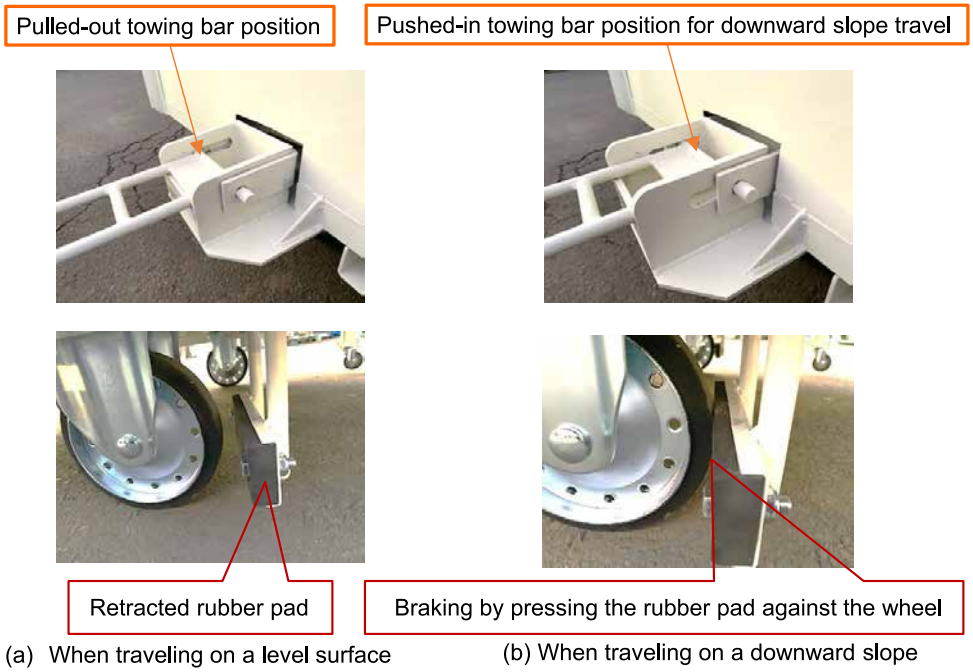

Fig. 2 Automatic braking system

and rain. The cover was opened and closed manually and a forklift was used to handle the parts. In order to achieve fully automated parts supply, it was necessary to have the same level of functionality for keeping out wind and rain as that provided by previous truck transport in an outdoor environment. In addition, the cart had to be fitted with a mechanism for automatically opening and closing the cargo door. To do that, a framework was constructed using aluminum frames. It was covered with a 3D molded tarp made of the same quality of material as that of the truck bed tarp and fastened. A gull-wing structure was adopted for automatically opening/closing the cargo door. The cart is equipped with two actuators to which air is supplied from the conveyor via an automatic coupling, making it possible to open/close the cargo door automatically (Fig. 3).

2.3 Fully automated parts supply

In order to achieve fully automated parts supply, it is necessary to prevent any problems of something getting caught when transferring from the conveyor to the cart. That could be caused by changes over time in the slope of the floor or by wear of the cart casters. Accordingly, it requires continuous monitoring and control of the heights of the conveyor and the cart so that their levels always coincide perfectly.

To ensure that the heights of the conveyor and cart always coincide, the AGV system adopts a towing bar that swings and floats vertically. This makes it possible to pull the entire cart onto hoist rollers for raising the cart. Figure 4(a) shows the cart before it is positioned on the hoist rollers. Because the casters are still in contact with the floor, the cart tilts along the slope of the floor. Figure 4(b) shows the cart positioned on the hoist rollers. Because the cart casters are off the floor, the cart is not affected even if the floor has a slope. Moreover, this system ensures stable automated parts supply even if the cart casters are worn.

Fig. 3 Gull-wing structure for automatically opening/closing the cargo door

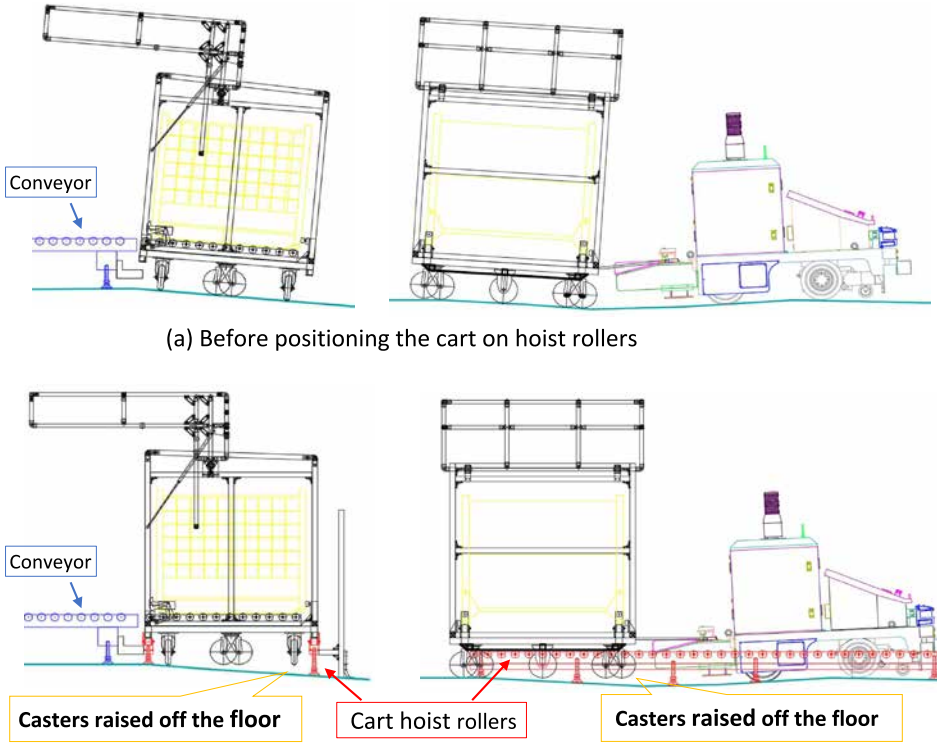

Fig. 4 System for raising the cart on a sloped floor

3. Outdoor AGV monitoring system

In this project, the AGV travels along an outdoor path out of sight of the employees and, in addition, there are few employees at the relay point in the path. There was concern that if some problem occurred in the AGV system, it might not be discovered immediately. In case a problem was not discovered right away, it might delay the transport of parts, thus causing a supply delay that could possibly stop production. To avoid that situation, it was considered necessary to continuously convey information on the condition of the outdoor AGV to the employees.

Systems for monitoring indoor AGVs have already been implemented at other JATCO production plants. However, one monitoring system is ancillary to an AGV acceleration control system and another system was adopted for the purpose of analyzing the uptime rate of the AGV. No system had been implemented previously for the purpose of notifying employees of an AGV problem like the function needed in the present project. Therefore, it was necessary to newly investigate an AGV monitoring system.

The requests of the shop floor employees who would be using the system are summarized below.

(1) A function for notifying employees in real time of an AGV problem

(2) A function for showing the AGV's position

A study was then undertaken of a system for satisfying these requests.

The parts to be used in the system were then selected. Because the necessary input/output pins were on hand, it was decided to adopt a single board computer that allows easy control and is inexpensive. For the first function, a local area network was built between plant buildings so that a trouble signal issued by the AGV could be transferred close to the vicinity of the employees. This achieves real-time notification of a problem. For the second request, a small GPS module is used to enable position information to be obtained and displayed. The monitoring system for the outdoor AGV was constructed in this way (Fig. 5).

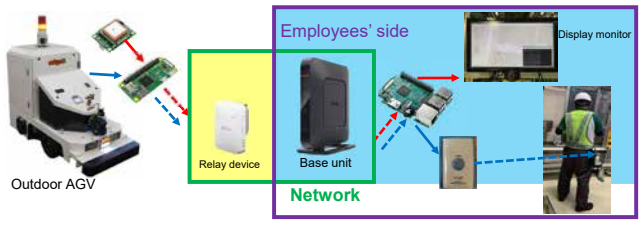

Fig. 5 Configuration of AGV monitoring system

4. Safety measures

In order to operate the outdoor AGV safely, a traffic control system is needed for avoiding collisions with other ordinary vehicles traveling on the plant premises. At other JATCO plants, traffic signal facilities connected to a wireless network are used at intersections traveled by both outdoor AGVs and ordinary vehicles. In this project as well, traffic signal facilities connected to a wireless network, rotating red lights and other equipment were installed as safety measures.

The obstacle sensors used heretofore for preventing collisions with outdoor AGVs cannot detect the wheelbase of the trailer bed. Consequently, the height of the trailer bed must also be detected. An obstacle sensor capable of detecting the trailer bed height was added, thus improving safety with respect to the trailer.

5. Conclusion

The outdoor AGV system described here transports parts between separated buildings and loads/unloads cargo fully automatically. Practical application of this system was achieved by implementing the following measures.

(1) Development of an automatic braking system to enable travel on downward slopes.
(2) Development of a cart equipped with an automatic opening/closing door and a function for preventing incursion of wind and rain so as to enable outdoor transport.
(3) Development of an automated parts supply system constructed with cart hoist rollers for raising the entire cart.
(4) Development of a function for notifying employees in real time of an AGV problem and a function for displaying the vehicle's position in order to enable outdoor transport out of sight of the employees.

As further automation is promoted in the future, it is expected that it will be necessary to transport products of various sizes and difficult-to-handle products as well as to transport them over longer distances. We intend to adapt the present AGV system so that it can meet such needs.

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