Autonomous Forklift Automatic Guided Vehicle

Kunihiko Aoki    Hideaki Furuno    Jun Nagaoka    Koji Furukawa

**OVERVIEW OF AUTONOMOUS AGV**

HITACHI has successfully delivered an automatic guided vehicle (AGV) system to South Korean industrial machinery manufacturer, Hanwha Tech M Co., Ltd. The requirements submitted by the client in advance were as follows.

1. AGVs should be able to handle special-purpose trolleys which are placed at two different heights (floor and conveyor) (see Fig. 1).
2. AGVs should be able to travel without following any travel guides that need to be installed on the floor and can potentially damage it.
3. The traveling route of AGVs needs to be capable of easy modification in case of changes to the factory layout.

**FEATURES OF AUTONOMOUS AGV**

Conventional AGVs required traveling guides to indicate the path to follow. These used specific materials such as magnets, markers, or reflectors on the floor or walls along the traveling route. On the other hand, Hitachi’s autonomous AGV is able to identify its own position on an electronic map by using a laser rangefinder and Hitachi’s novel localization algorithm. The system uses these to follow preset routes (see Table 1).

**STRUCTURE OF THE SYSTEM**

1. **Types of AGV**

   A forklift AGV is used to satisfy ‘requirement (1)’ of the client, described above (see Fig. 2).

**Table 1. Features of Autonomous AGV**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
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<tbody>
<tr>
<td>Laser rangefinder</td>
<td>(1) First, staff use a laser rangefinder to make an electronic map.</td>
</tr>
<tr>
<td></td>
<td>(2) When traveling, the AGV can determine its position on the map using the same laser rangefinder.</td>
</tr>
<tr>
<td>Travel guide installation</td>
<td>Not required</td>
</tr>
<tr>
<td>On-site work</td>
<td>Adjustment work only</td>
</tr>
<tr>
<td>In-floor installation</td>
<td>Not required</td>
</tr>
<tr>
<td>Layout changes</td>
<td>Adjustment work only</td>
</tr>
</tbody>
</table>

**Fig. 1—Material Handling Methods.**

*Special-purpose trolleys are placed at two different heights (floor and conveyor).*
(2) Vehicle Control System

The vehicle control system consists of a pair of workstations (master and slave), a shared disk and a wireless local area network (LAN) (see Fig. 3). The slave workstation acts as a backup in case the master workstation shuts down. The installed system included approximately 300 stations spread across the facility. Thus the arrival time for AGVs at a picking station (the traveling time from receiving an order until arriving at the pickup station) has a major effect on the total transport capacity. To shorten the arrival time, the vehicle control system assigns the closest available AGV to the picking station to pick the order.

(3) Transport Simulation

When designing an AGV system, it is important to estimate the number of AGVs needed to achieve the transport capacity required by the client. For this project, Hitachi consulted closely with the client to ensure that their needs were satisfied, and also conducted transport simulations based on the client’s requirement to optimize and verify the number of AGVs (see Fig. 4).

Conducting these simulations also provided following benefits.

(a) The simulations provided a visual representation of intersections where congestion occurred, allowing alternative routes to be designed.

(b) These visual representations of intersections could also be used to avoid unexpected deadlocks.

FUTURE DEVELOPMENTS

The effectiveness and advantages of Hitachi’s autonomous forklift AGVs have been proven at a manufacturing site by demonstrating a trolley handling system. Based on this experience, Hitachi is looking...
towards further opportunities at other manufacturing sites in the region with the aims of expanding and improving its business.

ABOUT THE AUTHORS

Kunihiko Aoki
Joined Hitachi Kiden Kogyo, Ltd. in 1982, and now works at the Logistics Systems Department, Electrical Machinery Division, Machinery Systems Division, Infrastructure Systems Company, Hitachi, Ltd. He is currently the Leader of the Autonomous AGV section.

Hideaki Furuno
Joined Hitachi Techno-engineering Ltd. in 1990, and now works at the Logistics Systems Department, Electrical Machinery Division, Machinery Systems Division, Infrastructure Systems Company, Hitachi, Ltd. He is currently the Leader of the Autonomous AGV Control Design section.

Jun Nagaoka
Joined Hitachi Kiden Kogyo, Ltd. in 1994, and now works at the Logistics Systems Department, Electrical Machinery Division, Machinery Systems Division, Infrastructure Systems Company, Hitachi, Ltd. He is currently engaged in designing Autonomous AGV systems.

Koji Furukawa
Joined Hitachi Kiden Kogyo, Ltd. in 2003, and now works at the Logistics Systems Department, Electrical Machinery Division, Machinery Systems Division, Infrastructure Systems Company, Hitachi, Ltd. He is currently engaged in designing Autonomous AGV systems.