topics

Autonomous Forklift Automatic Guided Vehicle

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OVERVIEW: One of advantages using our autonomous AGV is that it is equipped with a localization algorithm that is able to recognize its own position on an electronic map and trace the preset routes without following any traveling guide on the floor. Hitachi received an order for autonomous forklift AGVs from Hanwha Tech M Co., Ltd. of South Korea in September 2011, and completed delivery in June 2012. The system consists of three main parts: 22 AGVs, a vehicle control system, and approximately 300 stations that are spread across a floor space of 15,000 m² at the facility. The main purpose of using AGVs is to convey special-purpose trolleys between automated warehouses and manufacturing equipment at the facility, where the total number of transport movements per day is approximately 3,500.

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.

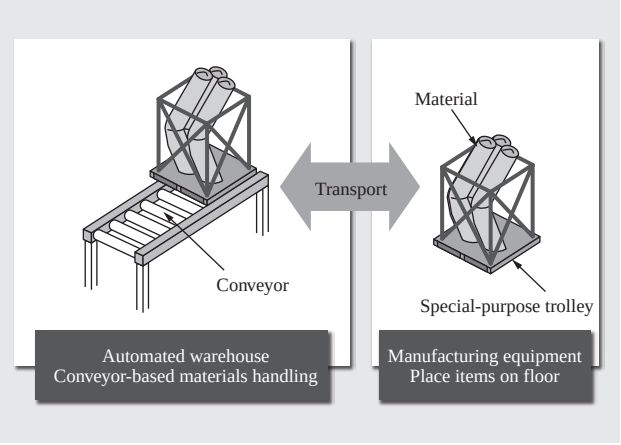


Fig. 1—Material Handling Methods.
Special-purpose trolleys are placed at two different heights (floor and conveyor).

FEATURES OF AUTONOMOUS AGV

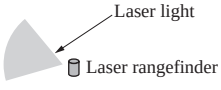
Conventional AGVs required traveling guides to indicate the path to follow. These used specific materials such as magnets, markers, or reflectors on the floor or walls along the traveling route. On the other hand, Hitachi's autonomous AGV is able to identify its own position on an electronic map by using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

Item	Description
Localization algorithm	 (1) First, staff use a laser rangefinder to make an electronic map. (2) When traveling, the AGV can determine its position on the map using the same laser rangefinder.
Travel guide installation	Not required
On-site work	Adjustment work only
In-floor installation	Not required
Layout changes	Adjustment work only

Item		Small model	Large model
Maximum load		100 kg	1,300 kg
Vehicle dimensions	Width	650 mm	1,130 mm
	Length	1,750 mm	2,970 mm
	Height	2,520 mm	2,545 mm
Traveling speed		3.6 km/h	
Vehicle weight		350 kg (approx.)	2,600 kg (approx.)
No. of vehicles supplied		4	18

Fig. 2—Main Specifications of Autonomous Forklift AGV.
Witness test was conducted using dummy loads.

(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.

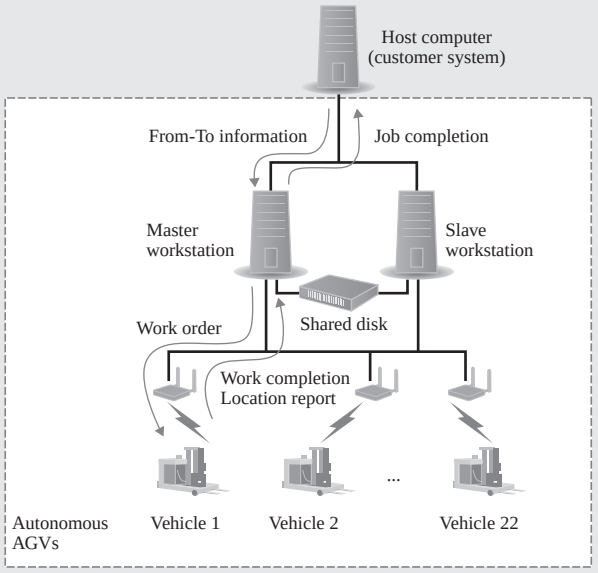


Fig. 3—A Structure of Vehicle Control System.
The fault-tolerant design of the system can deal with failure of the master workstation.

(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

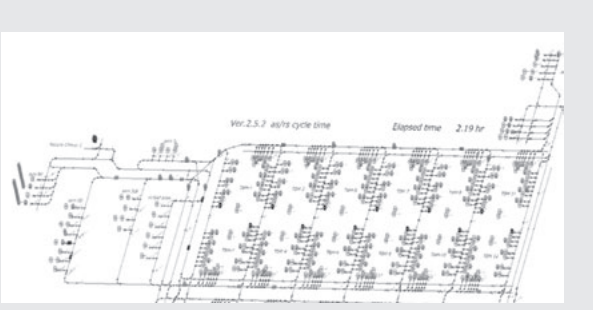


Fig. 4—Example Image from Transport Simulation.
Transport simulations were conducted based on client requirements.

towards further opportunities at other manufacturing sites in the region with the aims of expanding and improving its business.

ABOUT THE AUTHORS

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