New Small AGV Model "Automated Compact Truck (ACT)" Enables Mixed Fleet / Human-machine Cooperation

Mitsubishi Logisnext Europe Oy
https://www.mitsubishilogisnexteurope.fi/

This report presents a new model of small automated guided vehicle (hereinafter referred to as AGV) called the "Automated Compact Truck (hereinafter referred to as ACT)," whose shipment was started by Mitsubishi Logisnext Europe Oy (hereinafter referred to as MLFI) in October 2024. Located in Finland and serving as one of the development and production bases of Mitsubishi Logisnext Europe (hereinafter referred to as MLE), MLFI developed the ACT series by allowing the existing small power pallet AGVs (which have been on sale in Europe since 2010) to undergo a complete model change as their successor product. Conventionally, small AGVs were mainly used to transport goods, that is, moving inbound goods near the storage racks or towards the conveyor in a warehouse, or moving products from one production process to another in a factory. However, with customers' growing needs for seamless loading of items onto a higher shelf, MLFI has successfully expanded the maximum lift height to 6.0 m in the new series. The other features that MLFI has developed include the safety control based on the latest international standards and the functionalities enabling collaboration with on-site workers and manned forklift trucks.

The features of the new ACT series are reported herein, especially focusing on their best selling point: an innovative user interface. Behind the development lies the concept of "Mixed Fleet," which serves as the core of our logistics solutions business. The following chapter describes this key concept for the new ACT series.

1. Concept of Mixed Fleet

AGVs are one type of automated logistics equipment widely used in warehouses and factories. Because of their capability to operate day and night, AGVs are drawing attention from many countries recently facing a serious social problem of labor shortage such as European countries and Japan. However, the volume of goods to be handled/transported at logistics sites can greatly vary at every moment, with the work concentrated in the mornings and evenings. For AGV users, therefore, it is a considerable financial burden to have a sufficient number of units ready to operate during the busiest times of the day.

Utilizing labor-saving automated equipment and having robustness and flexibility to handle varying logistics demand at the same time is indispensable for building a sustainable logistics system. To realize this, we believe that human-machine cooperation, that is, the collaboration between humans and machines, taking advantage of the superior flexibility of manned forklift trucks and high productivity of AGVs (**Figure 1**), is effective.

This cooperation is the concept for the development of AGVs, which we call "Mixed Fleet." From a hardware perspective, our goal is to develop AGVs and forklift trucks whose safety features allow nearby workers to proceed with their assignments without worries, while achieving easy accessibility and intuitive manipulation of these machines. Our new ACT series boasts such superior features. In regard to software, MLFI is working on the development of its integrated control system called "Mixed Fleet Solution," to efficiently assist the human-machine cooperation. Specifically, it includes linking to the customer's warehouse management system for inventory, thereby giving AGVs and forklift trucks instructions for optimal operations of material handling

and transportation according to a given operation plan while controlling other automated logistics equipment as well.

Figure 1 "Mixed Fleet" environment in which humans and AGVs work together

2. Product features of new ACT series

2.1 Agile, compact body

The new ACT series consists of AGVs with a maximum load capacity of 1.6 tonnes and a maximum lift height of 6.0 m. The laser navigation system, which the series is equipped with, detects the vehicle's location to enable the vehicle to drive itself. As shown in **Figure 2**, the series is available as two models with different structures: Fork Over type (ACTff) and Counter Balance type (ACTcf). As indicated by the term "automated compact truck," both models are characteristically compact. The forklift trucks use the principle of leverage to maintain the balance of the body. Like a seesaw, the front wheels act as the fulcrum to balance the load with the vehicle's body. Therefore, the heavier the body is and the further away the center of gravity is, the less likely the forklift is to tip over when loaded. With the support legs under the forks to support the vehicle's body, ACTff can have an even smaller body, achieving a working aisle width with pallets of 2.6 m*. This high agility is a strong point in the turning ability, which is especially important for indoor logistics.

* Calculated by adding 200 mm as a practical margin to the aisle width that allows a forklift to turn 90 degrees with a European standard pallet (1,200 mm × 800 mm) loaded lengthwise.

Figure 2 New ACT model lineup

In indoor logistics, the aisle width in a place such as a warehouse or factory is narrowed as much as possible for efficient rack arrangement. Small forklifts with drivers called stackers, as shown in **Figure 3**, have superior turning ability and are often in operation, especially in Europe.

Most of these customers have set the aisle width at 3 m or thereabouts. Our new compact ACT series is quite suitable for indoor logistics operations in such narrow aisles, which can also benefit customers significantly in terms of reduced initial costs. The introduction of the ACT series only requires installing reflectors on the walls or rack columns without making drastic changes to the existing racking system.

Figure 3 Stacker

2.2 Safety features

Safety is placed as the top priority in the design of the new ACT series. The international standard ISO 3691-4:2023, which specifies the safety requirements for AGVs, is satisfied. **Figure 4** illustrates the safety features.

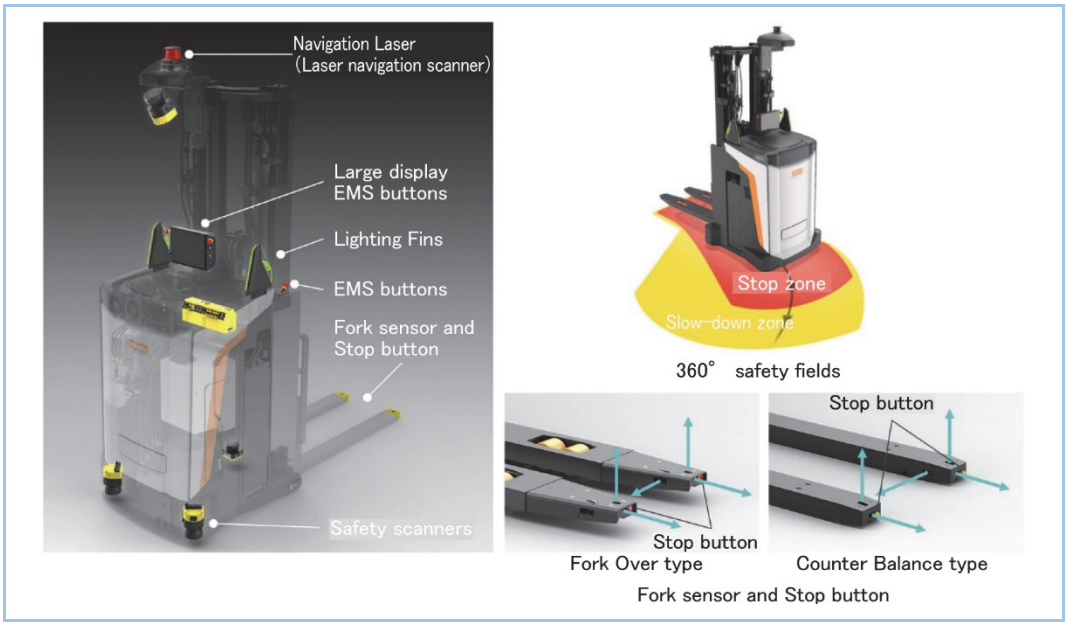

Figure 4 Major safety systems

1) 360° safety fields: The scanners attached to the bottom of the vehicle measure the distances to obstacles that are around the vehicle. The risk of collision or contact is detected if there is someone or an object in the immediate vicinity or if the gap is too narrow to pass other vehicles. The vehicle will accordingly slow down or stop. Fine-tuned control of traveling speed is realized by dynamically adjusting the obstacle detection range according to the direction of travel, steering angle when turning, and traveling speed.
2) Fork sensor and Stop button: The tips of the forks have sensors to detect pallets and obstacles, and the buttons to stop the vehicle itself. The sensors can detect obstacles right in front of the forks when lifting, which is not possible by the function of 360° safety fields described above. For example, suppose that a different item has been placed by mistake on

a shelf selected for loading. The detection of such items can prevent damage caused by a bump or contact with forks, and the manager can be informed of the detected items. The Stop button is used to stop the vehicle if required to prevent injuries to people and damage to objects on the site.

3) EMS button: Three emergency stop (EMS) buttons are installed in the upper part of the vehicle. On-site workers who notice any abnormal conditions can use these buttons to quickly stop the vehicle. The buttons can be found on either side of the large display to which most of the other command buttons are also attached, as well as on the lifting side. This layout allows easy access from any direction.

With these features, the new ACT series can exhibit excellent performance while ensuring the safety of the surroundings in a variety of operating environments of customers. This outstanding safety level was accomplished by our engineers, who meticulously carried out innumerable verification tests on top of our superior technological capabilities based on our 40 years of experience in AGV development.

Besides the functions to control the maneuvering of the vehicle, we developed a new, innovative user interface, which allows on-site workers to easily access the vehicle. The following chapter detail this user interface.

3. Innovative user interface

3.1 Large display

As shown in **Figure 5**, a large display is attached at eye level in the upper part of the vehicle for information and troubleshooting. The screen is an anti-glare touch panel, viewable from any angle. The size is 10.1 inches – as big as widely used tablets. During normal operations, the screen shows not only the vehicle's condition in a clear and visually recognizable manner, but also the messages related to vehicle ID, battery state, destination of transporting items, history of stops, etc. Lined along both lateral sides of the screen are the command buttons with a simple icon and a changeover switch to manual operation using a wired remote control.

Figure 5 Large display

In the case of an obstacle being detected in the vicinity, which sensor has detected the obstacle is indicated on the screen. If an abnormal condition occurs in the vehicle itself such as an equipment malfunction, the error code and the location of the failure are displayed visually, using a

message and illustration of the vehicle. Although having no equipment malfunction would be the best, a failure can occur, however rarely it might be. If this happens, a suggestion to help the customer with recovery work will be made in an easy-to-understand manner. This is part of the user experience we are pursuing, and we believe that a-cut-above usability can be realized in this way.

3.2 Lighting Fins

Large LED light guiding panels, which can be seen from all directions, are installed on both sides of the display. Lighting Fins communicate with on-site workers and forklift operators as if having a face-to-face conversation, by making a sound and illuminating different colors according to the operating status (e.g., normal operation, detection of abnormality, limited output for safety reasons, and temporary stop due to other vehicles at work). This concept of informing the operating status by color is also shared by our AGV's group control, Fleet Controller. As shown in **Figure 6**, Fleet Controller offers a dashboard as a tool to visualize the operating status of each AGV. Also on the dashboard are the list of tasks undertaken by AGVs, and a detailed layout map of the site to plot AGV locations using vehicle icons that can move in synchronization with their actual operations. The icons are displayed in colors corresponding to those of the Lighting Fins of their linked AGVs. This enables the customer's vehicle manager to follow the ongoing operations on the site from the office and, if a problem occurs, acquire the same knowledge about the situation as the on-site workers without delay.

These new functionalities in the user interface allow the new ACT series to communicate easily with on-site workers, thereby enabling them to work together in a safer and more efficient manner. Being highly praised for this concept and design, our new ACT series won two international design awards: "Red Dot Design Award" and "iF Design Award." Moreover, the series was also honored with the UK's logistics innovation award, "The Archies Award" (all received in 2024).

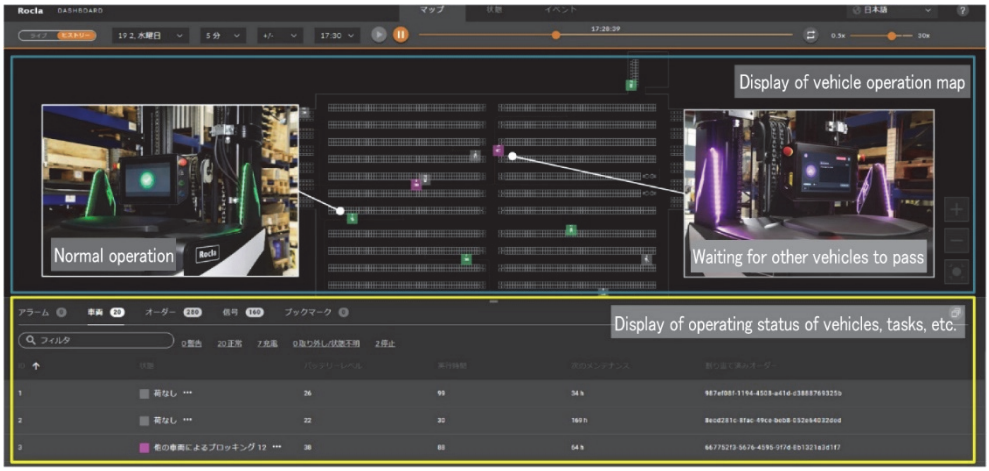

Figure 6 Fleet Controller dashboard and Lighting Fins

4. Future directions

Logistics are closely connected with daily lives. Our mission is to stand by our customers in the field of logistics and provide solutions to their challenges, with a view to building a safe and secure society with sustainable logistics. To make our vision of sophisticated logistics Mixed Fleet a reality, we continue to work on the development of even more innovative AGVs and high-usability devices/functionalities for manned forklift trucks, as well as implement the functions to enhance the added value of our integrated control system "Mixed Fleet Solution".