

Development of Side-Fork Type AGV

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Abstract

At the logistics system project sites, forklift type Automatic Guided Vehicle (AGV) are being introduced for transporting pallets. We already released automatic guided low lift (Model: 2APLB) but has reviewed the load capacity, lifting height and lift system. We newly developed side-fork type AGV. Since the side-fork type AGV (Model: 3ML-M11) can move in all directions, it can move even if the path width is narrow and has a reach function. In addition, since the load can be drawn into the AGV body by the reach function, it is possible to detect obstacles around the entire body and to travel safely. This AGV was awarded the Good Design Award 2014 because of its excellent design and functionality.

1 Preface

In the manufacturing industry, pallets are often used to transport materials from warehouses to production lines. In addition, a lot of pallets are used for the storage of the stock in the distribution warehouse. In logistics using such pallets, pallets are often loaded and unloaded to different heights such as floor and shelf.

Conventionally, there were many transportation by manned forklifts, but now Automatic Guided Forklift (AGF) are being widely used due to the difficulty of securing of drivers and for accident prevention.

However, existing AGF have the following problems.

- (1) It is necessary to change the orientation of the fork by 90° when placing the pallet after AGF travels through the passage. It takes time and a path width of 3m or more is necessary.
- (2) Since AGF approaches the pallet or shelf by running in the direction of the fork, there is a danger of pinching people.
- (3) When traveling with the fork lifted, there is a danger that loads will fall due to a sudden stop.

In this paper, we introduce side-fork type Automatic Guided Vehicle (AGV) developed to solve these problems.

2 Product Specifications

Table 1 shows the specifications. The forward

Table 1 Specifications

It shows the specifications of 3ML-M11.

Items	Specifications
Guidance system	Magnetic guidance or laser-type radar
Driving for traveling	2-wheel differential drive unit × 3 units
Traveling direction	Forward/backward traveling, traversing, and spin turn
Max. traveling speed	60m/min
Max. lifting height	1000mm or 1800mm for optional
Max. lifting speed	250mm/s
Reach stroke	1350mm
Reach speed	250mm/s
Transport pallet size	Max. 1200 × 1200mm
Max. load capacity	1100kg (Cargo center 600mm, deviation from the center of gravity ±50mm)
Stopping accuracy	Machine base end ±10mm, fork end ±30mm
Vehicle dimensions	W2278 × H1738 × L1748mm
Min. turn radius	1500mm (Forward/backward traveling 15m/min)
Self-weight	2050kg

and backward direction is a direction orthogonal to the fork direction. The load capacity is 1100kg at the maximum, and it targets pallets up to 1200 × 1200mm. Fig. 1 shows the outline drawing.

3 Features

3.1 Application to Narrow Paths

Fig. 2 shows the path width required for travel-

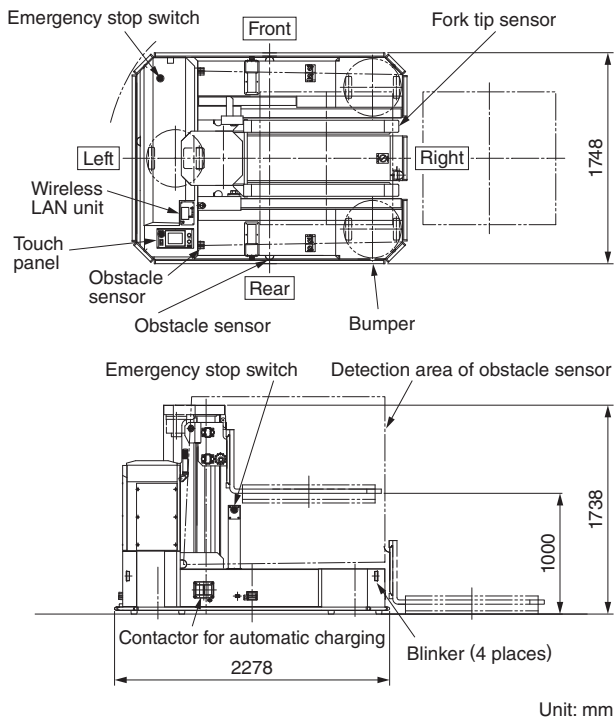


Fig. 1 Outline Drawing

It shows the standard outline drawing of 3ML-M11. The vertical direction of the top view is the front-rear direction.

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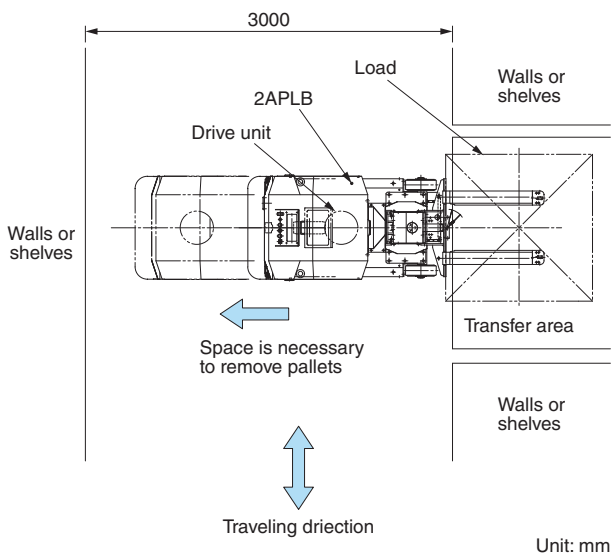


Fig. 2 2APLB Path Width

It shows the required path width for 2APLB. The conventional fork type AGV turns 90 degrees and approaches the shelf.

ing by automatic guided low lift (Model: 2APLB), and **Fig. 3** shows the path width of side-fork type AGV (Model: 3ML-M11). 3ML-M11 can be carried out from a fixed shelf placed at a path width of 2400mm. Since the path width can be narrowed by 600mm compared to the conventional way, the storage area can be expanded.

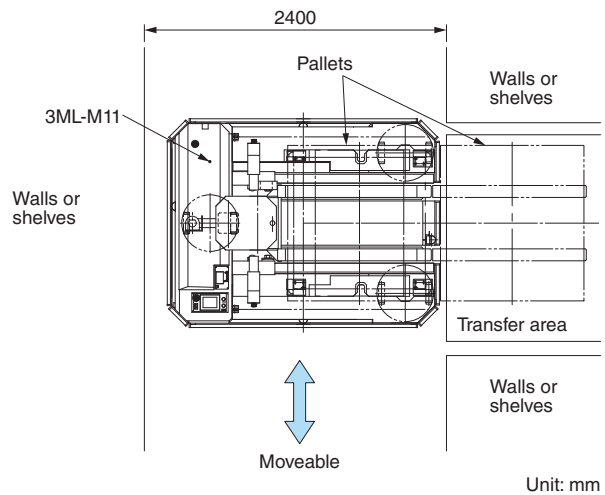


Fig. 3 3ML-M11 Path Width

It shows the required path width for 3ML-M11. The side-fork type can be transferred immediately after going forward and backward.

3.2 High Drive Performance

The driving wheel of 3ML-M11 is a 2-wheel differential drive, and it is arranged in 3 places. The drive wheels of the drive units have a swing mechanism to prevent slipping of the drive wheels due to undulation of the floor of the wheel axle of the wheel. Because this AGV is three-wheel drive, it can move forward and backward, traverse, skew, and spin turn.

3.3 Improved Safety

AGV has the greatest merit that can be operated without a dedicated path. As a result, here are cases where the AGV travels on a walking path, and designing must be made with safety so that the AGV will avoid collision with people.

Particular points to be considered about side-fork type AGV are “falling of the AGV main body” and “collision with the person by the fork part or movable part, etc.” In order to solve these safety problems, 3ML-M11 has a reach function and several obstacle detection sensors for collision avoidance.

(1) AGV’s fall prevention

Fig. 4 shows the relationship between the center of gravity position and falling. In the conventional fork type AGV, since load is applied to the outside of the space surrounded by the wheels when pallets (loads) are loaded, there is a risk of falling down depending on the load position and acceleration / deceleration. 3ML-M11 always moves with the fork pulled in (reach-in), thereby preventing falls. By the reach operation of the fork, the center of gravity of

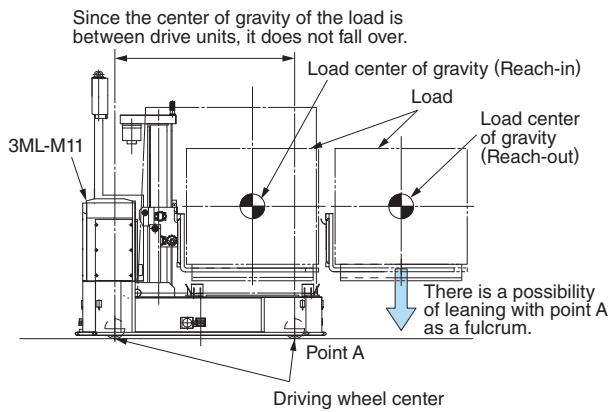


Fig. 4 Load Center of Gravity

It shows the load center of gravity position of reach-in and reach-out.

the load is moved to the inside of the space surrounded by the wheel, and AGV is not inclined even if the load is more than the allowable load, so that the vehicle can travel safely.

(2) Avoiding collision with people

Because the tip of the fork is thin, people are unlikely to notice when empty. 3ML-M11 prevents collision between the fork part and the person by bringing in the fork pulled in. The state in which the fork is out of the vehicle body is only when the AGV is stopped, and since the reach operation is performed after approaching the pallet, the collision risk of the person to the fork is low.

The collision between the person and the AGV is more dangerous during on the move than during the stop. In order to avoid collision during traveling, 3ML-M11 monitors all directions with obstacle sensors so that the AGV will stop even if a person approaches from any direction.

In addition, since the reach operation involves danger such as collision and nipping accident, as a safety measure during the reach operation, obstacle detection sensors for avoiding the collision with the moving part were arranged so as to surround the work that was drawn.

Fig. 5 shows the sensor detection area of obstacle detection sensor for collision avoidance with people. These sensors stop the reach operation when there is a risk of a collision with people outside the AGV and it is detected by the sensor, and prevents the collision.

3.4 Design Excellence

3ML-M11 was designed not only for the parts related to transportation such as traveling perfor-

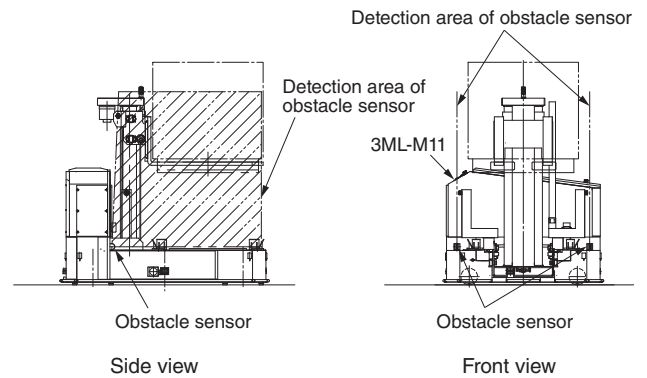


Fig. 5 Sensor Detection Area of Obstacle Detection Sensor for Collision Avoidance with People

It shows the detection area of the intrusion monitoring obstacle sensor. Monitor penetration during reach operation.

mance and reach function, but also considering frame shape and color arrangement. In general forklift trucks move forward and backward in the direction of the fork, but 3ML-M11 has a fork on the side, so it is difficult for the operator to predict the direction of travel. As a countermeasure, we adopted a body shape with a slope that is lower in the front and higher in the back. The inclined cover is reminiscent of an arrow and clearly indicates “progress direction” psychologically and visually. We arranged a lavender color in the front, making it easier to recognize the front side in terms of color. It made the center of the bottom surface black color, so that it looks compact. Also, consideration was given so that the end of the car could be brightly colored and the turning radius could be visually imagined. The above-described design contributes to improvement of safety.

Improved workability such as reduction of necessary path width mentioned in Section 3.1 and rational design were highly appreciated, and received the Good Design Award 2014.

4 Postscript

Unlike conventional automatic guided derived from manned forklift, developed side-fork type AGV with concept not confined to existing concept.

For coexistence with people, it is an advanced AGV that enhances design. We will continue to incorporate the demands from the market and develop AGVs that are friendly to people and load.

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