



Figure 1: Automated forklift in operation

Task

Cartoned goods on standard EU pallets are provided on roller and chain conveyors in front of the production halls. The AGV has to transport the pallets to the intermediate storage and transfer them to the conveyor system for storage.



Figure 2: Load transfer to conveyor with bearing marks

Implementation

Vehicle

A Linde E20 Li-Ion forklift truck of the 387 series was equipped for the transport task (see figure 1 above).

Job creation

The AGV operates without a control system and creates transport orders based on the waiting pallets reported by the materials handling system. The processing takes place automatically without user interaction according to a definable priority list.

Navigation

The transport takes place between the pick-up and delivery points on predefined routes (Figure 3, left side). Environmental navigation is realized by a laser scanner on the AGV (Figure 3, right side).

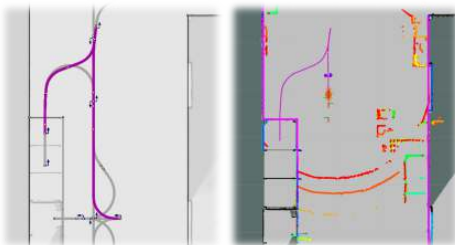


Figure 3: Alignment between target position (left) and actual position (right)

Load handling

To pick up and deliver the pallets in the exact position, the AGV "takes bearings" on bearing marks on the conveyor system with the safety laser scanners close to the ground (Figure 2). Monitoring for the exact position of

the waiting pallet or checking for completeness of the load was not implemented in this project scope. The load transfer area is designated as a hazardous area.

The main direction of travel when loaded is backwards so that the load is not thrown off in the event of emergency braking.

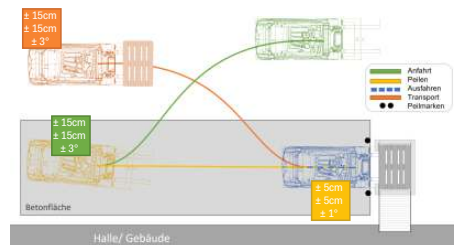


Figure 4: Load transfer sequence

Safety

A comprehensive safety concept, derived from risk and hazard analyses as well as current, applicable standards, guarantees an operation free of personal injury and material damage. The safety concept is based, among other things, on the standards listed to the right.

Other functions

Other system functions round off the use of the AGV and guarantee high availability.

- Navigation tower with laser scanner for environmental navigation
- Sensor taps for safe speed and steering angle detection
- Safety laser scanner for person detection
- Laser scanner on the roof for machine protection
- Four emergency stop buttons
- Signal light on the roof for visual and acoustic signal output
- WLAN communication with existing material handling equipment
- Processing and provision of release and blocking signals to the conveyor equipment
- Spacers on the fork with reflex light scanners for pallet detection
- Sensors for monitoring fork height and inclination
- Automated charging of the vehicle battery in a charging station (modified roof structure)
- Control display in the driver's cab
- Control panel on the outside of the AGV with illuminated buttons
- The possibility of manual operation is still given

Project profile

- Customer: Ostendorf Kunststoffe GmbH
- Regular operation: Since June 2022
- Place of operation: Internal goods transport in the outdoor area
- Transport relation: From several sources to one sink
- Load carrier: Palletized goods approx. 300 kg on standard Euro pallet (pick-up: crosswise)
- Pick-up / delivery: On roller conveyors and chain conveyors
- Average transfer distance: 50 m
- Turnaround time: 2-3 min per relation
- Availability: Workdays 3-shift operation (24h)

Standards relevant to the safety concept

- Directive 2006/42/EC (Machinery Directive)
- DIN EN ISO 12100:2011-03: Safety of machinery - General principles for design - Risk assessment and risk reduction
- EN ISO 13849-1:2008: Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design
- EN ISO 13849-2:2012: Safety of machinery - Safety-related parts of control systems - Part 2: Validation
- EN ISO 3691-4: Industrial trucks - Safety requirements and verification - Part 4: Driverless trucks and their systems

