Ready to Roll

Scaling Autonomous Pallet Handling from Pilot to Fleet

Executive Summary

Warehousing has always been an industry that embraces innovation, from the introduction of conveyor belts and forklifts during the early 20th century to today's autonomous mobile robots (AMRs), used to automate workflows ranging from individual item fulfillment to heavy-duty full-pallet handling.

A global warehouse automation provider specializing in delivering scalable, intelligent fulfillment solutions approached AAEON with plans to develop a pallet-agnostic AMR that could support personnel-led case and piece picking workflows while transporting heavy payloads through busy warehouse environments.

To handle the vision, navigation, and processing workloads required for autonomous operation, the customer used AAEON's BOXER-6647-MTH, a fanless compact embedded computer equipped with Intel® Core™ Ultra processing.

Project Requirements

In discussing their project aims, the customer highlighted that in addition to incorporating the AMR into their own warehousing operations, the solution would be offered to other organizations as part of their Robotics as a Service (RaaS) business model.

As such, they wanted the AMR to be capable of supporting multiple warehouse workflows, including piece picking, case picking, cross-docking, and heavy-duty pallet transport, without unnecessarily increasing the vehicle's size or thermal load.

The feasibility of the proposed embedded platform subsequently came down to four main factors:

- The system needed substantial processing capabilities to simultaneously handle data ingested from multiple cameras and sensors while also performing autonomous navigation tasks.
- The system would need to provide a broad interface selection, given the AMR would utilize cameras, sensors, and other peripheral hardware as well as maintaining communication with warehouse network infrastructure.
- Because it would be deployed in demanding warehouse environments and transporting heavy payloads, the solution had to be exceptionally robust and able to tolerate high levels of vibration over long periods.
- As the AMR would be used to assist human operators in piece picking tasks, it needed to support an intuitive, interactive, user-friendly interface.

With Intel® Core™ Ultra processing, an extensive interface selection, fanless operation, and environmentally robust design, the BOXER-6647-MTH addressed each of these requirements.

Navigating the Demands of Autonomous Warehousing

Environmental Perception and Sensor Integration

To detect obstacles while operating in different warehouses, the AMR used 2D LiDAR sensors connected through the BOXER-6647-MTH's Ethernet ports. Meanwhile, visual data capture was handled by depth cameras, connected through the system's USB 3.2 Gen 2 ports. The cameras chosen for the AMR were equipped with integrated IMUs, which supplied angular velocity and acceleration data for motion estimation. To facilitate communication with compatible motor or servo controllers, the BOXER-6647-MTH provided configurable DB-9 serial ports offering RS-232/422/485 interfaces.

For personnel-led picking workflows, one of the BOXER-6647-MTH's HDMI outputs was used to support a high-resolution display panel mounted on the AMR. A touchscreen controller was also connected through one of the system's USB 2.0 ports, providing an interactive HMI for personnel.

Industrial Reliability in a Compact Platform

Installed within the AMR's housing, the BOXER-6647-MTH's fanless design helped manage the heat generated by its processor and other components without requiring

an active cooling fan. Its environmental robustness also meant it could cope with the physical demands of its operating environment, with rated vibration resistance of 2 Grms across 5–500 Hz during operation with an SSD installed, and shock resistance of 30G for 11 ms.

Computing and Navigation

The system's Intel® Core™ Ultra 5 Processor 125H, offering 33 TOPS of AI performance alongside 14 cores and 18 threads, granted the computing resources the AMR needed to perform localization and process sensor data.

An NVMe SSD was installed in the system's M.2 2280 M-Key slot for the high-speed storage of software, map data, and operational logs.

The BOXER-6647-MTH's quick-access M.2 2280 M-Key device tray design also had a practical benefit when it came to SSD installation, allowing access to the slot without the chassis needing to be opened.

Network Connectivity

Intended for use both in the customer's own warehouse fleets and at customer sites to help meet demand during demand spikes, the AMR needed to be able to communicate with fleet-management systems for operational monitoring and coordination.

To do this, one of the BOXER-6647-MTH's Ethernet ports was used for wired networking, while its M.2 E-Key slot housed a Wi-Fi module. This meant the AMR could

be deployed across sites using existing warehouse racking and Wi-Fi without requiring pallet stands or an on-premises server. By using existing warehouse Wi-Fi, the customer could simplify installation at customer sites.

Successful Rollout, Business Impact, and Key Takeaways

Following a successful 35-unit pilot run, the customer outlined plans to adopt the AMR more broadly across its business, placing an additional order of 110 units as a starting point to do so. The pilot provided a glimpse of how significant an impact the AMR could have on both expanding the customer's warehouse automation capabilities and supporting the growth of their RaaS offering, a goal which AAEON will work to help them achieve as demand for the AMR continues to rise.

With the BOXER-6647-MTH as its primary computing node, the AMR could handle versatile workloads across different warehouse infrastructures, from personnel-led case and piece picking to heavy-duty pallet transportation. Its compatibility with existing warehouse racking and reliance on Wi-Fi dramatically simplified integration needs, with the customer stating the solution can be deployment in as little as 14 weeks.

This benefit is compounded by the fact fleets can be scaled up or down in response to seasonal demand.

In line with the project's overall objective, the customer reported that the AMR helped shorten order completion times, bolstering warehouse efficiency while helping downstream customers meet service-level agreements without the commitment of full product ownership.

By reducing dependence on manual forklifts and certified forklift operators, the solution supports the customer's goal of providing a safer, more productive warehouse environment. The customer plans to expand deployment following the 35-unit pilot, using the AMR to support additional picking and pallet-handling workflows. Its ability to work within existing warehouse infrastructure could also simplify rollout across customer sites.

About AAEON

Established in 1992, AAEON is one of the leading designers and manufacturers of industrial IoT and AI Edge solutions. With continual innovation as a core value, AAEON provides reliable, high-quality computing platforms including industrial motherboards and systems, rugged tablets, embedded AI Edge systems, uCPE network appliances, and LoRaWAN/WWAN solutions. AAEON also provides industry-leading experience and knowledge to provide OEM/ODM services worldwide. AAEON works closely with premier chip designers to deliver stable, reliable platforms. For an introduction to AAEON's expansive line of products and services, visit www.aaeon.com.