PIONEERING TECHNOLOGY FOR AUTOMATED ROBOTIC DEPALLETIZATION AND ASRS TOTE INDUCTION

*Applied Manufacturing Technologies (AMT) partnered with Dematic to design, build, and install a robotic AI-enabled system to remove a layer or layers of product from a pallet and optimize the placement of the product in totes for induction into an automated storage and retrieval system (ASRS). AMT's Robotic Induction System (**ROBiN**) is capable of handling a large variety of case sizes and uses machine vision and intelligent algorithms to increase tote fill density.*

The system was implemented at an American multinational consumer goods corporation that specializes in a wide range of personal health, personal care, and hygiene products.

PROBLEM

Throughput requirements and ergonomic issues made it almost impossible for operators to fill the totes to capacity, thus impacting the efficiency of the ASRS system.

The goal was to increase the storage capacity of the ASRS system by making the best use of the space in each tote enabling an increase in order handling capability at the Morris plant with an eye on implementation at other facilities.

CHALLENGES

- The system is required to adapt to changes in packaging size, shape, and color without reprogramming the robots.
- Maximum utilization of tote space is determined in real-time by AI-enabled vision system algorithms. When direct tote loading does not satisfy the requirement for space utilization, the system chooses the best option to reorientate the product before tote loading.
- Top pallet layers may not be complete. The system is expected to adjust accordingly.
- Lighting conditions vary in the working area and the vision system must adapt.

SOLUTION

The solution was to implement an automated induction system employing a depalletizing robot, two tote-filling robots, machine vision, and AI with AMT's **ROBiN**, or Robotic Induction System.

The depalletizing robot removes layers as specified by the operator from an incoming assembled pallet and places the product on a layer table. It is a four-axis robot with a flat vacuum-enabled end-of-arm tool (EOAT) designed to handle variable case sizes.

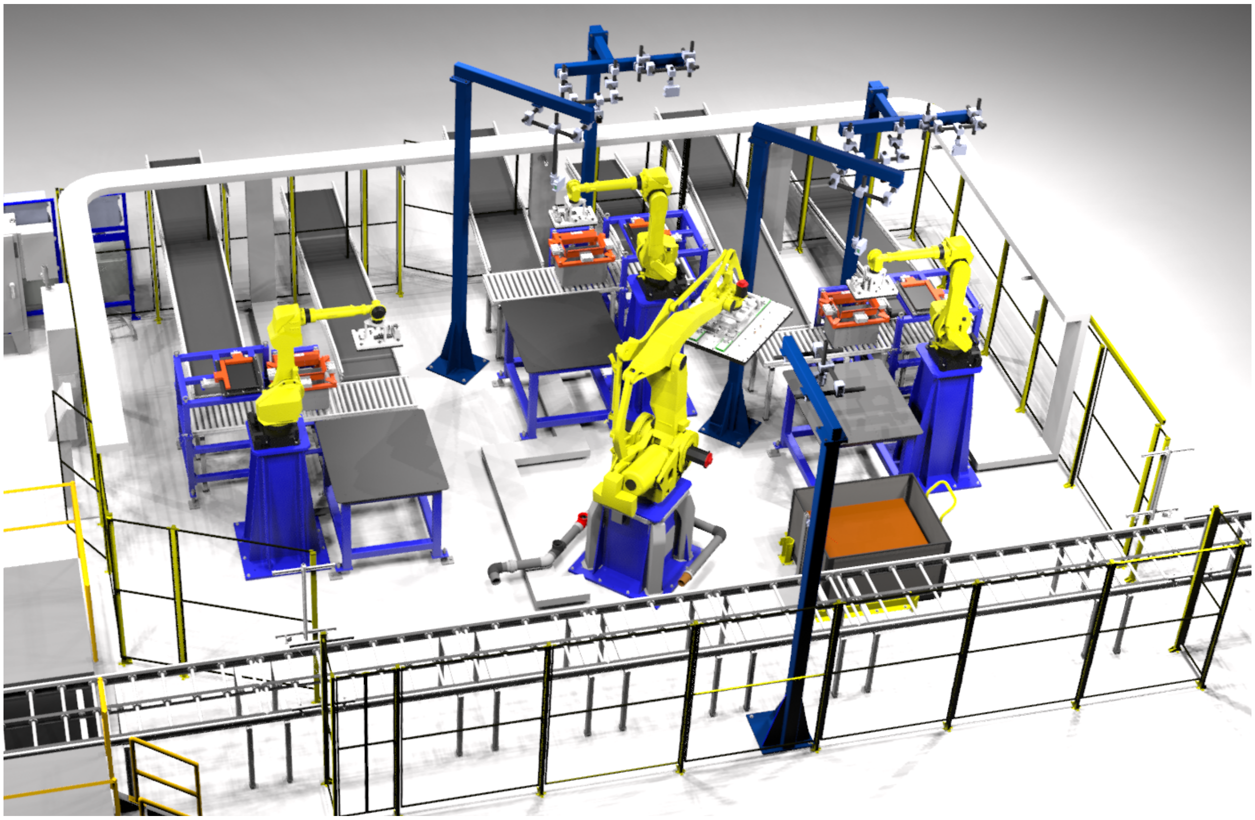
The tote-filling robots draw on vision and AI to strategically pick cases from the layer table for direct placement into totes, maximizing the available space. When direct placement cannot achieve the best utilization of tote space, the tote-filling robots place the product on a framing table for tote-fill arrangement. When the optimal configuration is reached, pushers mounted to the framing table actuate to compress the cases and remove any gaps that may have formed during handling. Tote utilization is consistently maximized regardless of incoming pallet configurations.

AI and Machine Vision Realize Smart Picking

3D image sensors provide input to the software controlling each tote-filling robot. Algorithmic analysis then selects the "best" group pick with the singular goal of prioritizing cases per load. This is achieved either by directly loading cases to totes or by reconfiguring case patterns at the framing table.

ROBiN provides the flexibility to handle edge cases where other systems traditionally struggle:

- The cases do not need to be stacked in a predetermined pattern
- The system does not need to be told how many boxes are on the pallet layer
- A wide range of flexibility in the shapes of boxes can be accommodated
- Any size gripper and tote can be used
- No special lighting is required as the vision uses light outside of the visible spectrum



Parameters are set for pallet layer weight and dimensions, as well as pallet type, stack height, and tier sheet size. The outer and inner tote size and maximum weight are additional parameters for the system.

The system is also programmed to handle the edge case of boxes larger than the tote size by programming the robot to place the box directly on the conveyor rather than inside the (too small) tote.

Safety PLC Controls the Process

At the facility, an Allen-Bradley safety PLC was selected to control the whole process. Like most PLC operations, the flow is sequential and cyclical. At the highest level, its cycle involves communicating with the robots to tell them their current task (i.e. decanting, pallet picking, etc.). The robots then complete the specified task, communicating back with the PLC their task status.

Error Handling

Given the large variance of case types that the system can handle, the possibility for anomalies must be considered in the design. Some anomaly examples that are handled include:

- Product sizes outside of tolerance
- Poor case quality (i.e. torn cardboard)
- Case construction variation

RESULTS

The robotic system maximized order handling capability at the plant. Each working robot trio was programmed to collaboratively break down a selectable number of pallet layers into totes, destined for an ASRS system. AMT's **ROBiN** induction system was used to efficiently make the best decisions in the induction process considering a large variety of product shapes. The option to further increase throughput was accomplished by leaving design room for another tote-fill induction robot at each of the two working areas. The fully-implemented system is designed to process more than 3000 cases per hour.

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