Case study

Random Depalletization

CMES

1. CHALLENGE

· Difficulty handling orders that have surged over 130,000 per day.
· Limitation of manpower due to pandemic
· High staff turnover due to repetitive and laborious labor
· Existing robot automation, which was one of the solutions, had many restrictions such as various box sizes

2. SOLUTION

· Box depalletizing software (EQUAL™ for logistics)

EQUAL

- New-Box registration package
- Calibration package (vision, robot, vision to the robot)
- Advanced path generation package

· 6-axis robot and Multi-channel vacuum gripper
· 3D scanner for box recognition on pallets
· Processing unit
· Conveyor system

SUMMARY

3. RESULTS

· EQUAL™ simulator reduces process setting time and increases maintenance convenience
· Greater throughput (600 boxes per hour)
· Enhanced speed and accuracy
· Effect of replacing two workers (depending on working time setting), ROI 18-24 months

CHALLENGE

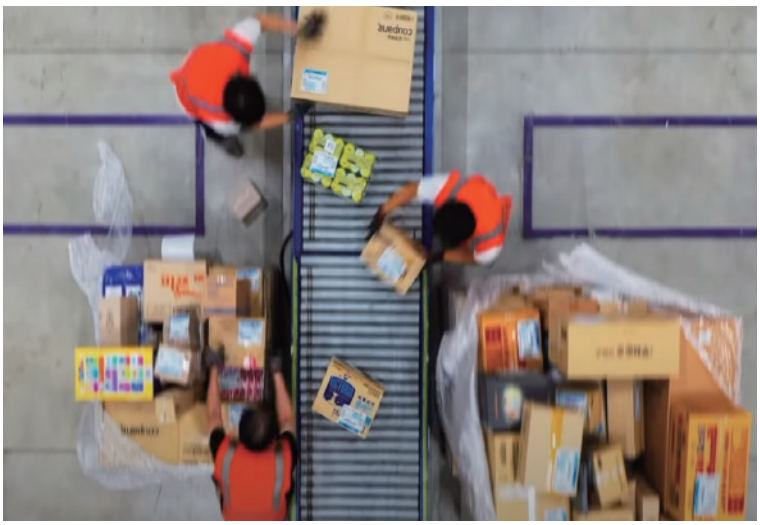
1. BACKGROUND

Korea's e-commerce industry has grown by 250% in the last eight years, and the total market size is expected to reach 120 billion dollars as of 2020. The gross revenue of top e-commerce groups in 2020 increased by more than 45% on average compared to the previous year. In particular, online consumption compared to offline has multiplied because of the COVID-19 pandemic, so e-commerce orders in the first quarter of this year increased by more than 50% compared to the same period last year.

Meanwhile, e-commerce companies are struggling to come up with a way to handle orders that have risen sharply to over 130,000 per day.
It is because the pandemic not only requires strict prevention management of the working environment but also limits the density of the workforce on the shop floor. Also, high staff turnover is occurring due to the repetitive labor of moving heavy products in the distribution center. To solve this problem, the need for robot automation emerged to tackle efficient workforce assignment and unloading of the warehoused product boxes in areas of high staff turnover, and CMES participated in this project.

2. CHALLENGE

The first process of the e-commerce distribution center starts with the process of putting product boxes received from various suppliers into the distribution center in the form of pallets.
The operator moves the product boxes on the pallet to the conveyor belt. At this time, the product boxes are not uniform in size, the position on the pallet is not regular, and there are a lot of boxes that are heavier than 10 kg.
“Currently, conveyor belts are responsible for transporting products from one process to another, but the majority of the other work, especially the handling of millions of boxes of goods of varying weight and shape, is often done by humans.” explains Operation Manager of a logistics company, one of our clients.



Source : Coupang YouTube

As the existing robotic automation could only handle boxes of consistent size and with certain conditions, there was a limit to realize full automation in reality. It stems from the fact that the robot could not take boxes of irregular sizes. Considering these limits, CMES offers advanced automation to reach new levels of output and performance.

SOLUTION

1. PACKAGE SPECIFICATIONS

ITEM	SPEC
Depalletizing Speed*1	600 boxes/hour (6~8 sec/box, based on condition of environment)
Maximum Box Size*1	600 mm x 500 mm x 400 mm(W,H,D)-can be customized
Minimum Box Size*1	250 mm x 200 mm x 100 mm (W,H,D)-can be customized
Maximum Box Weight*1	< 20 Kg
Available Workspace (pallet size)	1.1 m x 1.1 m x 2.0 m
Power consumption*1	>3 kW, 200-600VAC, 50~60Hz Robotic System : 1.62 kW (average) Processing Unit : 0.7 kW
IP classification	IP54
Air Inlet	Dry Compressed Air @ 4~5 Bar
Input / Output	Digital In (8 ports), Digital Out (8 ports)
Communication	TCP/IP interface to PLC
Warranty	1 year

*1: Can be modified

2. PACKAGE COMPONENTS

1) Software

Box depalletizing software
(EQUAL™ for logistics)

EQUAL

- New-Box registration package
- Calibration package
- Advanced path generation package

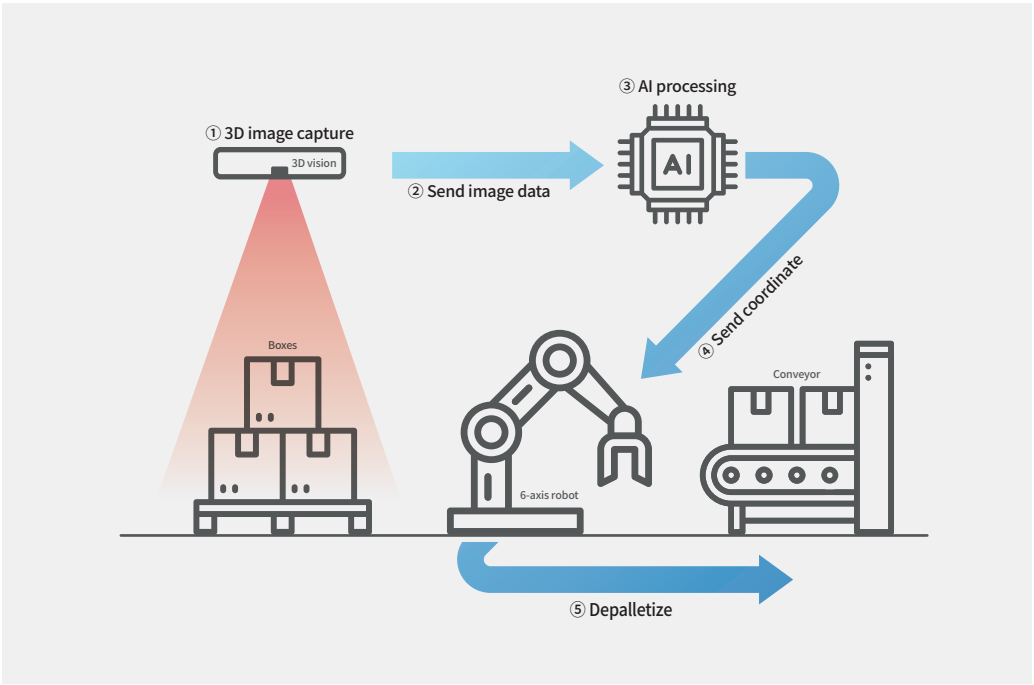
2) Hardware

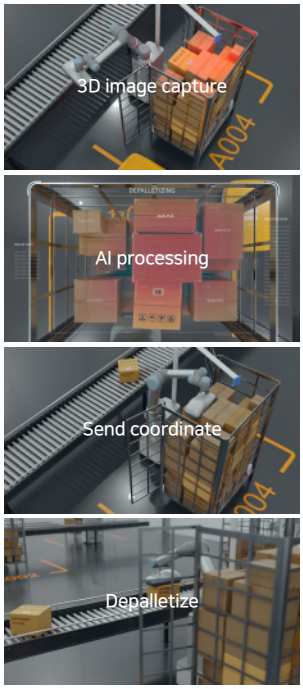
Compact booth style equipment
① *Robot (6 axis)
② Multi channel vacuum gripper
③ Processing unit (GPU for AI)
④ 3D scanner for box detection on the pallet
⑤ Vision for box height calculation
⑥ Calibration target
⑦ Pallet conveyor system (including PLC)

*Robot specifications

ITEM	SPEC
Controlled axes	6
Maximum payload (kg)	40
Repeatability (mm)	+/-0.06
Horizontal reach (mm)	2,552
Weight (kg)	435
Ambient temperature	5 to 45˚C
Power type	200~600V, 50/60hz 3-phase
Ave. Power consumption (kW)	1.62

3. MECHANISM





After the 3D scanner scans boxes of various shapes and sizes, AI Processing recognizes the shape of the box and locates it.
The location information found is transmitted to the robot along with the path in the form of coordinates.
The robot transfers the box to the conveyor belt using the coordinates.

4. FUNCTIONS

1) BASIC

① Accurate detection
- 3D scanning and box location detection
- Randomly placed box picking
- AI-based box recognition + Rule-based Algorithm for accurate detection
- Box size detection (including box height)

② Comprehensive handling for full automation
- Retry in case of box drop and non-recognition
- Self-diagnosis
- Statistics reporting about depalletizing results

③ Powerful and fast handling
- Multi-channel vacuum gripper (increase gripping robustness)

2) ADVANCED

- Collision-free robot path generation
- Automatic calibration(Vision, Robot, Vision to the robot)
- Box registration software for AI training of a new box
- 3D simulation interface

5. ADVANTAGES

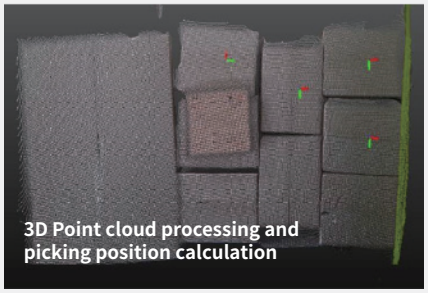
1) AI-BASED BOX RECOGNITION

Boxes are recognized using an AI core that has learned by big data of hundreds of thousands of box images.
Distinguishes the boxes from other objects, and can recognize individual boxes regardless of the waybill on the box and various taping conditions.
Provides software that enables evaluation and registration of new boxes.

AI Recognition result

2) 3D POINT CLOUD PROCESSING

Minimizes interference with surrounding objects by extracting only the data necessary for box recognition from the 3D scanned data.
In addition, using 3D depth information, it is possible to reduce the probability of erroneous detection/non-detection of the box and extract the exact location of the box.


3D Point cloud processing and picking position calculation

3) ROBUST VACUUM GRIPPER

Multi-channel vacuum system and sealing foam can be used to pick up objects that may be wrinkled such as the box surface. Through periodic replacement of sealing foam, the gripping performance can be maintained in an optimal state.

4) RETRY FOR CONTINUOUS OPERATION

In the case of occasional erroneous detection and non-adsorption, rescan and retry are automatically performed to minimize equipment stop time to maximize productivity. Statistics on the frequency and number of retries are made to help to maintain equipment.

5) COLLISION-FREE PATH GENERATION

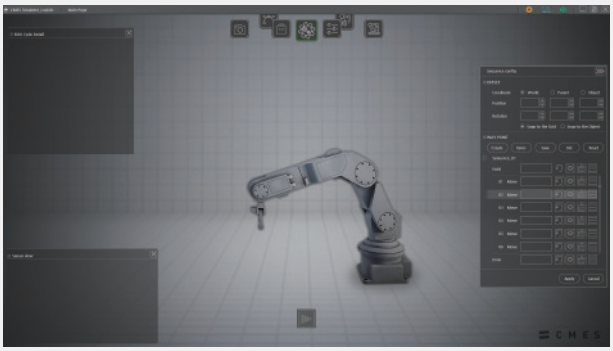
In order to prevent damage to the box itself or surrounding facilities while the robot picks up the box, and to guarantee the life of the robot and the gripper, a robot path that avoids collision is automatically created. This feature is a must-have feature especially for roll pallets.

6) EASY & AUTOMATIC CALIBRATION

The calibration between the 3D vision sensor and the robot can be changed continuously after initial setup, and this can degrade the robot's gripping performance. Through a very easy interface, the user can perform calibration either directly or in a periodic automatic mode, so that the calibration state is always optimally maintained.

7) 3D SIMULATION INTERFACE

Hardware setup can be reviewed in advance in a 3D simulation environment, and intuitive setup for the workspace of robots and 3D sensors is possible.
It is easy to check current equipment status, box detection, and robot path generation results, and calibration results in a 3D simulation environment.



8) COMPATIBILITY WITH MOST INDUSTRIAL ROBOTS

Interface with almost all industrial robots is possible, and robot movement can be optimized to increase productivity.

RESULTS

Source : CJ Logistics YouTube

“The existing robotic automation could only handle boxes of a certain size and under specific conditions. So, there was a limit to realize full automation because the robot could not handle boxes of irregular sizes. However, the robot can now recognize the irregularly shaped boxes and correctly pick them up and accurately move them to the conveyor,” automation process managers from a lot of logistics centers explained. If the robot moves one box at a time, it can handle 600 boxes per hour.
The robotic system such as random mixed depalletization is usually able to run at 95 percent efficiency, while the average worker is usually about 20 to 25 percent efficient during any given shift due to the consideration of break time and working time. If the gripper moves 2 boxes at once, it can process more boxes within the same working time.

CMES' Random Mixed Depalletizing Application improves production efficiency by sorting or moving boxes of irregular sizes and heavy boxes by processing the planned workload at a fixed time.
If a person or a robot picks up and moves one box on to the conveyor belt at a time and there are 7,500 boxes to move from a pallet to the conveyor belt, 9 to 10 people are required, compared to 12.5 robots when random mixed depalletization is applied on the line. In terms of the cost-saving aspect, ROI would be between 18 to 24 months. If the robot moves two boxes at a time, the productivity effect will be more significant.

CMES

Website	www.cmes3d.com
USA Office	2205 152nd Ave NE, Redmond, WA 98052
R&D Center	3-7, Seolleung-ro 132-gil, Gangnam-gu, Seoul, Republic of Korea (06065)
South Korea HQ	No.502, 35, Techno 9-ro, Yuseong-gu, Daejeon, Republic of Korea (34027)
Contact	**South Korea** - sales@cmes.kr/ +82 1800 8647 / FAX : +82 0505 355 6009 **USA** - info@cmes3d.com / +1 206 200 0444