Robotics247

SPECIAL FOCUS ISSUE
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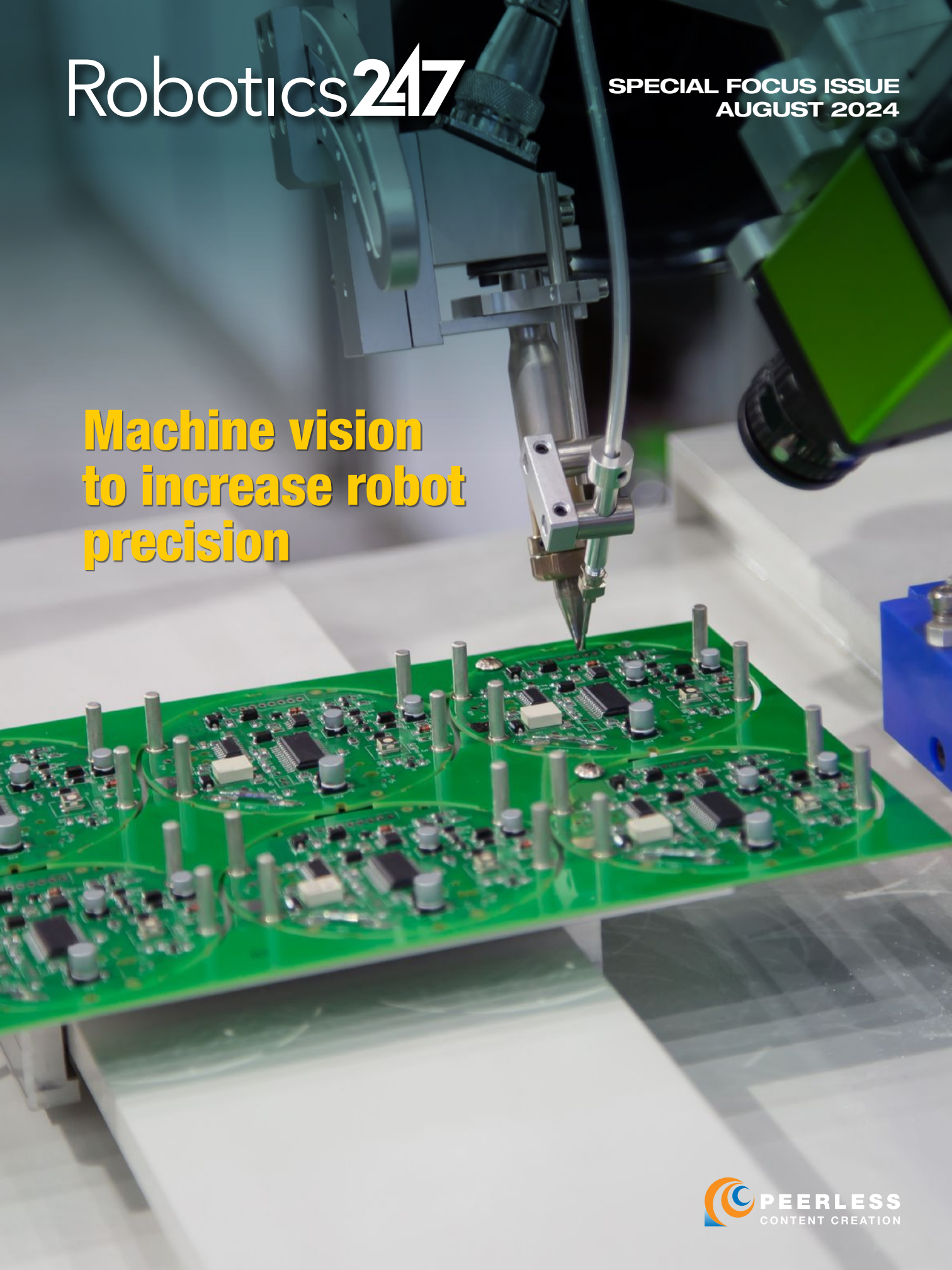
Machine vision to increase robot precision



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EDITOR'S NOTE

As technology improves, so too does a robot's ability to identify elements of its surroundings with more precision. Advances in machine vision have allowed robots to better visualize and conceptualize objects within their view, and utilize that information for better performance. What are the next steps in machine vision development and what areas are ripe for improvement to further robotic performance?

Across industries, machine vision has enabled organizations to identify and predict critical elements in their ongoing processes. An increase in technological advancements, coupled with lower costs for components such as 3D scanners and cameras, has created a perfect storm of innovation within the world of machine vision, machine learning and artificial intelligence.

In this Special Focus Issue, we'll examine how robotics developers, integrators and customers are harnessing the power of machine vision to increase efficiency, precision and ROI in their operations.

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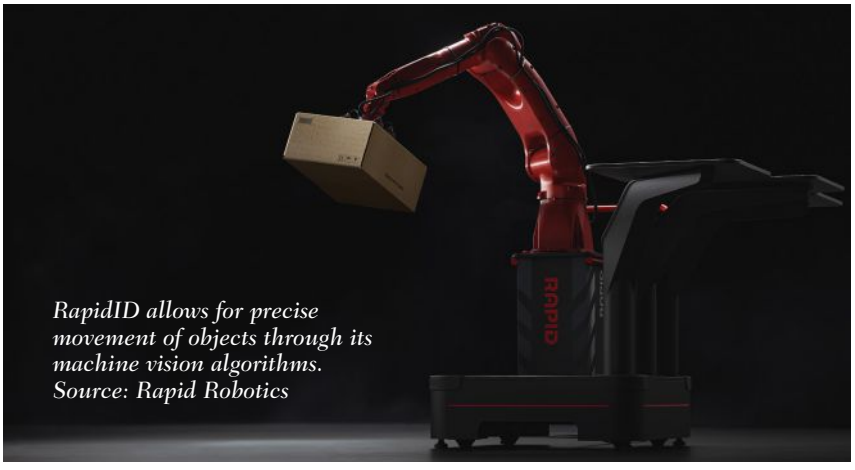
How RapidID machine vision technology 'gives robots human-like instinct'

Rapid Robotics' cloud-based vision platform identifies and grasps objects with precision

BY TIM CULVERHOUSE



RapidID allows for precise movement of objects through its machine vision algorithms. Source: Rapid Robotics

San Francisco-based Rapid Robotics continues to evolve.

The message of the company remains the same in solving the labor crisis and helping manufacturing companies thrive.

The vision, specifically of the machine variety, is where the biggest change has occurred.

RaaS to RapidID

When Rapid Robotics was founded in 2019, it was primarily a robotics-as-a-service (RaaS) provider and integrator for companies looking to automate portions of their manufacturing processes. But by 2023, and largely spearheaded by the COVID-19 pandemic, the company shifted its focus from hardware to software.

"The pandemic gave us the ability to deploy all these robots because everybody needed them," said Kim Losey, CEO of Rapid Robotics. "We figured out how to use primarily cobots at that time to do all kinds of machine tending tasks, from pad printing PCR chips for covid tests, to packing pharmaceuticals into boxes, dispensing pills into jars and putting embalming fluid in boxes."

Losey noted that the market and demand for automation helped drive revenue for Rapid, but created other issues that made her and the rest of the company rethink how they approached their underlying hypothesis of solving the labor crisis.

"We proved speed, we proved service and support, and we proved that we could do the custom engineering and design required to make them successful," she said. "What we didn't do was focus enough on the technology that would really allow us to scale beyond deploying hundreds of robots to deploying thousands or tens of thousands of robots. That was really the shift. It's not so much a shift in vision, but more a shift in how we do it."

That shift from "Rapid 1.0," as CTO Tom Hummel called it, saw Rapid Robotics stop deploying robots in 2023 - although the company still supports those customers - and focus its efforts on its RapidID software and the underlying machine vision, machine learning and AI technologies to "give robots human-like instinct."

Palletizing served as the start for RapidID

"The initial application for this to test out the infrastructure was palletizing," Hummel said. "Boxes were actually the first things onboarded. Then we tried other simple shapes, like cans, other types of boxes, but it's all really customer driven."

As Rapid added customers, it also added to its internal object database of objects and shapes. Hummel noted that one of the beauties of the system is that Rapid Robotics doesn't need a massive object database before RapidID goes to market. Onboarding objects - in the grand scheme of all this very extensive and ever-evolving

technology - is actually the "easy" part, he said.

"That's the beauty of modern machine learning approaches," Hummel added. "The modern way to do it now is called object intelligence. Instead of figuring out what I need to pick in a bin of objects, let's learn everything about this object first. Once I know everything about that object, then I can make a decision around it. And it's far easier to learn about an object than it is to teach a robot to grasp it."

In conjunction with this major company overhaul from robot hardware to a machine vision software platform was the emergence of higher quality, but cheaper 3D scanners, cameras and AI.

"If we go back almost five years to when Rapid started, 3D vision wasn't what it is today," Losey said. "I don't even know that we could have done this and if we could have achieved it. The technology just wasn't there."

With this perfect storm of cheaper, but better technology and more evolved AI, machine learning and machine vision, RapidID was placed front and center by Rapid Robotics.

"Advanced 3D vision cameras were probably 10 times more expensive, five times at least, more expensive than they are today," Losey said. "Generative AI really wasn't as prolific as it is today. It's very difficult to be able to use traditional machine learning to be able to handle that kind of variability. We believe this convergence of opportunity all at one time… brought everything all together that made RapidID possible."

Shape matching, completion create the vision

"We perform things called shape matching," Hummel said. "If we know that we have a bin full of 'Object As' and 'Object Bs' because we've deployed this system at a customer site, we know that we're only grabbing Object A and Object B. We're only finding these two objects."

The overarching library of objects in the aforementioned database that Rapid maintains provides a level of context for the machine learning system to make inferences. But because the system is trained on the customer objects, it allows for quicker deployments of the platform.

"Pick-and-place is never really just pick-and-place," he said. "There's always some intermediate step or some wrinkle that requires a little bit more attention."

As the technology continues to evolve, Rapid is keeping its eye on different industries that are ripe for automation. Losey specifically highlighted food and beverage and consumer packaged goods as prime examples that could benefit from RapidID.

"Automation was always standard for the upstream process in these industries, but not so standard for the downstream process," she said. "I think that's where advances in vision and perception are really going to help make that more digestible."

3D-printed grippers add customization for customers

Along with the machine vision and AI technology behind RapidID, the company also 3D prints custom grippers for its deployments to hone in on the precision required to identify, pick and place objects to and from boxes.

"3D printing technology allows us to create the geometries that are specifically required for that task," Hummel said. "The only real expense is the engineering time to make that, but we've managed to be pretty good at constraining that amount of time."

The end result is end of arm tooling (EOAT) combined with a software platform that can identify and grasp objects to within a few millimeters. That capability creates the high level of precision required to work in a variety of environments, including a current Rapid customer that handles stuffed animals.

"The grippers usually only have to handle 10 or less things," Hummel said. "It basically means that we can really tune the gripper in a reasonable amount of time, like a week or two, to do that task very successfully."

Whether RapidID is grasping stuffed animals, cans, embalming fluid or anything in-between, the overarching simple message remains the same.

"Stuff goes in boxes, travels in boxes and out of boxes all around the world every day and on pallets," Losey said. "It's not that different, putting something into a box, taking something out of a box, sorting something. It's all very similar. That's where we're thinking about RapidID and the platform is what makes that possible." •

Kawasaki, NEURA showcase new CL series cobots at Automate 2024

Partnership robots for various applications displayed at Kawasaki booth

BY ROBOTICS 24/7 STAFF

The CL series cobots from Kawasaki Robotics are designed for welding, finishing, multi-SKU palletizing and depalletizing, and automated corner board applications. Source: Kawasaki Robotics

Industrial robot manufacturer Kawasaki Robotics recently offered a first look at its new CL family of collaborative robots (cobots) at Automate 2024. The trade show was held May 6-9 at the McCormick Place Convention Center in Chicago.

Kawasaki Robotics also featured new applications using the Kawasaki R Series and BX Series AI-enabled industrial robots, all created in close collaboration with partners such as Mech Mind, CRG Automation, AMT Precision Parts and Olis Robotics.

"From our AI-enabled robots to our rich library of technology partners, it's the collective use of human ingenuity that fuels Kawasaki's product offerings," said Seiji Amazawa, Kawasaki Robotics president. "Our goal is to harness industrial automation in a way that makes the possibilities virtually limitless for our customers, and our Automate showing will help to reinforce that."

CL series cobots fitted for welding, finishing, and palletizing

Designed and built in Germany, and powered with NEURA Robotics' robot assistance technology, the CL series can run at a speed of 200 degrees per second with repeatability of +/- 0.02 millimeters, or 0.0008 inches. Payloads and reaches include:

- 3 kilograms at 590 millimeters, or about 6.6 pounds at 23 inches
- 5 kilograms at 800 millimeters, or about 11 pounds at 31 inches
- 8 kilograms at 1300 millimeters, or about 17.6 pounds at 51 inches
- 10 kilograms at 1000 millimeters, or about 22 pounds at 39 inches

The CL series robot arms also include free mounting orientations, small footprints and IP66 classification.

Kawasaki said its CL series offers components such as integrated 24-bit encoders and a lightweight construction. Paired with the CL Series user interface and safety architecture, these cobots can facilitate human/robot collaboration.

The CL series and applications including welding, finishing, multi-SKU palletizing and depalletizing, and an automated corner board solution demonstrate Kawasaki's commitment to continually optimizing its product offerings, aided by its technology-agnostic stance and expanding network of partners, the company said.

Partnership projects on display at Automate

Kawasaki Robotics' display at Automate 2024 also included:

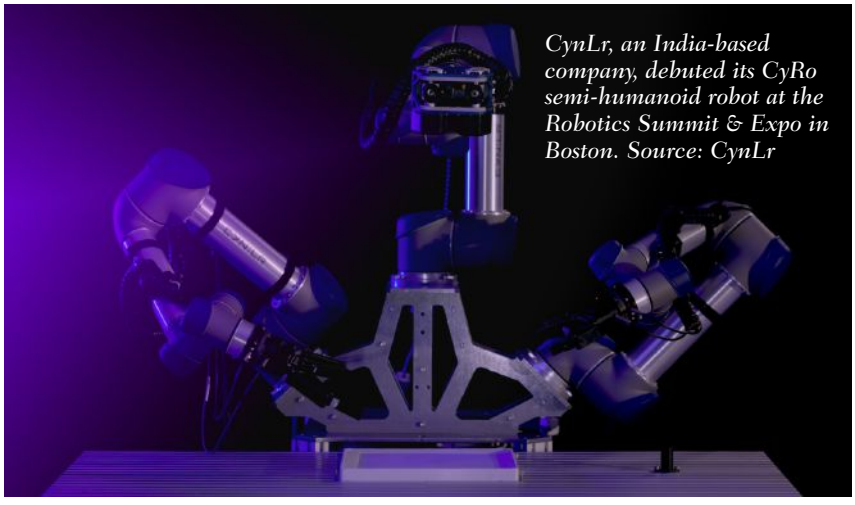
- An adaptable robotic finishing solution designed by AMT Precision Parts, capable of handling diverse materials and surface types.
- Unstructured, autonomous parcel sorting with the Kawasaki R Series, enabled by Mech Mind's 3D camera and AI-powered software.

A full-featured technology display was brought to life by partner CRG Automation, showcasing multi-SKU palletizing and depalletizing using a BX130X robot and an automated corner board application using an RS007L robot, with "Olis Connect," an edge-hosted product by Olis Robotics providing remote control and monitoring of the entire system. •

CynLr unveils CyRo semi-humanoid at 2024 Robotics Summit and Expo

CyRo is a multi-arm vision-guided robotic manipulator

BY ROBOTICS 24/7 STAFF



CynLr, an India-based company, debuted its CyRo semi-humanoid robot at the Robotics Summit & Expo in Boston. Source: CynLr

CynLr, an India-based startup specializing in visual object intelligence robotics and cybernetics, recently launched and showcased its all-purpose, reusable visual robot platform that doubles as a semi-humanoid called 'CyRo' at the Robotics Summit & Expo in Boston.

CyRo, powered by CynLr's proprietary vision object intelligence stack, is a multi-arm vision guided robotic manipulator that can grasp objects it has never seen before - under extreme variable lighting conditions - requires no lighting engineering and can handle complexities like reflective objects such as transparent/translucent packaging, according to the company.

Multi-purpose humanoids

CyRo represents a paradigm shift in robotics technology through its multi-purpose applicability in warehousing, manufacturing, lab automation, industrial kitchen and kiosk dispensing, CynLr said. In these industries, CyRo can be used for piece-picking, kitting, induction, sorting, packing, screwing, bolting, general assembly and more, according to the company.

"We are transforming robots from mere programmable machines into perceptive human-like entities," said Gokul N A, founder - design, product & brand at CynLr. "Imagine a world with simple dexterous visual robots like Cyro deployed at manufacturing lines. Manufacturers will have unparalleled flexibility and will be able to make products as per market demand."

CyRo is different than traditional robots

Unlike traditional robots that require extensive training and hardware customization specific to each task with a highly-controlled environment, CynLr said CyRo requires no hardware integration or environmental customization. CyRo possesses a human-eye inspired vision and intelligence hardware and software stack which makes it "natively intuitive" - according to the company - about objects without having to see or train on them before. This makes the robot repurposable for any task without any hardware customization or modification. Currently, the company is piloting its visual robots with General Motors & DENSO.

"We are excited to bring our technology to the global stage," said Nikhil Ramaswmay, co-founder & CEO at CynLr. "We recently opened a hardware design facility in Switzerland where we are developing these visual robots using the skilled talent and advanced research facilities available there… We envision that CyRo has the potential to change the future of industrial automation, ushering in an era of 'universal factories - product agnostic factories.'"

CynLr has a team of over 50 engineers who are skilled in vision, robotics and engineering. CynLr's vision stack is packed with over 400 technologies that are supplied by more than 250 partners and vendors from over 30 countries. •

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Comau introduces MI.RA/OnePicker automated intelligent piece picking solution at Automate 2024

Hardware agnostic offering incorporates simulation and AI algorithms

BY ROBOTICS 24/7 STAFF

Comau's new MI.RA OnePicker AI-backed vision system can pick miscellaneous objects from bins without prior information. Source: Comau

Industrial automation systems provider Comau recently introduced its new OnePicker machine vision system at Automate 2024.

"MI.RA/OnePicker is a result of our continued efforts to make complex technology more accessible and effective for a diverse range of industries," said Nicole Clement, chief business unit leader for advanced automation solutions. "Comau's dedication to powering automation for companies of all sizes with intelligent robotic solutions now extends to complex piece picking operations in industries such as warehousing and manufacturing, among others."

Latest MI.RA machine vision system is hardware agnostic

OnePicker is the newest system in Comau's Machine Inspection Recognition Archetypes (MI.RA) family of hardware-agnostic, intelligent vision systems.

Comau said its new perception-based piece picking system can eliminate unsustainable sorting activities within diversified industries, which in turn can increase both worker well-being and overall efficiency. The hardware-agnostic AI system pairs vision technology and sensors to pick randomly displaced objects after calculating the picking pose within seconds.

The compact and lightweight robot vision guidance system

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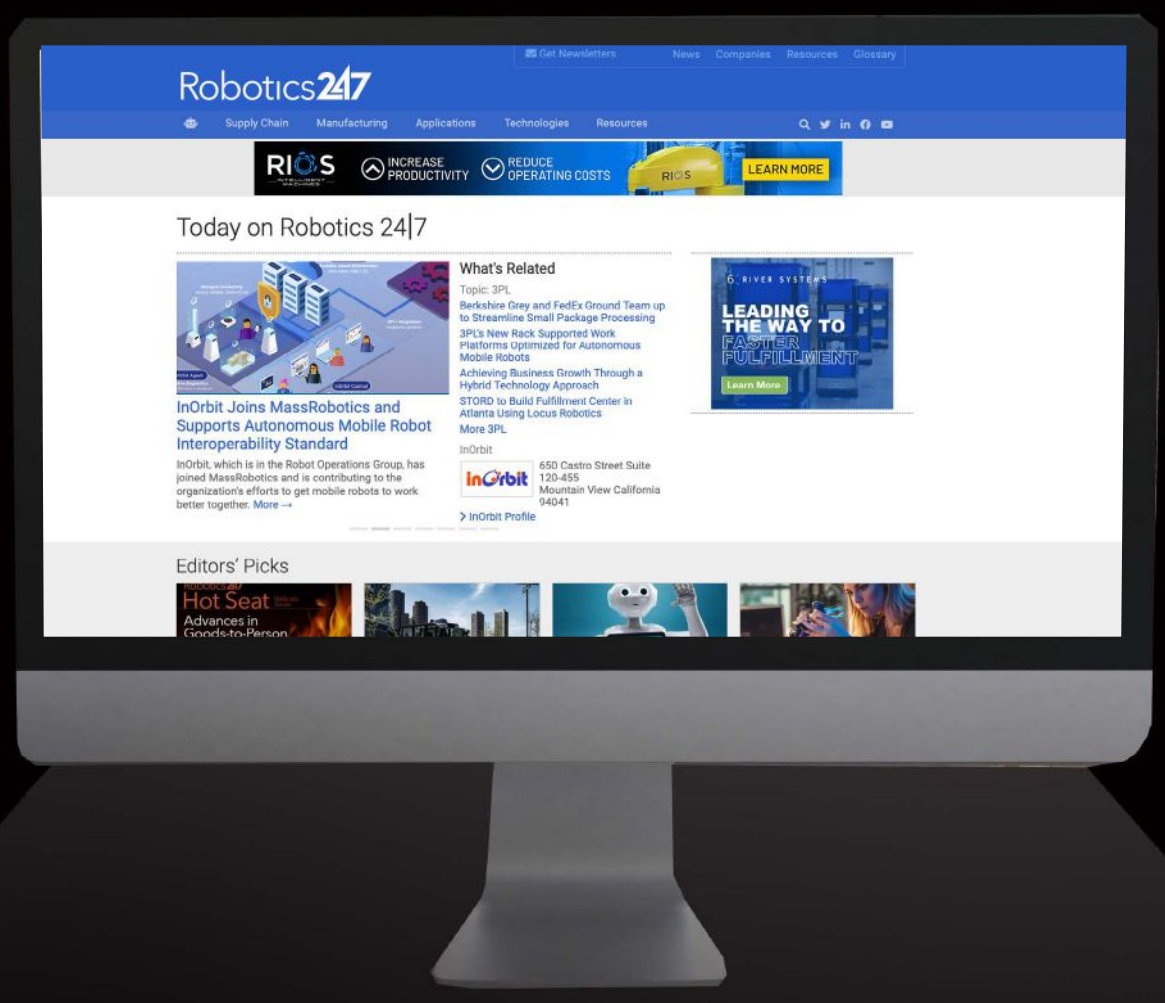
dedicated to real-world applications from the entire robotics ecosystem.



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determines the most effective way to empty a bin. MI.RA/OnePicker can be installed on even the smallest collaborative robots without limiting reachability inside the bins.

MI.RA/OnePicker is designed to autonomously pick miscellaneous objects from bins without relying on CAD-based assistance or prior information about their size, shape, color or characteristics.

Simulation and AI algorithms offered on fenceless cobot

AI-enabled and adaptable to any brand of commercial robot, customized bin, or customized gripper, the smart functionality of Comau's newest MI.RA system is ideal for pick and place, kitting, sorting, warehouse, ecommerce and similar applications, the company said. Thanks to virtual simulation tools and predictive algorithms that enable optimal path management and collision-free trajectories, Comau said its new MI.RA/OnePicker can ensure precision and reliable performance while reducing the need for costly manual and repetitive operations.

Leveraging proprietary automation and machine learning paradigms, MI.RA/OnePicker has a configuration page from which customers can set up the bin environment and parameter specifics. From the user-defined 3D models of the bin, environment and robot, the integrated algorithms can calculate the ideal balance between computational speed and accuracy.

The neural network autonomously recognizes the surfaces from which an object can be picked, using a suction cup to facilitate identification of the most suitable grasping points. As a result, MI.RA/OnePicker can achieve path planning and collision-free movements safely while ensuring optimal piece picking performance by the robot, Comau said. The vision-based piece picking system can autonomously grasp randomly-placed heterogeneous objects

As an all-in-one-system, MI.RA/OnePicker comes with Comau's Racer5 cobot, a six-axis articulated robot that the company said can deliver speed, accuracy, repeatability, and certified fenceless collaboration safety without cages. The compact cobot can automatically switch from industrial mode to collaborative mode, working at full speeds when human operators are not in the vicinity and at collaborative speeds when they are. •

Yale Lift Truck autonomous vehicles, operator assist enable precision in the warehouse

Reliant and forklifts utilize lidar and other sensors for safety

BY TIM CULVERHOUSE

According to the Oxford English Dictionary, the term "reliant" is an adjective that means "dependent on someone or something."

Let's flip that around. How about if someone - say an operations manager in a warehouse - is depending on something Reliant to not let a truck hit anything.

Enter Yale Lift Truck Technologies' Reliant operator assist system and autonomous lift truck lineup.

Thanks to machine vision and lidar, Yale lift trucks are able to identify potential hazards. Source: Yale Lift Truck Technologies

Lidar keeps humans safe and vehicles in motion

With both Reliant and the autonomous vehicles from Yale, lidar plays an integral role in object detection, precise movements and safely navigating the potential hazards of the warehouse.

"From an object standpoint, we are utilizing a lidar-based technology," said Joe Koch, sales manager, emerging technology, operator assist systems and telematics at Yale. "It's constantly scanning at about 170 degrees at about 30 feet. But there's a certain buffer zone that we put in there for the system to actually target a controlled slowdown. But with that 170 degrees, we're actually calculating the algorithm to the width of the truck."

As Reliant constantly scans the lift truck's surroundings, it's not only looking for objects in the lift truck's path, but also running advanced computations to continue safely moving the vehicle and its load without tipping or creating another dangerous scenario.

"It all sounds simple in concept, but all of these factors are actually playing in with our advanced dynamic stability in the moment," Koch said. "We're calculating the center of gravity and each input that you have, each stage that you're in, for your mass, the tilt, the weight, your travel direction, your speed, your acceleration. It will all be tailored into how that truck reacts in real time with the operator - no matter what they're doing from an input standpoint - as they're utilizing that truck for a different controlled slowdown each and every time. We're not throwing a load, we're controlling that load, we're controlling the truck, we're controlling stability, but we're not hindering the operator from doing anything either."

On the autonomous lift truck side, the main focus of the lidar sensors on the vehicles is object detection in the primary directions of travel.

"Any fork autonomous solution is going to be able to move a full 360 degree direction forward, reverse and left to right," said Kyle Smart, sales manager, emerging technology, robotics

and automation at Yale. "And it's going to have fields of view displayed accordingly."

What slows the vehicles down?

Lidar, as Smart described, is a consistent and reliable technology that Yale utilizes across its offerings for safety and precision.

"In terms of lidar versus some of the other technology out there, from the autonomous standpoint, lidar just continues to be really one of the most reliable and robust safety mechanisms in the industry," Smart said.

Koch agreed.

"Lidar, for where the market currently is in a technology standpoint, it is more feasible, it's more reliable and it's more consistent in its detections," he said. "It's not looking at, 'Hey, is this a human shape, or is this going to cause a false detection?' It can see a cone and it looks like someone is crouching, or a ladder looks like someone is standing up. From an operator assist standpoint, it takes a lot for us to be able to validate and put that onto our vehicles, whereas lidar is like a plug and play once you get the algorithm in there."

However, elements present in the warehouse can slow down lidar - along with cameras and sensors - on these vehicles. Stretch wrap, dark colors, low-light areas and items under three-quarters of an inch in diameter are elements that Koch and Smart described as somewhat tricky for lidar to comprehend, but the Yale systems and vehicles are able to navigate safely in and around these areas.

CAD layouts, pictures get the system going

When customers come to Yale exploring autonomous lift truck options, the start of a project begins with a CAD layout.

"A CAD gives us a number of things," Smart said. "It gives us the ability to determine the size of the space we're going to operate in, to measure our aisles, our turning radiuses where we need to pivot at, where we're manipulating the loads. Do we have any general space constraints?"

After that, some simple pictures really start expediting the project.

"Then it's going to be what is the size and the weights of the loads we need to move in that project," Smart added. "A lot of times, pictures are worth 1,000 words."

Reliant never stops, just crawls

On the operator assist side of the equation, Reliant's constant scanning of the lift truck's surrounding area creates a standard buffer zone to slow down the vehicle around anything it detects as a possible hazard.

"The standard buffer zone of about three meters is when we start slowing down the truck, even though we're looking out 30 feet to predict the path of travel," Koch said. "Once it hits that three meter threshold, it'll start bringing down that speed depending on that load that's on there, the direction of the truck and the speed of travel currently."

Another safety element that Yale is mindful of involves regulations - at the state, United States and/or European Union level - of

Onboard tools provide operators additional levels of system stability on Yale lift trucks. Source: Yale Lift Truck Technologies

the vehicle's movement.

"As the lift trucks approach the buffer zone, they will just go to a crawl at 1.5 miles per hour," Koch said. "The operator still has control of the vehicle at all times. We never bring it to a stop, which is key, because there's just states that you're not allowed to stop the vehicle. Operators remain in control."

With the entirety of the Yale ecosystem, one thing encompasses all the various offerings, from the manual forklifts the company has produced for over a century, to the technologically advanced autonomous lift trucks and Reliant operator assist system- precision is key.

"Precision is critical," Smart said. "Navigational accuracy and the tolerance that lidar provides is critical. Using some of the other sensor technology on the vehicle, we can overcome some of the tolerances that exist with all aspects of technology that the vehicle's equipped with in terms of speed and safety that we're maintaining around racks, other equipment or things that are just in the environment. They are all going to directly correlate to each other." •

VisionNav launches trailer loading and unloading system at MODEX 2024

VNST20 PRO uses SLAM positioning for navigation within trailers

BY ROBOTICS 24/7 STAFF

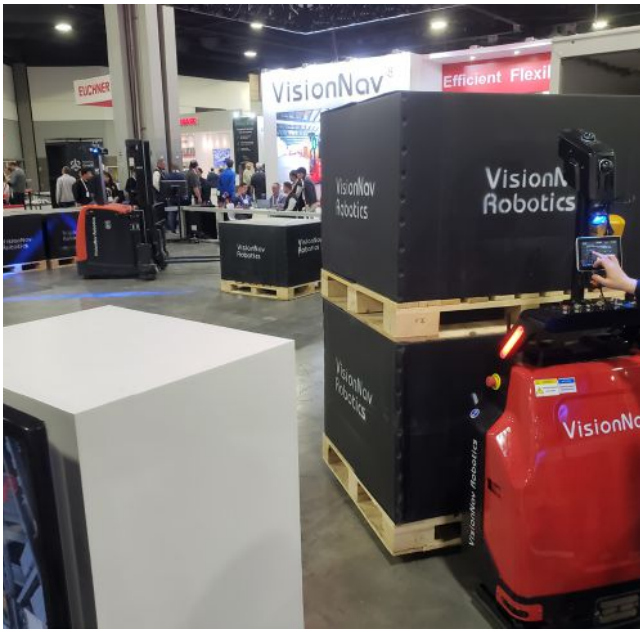
VisionNav's VNST20 PRO AGV has been designed specifically for automated loading and unloading of trailer trucks, incorporating 3D lidar and SLAM machine vision. Source: Donald Halsing, Peerless Media

Automated warehouse vehicle provider VisionNav Robotics launched its latest automatic trailer truck loading and unloading system in North America at MODEX 2024 in Atlanta. The system features VisionNav's newly unveiled VNST20 PRO automated guided vehicle (AGV).

VisionNav's new offering combines its VNST20 autonomous forklift, a robot control system (RCS) for fleet scheduling, and 3D lidar for simultaneous location and mapping (SLAM) with deep learning positioning technology. The system has been designed specifically for automated loading and unloading of trailer trucks and manual handling tasks.

VNST20 PRO AGV turns 180 degrees inside trailers

VisionNav's VNST20 PRO features a rated load capacity of 2,000 kilograms, about 4,400 pounds, a cargo top clearance of 150 millimeters, about 5.9 inches, a gap between goods of 0-30 millimeters, about 0-1.2 inches, and a minimum turning radius of 1,431 millimeters,



VisionNav's VNST20 Pro AGVs in action at MODEX 2024 in Atlanta. Source: Donald Halsing, Peerless Media

about 55 inches. When loading, the AGV drives into trailers with the load behind it, then turns around inside the trailer to spot the pallet.

"Boosting overall work efficiency and safety, the VNST20 PRO is at the cutting-edge of AGV robotics technology, revolutionizing cargo handling to enable loading or unloading a trailer truck in as little as 45 minutes," said Don Dong, VP of global sales for VisionNav Robotics.

At MODEX, VisionNav featured an immersive display showcasing the capabilities of its VNST20 PRO, which the company said marks an evolutionary step in the development of trailer truck loading and unloading.

Bright Eye, 3D lidar and SLAM offer adaptability

Fitted with an RCS which utilizes mapping, 3D perception, localization and routing technologies, the VNST20 PRO generates loading and unloading strategies, devises optimal delivery routes and maximizes loading rates.

The VNST20 PRO AGV works in tandem with a fixed Bright Eye visual mapping station to map the inside of trailers. VisionNav said its dedicated, proprietary system delivers increased space utilization, high scenario adaptation, high compatibility and reliable solution redundancy to provide fast, safe and efficient cargo handling.

Available in the U.S. starting in 2025, VisionNav said its VNST20 PRO can adapt to diverse trucks, goods and environments, utilizing self-adaptive perception for unstructured environments and dynamic mapping for dynamic routing in containers. It is compatible with a wide range of trucks in North America and Europe, and can be tailored to a variety of pallets, including EPAL and CHEP. The VNST20 PRO can be switched into manual mode to prevent delays. •

ForwardX Robotics introduces Apex C1500-L autonomous forklift

Multiple sensors to permit safe and accurate operation

BY ROBOTICS 24/7 STAFF

Autonomous mobile robot (AMR) provider ForwardX Robotics recently announced its new Apex series autonomous forklift, the C1500-L. With a load capacity of 3,300 pounds, or 1,500 kilograms, the Apex C1500-L leverages a combination of machine vision and laser SLAM sensors.

ForwardX said its new forklift is equipped with the means to execute precision docking and pallet placement with an accuracy within 10 millimeters. The C1500-L can also discern the angles at which the pallets are positioned, performing real-time adjustments autonomously to ensure square entry into pallet pockets.

ForwardX's C1500-L is also capable of performing triple pallet stacking with a maximum lift height of 14.7 feet, or 3.5 meters. Sensors in the forks enable variable pick and drop heights to prevent load damage during stacking operations.

Through the ForwardX f(x) robot fleet management software, the C1500-L can be integrated with ForwardX's conveyor, towing, and deck-lift AMRs.

ForwardX Robotics' new Apex C1500-L autonomous forklift is equipped with the company's new "Total Spatial Awareness" module for 360 degrees of operational visibility. Source: ForwardX Robotics

Total Spatial Awareness module features array of sensors

The Apex C1500-L is equipped with a CE-certified safety laser radar that can detect static or dynamic obstacles 85 millimeters, about 3.35 inches, or larger. ForwardX said its C1500-L's safety performance surpasses the European CE-MD standard, with the ability to detect obstacles both on the ground and overhead.

ForwardX's C1500-L forklift includes its new "Total Spatial Awareness" module. The new module incorporates two multi-line lidar sensors and three sensing cameras, which the company said ensures 360 degrees of 3D obstacle detection and avoidance and omnidirectional recognition.

With five laser radars, two wide-angle cameras, four pallet placement sensors, and a total of three multi-line laser radar sensors, ForwardX said the Apex C1500-L is capable of 360 degree stereoscopic obstacle detection.

ForwardX said the C1500-L can handle Euro pallets, GMA pallets, storage cages, storage racks, and cruciform carriers. The Apex C1500-L can cover inbound and outbound workflows, including pallet stacking, receiving, cross docking, order picking, inter-line transit, and integration with storage and production lines.

The ForwardX Apex C1500-L won MHI's 2024 Innovation Award for best innovation of an existing product, presented at MODEX 2024. •

MiR launches AI-enabled MiR1200 pallet jack

NVIDIA Jetson AGX Orin module provides pallet detection capabilities

BY ROBOTICS 24/7 STAFF

Through NVIDIA Jetson AGX Orin, the MiR1200 autonomous pallet jack combines data from four RGBD cameras and 3D LiDAR to detect obstacles and navigate autonomously. Source: Mobile Industrial Robots (MiR)

Robot manufacturer Mobile Industrial Robots (MiR) recently announced the launch of its MiR1200 pallet jack AMR. With AI pallet detection powered by NVIDIA Jetson AGX Orin, the MiR1200 pallet jack uses 3D machine vision to identify, pick up, and deliver pallets.

"We believe that the built-in AI detection system is a significant improvement over older detection technologies," said Mads Paulin, vice president of R&D at MiR. "Our approach will reduce pick-and-place cycle times, deliver best-in-class pick accuracy and allow us to continuously deliver advanced, AI-based functionality and value to our customers."

Pallet jack interoperable with MiR deck load AMRs

The MiR1200 pallet jack is designed to integrate with existing MiR AMR fleets and interoperate with MiR's deck-load AMRs. MiR said offering a pallet jack enables it to market a single material handling system for large-scale enterprise customers who typically operate more complex workflows with larger fleets and multiple sites.

Jean-Pierre Hathout, president of MiR, said the MiR1200 pallet jack can work in brownfield sites "that present unique environmental challenges for automation." The company's robots can be integrated via MiR Fleet - the company's fleet management tool - and mon-

itored and optimized through MiR Insights.

"In the design of this robot, we have leveraged the accumulated expertise in software from MiR, and high-payload AMRs that are the result of MiR's 2022 merger with AutoGuide," Hathout said. "The MiR1200 pallet jacks' robust tricycle drive system is developed through a partnership with Logitrans."

Key features of the MiR1200 pallet jack include:

- **AI-based detection powered by NVIDIA:** Trained on over 1.2 million real and synthetic images, which MiR said enables fast and precise pallet detection.
- **High battery capacity and fast charging:** With a charging ratio of 1:14 and the possibility of opportunity charging, the MiR1200 pallet jack is ideal for 24/7 workflows.
- **Compliance with ISO safety standards:** Designed to comply with the latest robot safety standards for AMR products, including ISO 3691-4, ensuring safety in various environments.
- **3D sensors for obstacle detection:** LiDAR and 3D machine vision are fused for precise detection of obstacles on the floor, overhead and around the pallet jack, which MiR said ensures precise and secure pallet placement.
- **Durable mobility:** The IP 52 rated AMR and rugged wheels enable mobility over multiple challenging surfaces.

3D machine vision through NVIDIA Jetson AGX Orin

Thanks to its 3D vision capabilities from NVIDIA, MiR said the MiR1200 pallet jack can address challenges many enterprises face with resource-intensive material handling, especially in complex environments that make automation difficult and where automation is needed due to increasing labor shortages.

The MiR1200 pallet jack can dynamically modify its route to avoid obstacles such as loose objects on the floor or overhead obstacles. It processes a large number of cameras and LiDAR data in real time by accelerating the full stack on the GPU and several other processors built into the NVIDIA Jetson AGX Orin module.

MiR said the MiR1200 pallet jack's ability to navigate in tight spaces with minimal changes to the existing infrastructure makes it the perfect fit for optimizing logistics efficiency and ensuring timely delivery of pallets.

Teradyne Robotics, MiR's parent company, also recently announced another partnership with NVIDIA through Universal Robots. •

Seegrid's AI, machine learning bring precision to automated lift trucks

Deep learning algorithms help robots pick and place pallets

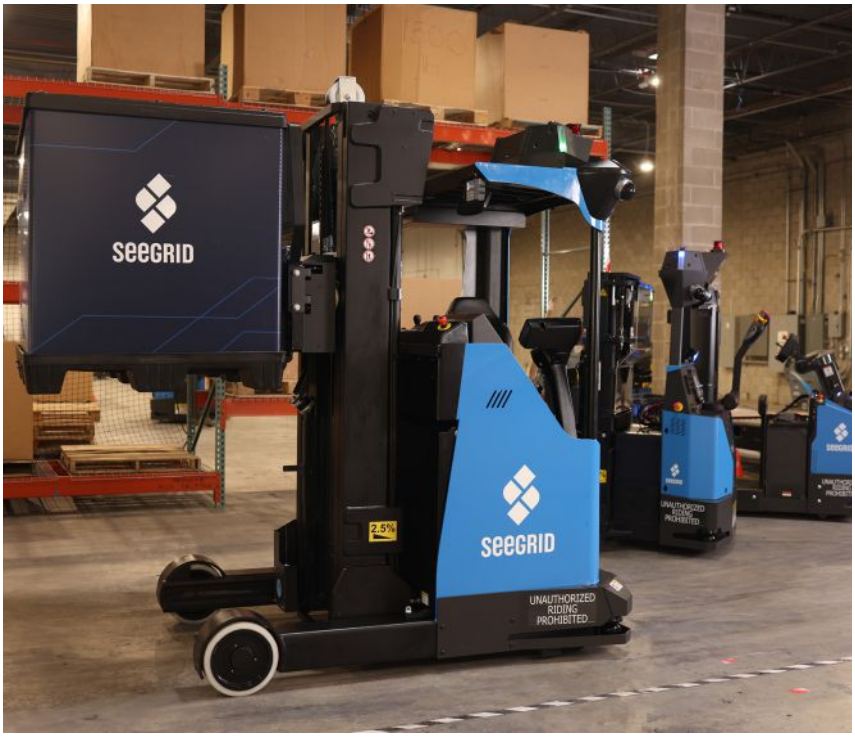
BY DONALD HALSING

Tasks that are easy for humans can be difficult for robots. Pallet handling is a perfect example.

Human operators are great at picking pallets of all shapes and sizes, even if there is plastic wrap covering the pockets, or if the pallets are skewed in the rack. Historically, automated lift trucks work best when pallets are clean, in good condition, and oriented neatly.

Conversely, repetitive tasks requiring precision are easy for robots, but human forklift operators can find it challenging to deliver the same level of precision. Automated lift trucks can place down pallets with consistent, miniscule gaps between units, while human operators will naturally vary their placement.

The big question manufacturing and warehousing operators need to ask is what workflows can be automated with today's technology?



Seegrid's autonomous lift trucks are capable of precisely picking, moving, and placing pallets - a task which depends on industry-ready machine vision hardware and software. Source: Seegrid

Setting up tech for success

Tom Panzarella, chief technology officer at Seegrid, said robotics customers and integrators need to mutually set each other up for success.

When Seegrid proposes solutions to problems provided by its customers, it defines the technology's operating constraints. Usually those constraints aren't burdensome for customers who are willing to meet technology at its current stable-functioning level for their deployments.

"It doesn't make a lot of sense to try to push the edges of the tech [when deploying commercially]," Panzarella said. "What you really want to do is set the tech up for success."

David Griffin, chief sales officer at Seegrid, said because automated lift trucks are a relatively new technology, new customers haven't developed an appropriate set of expectations just yet. But, as the industrial materials handling market gains more experience with automation, expectations will begin to fall in line with reality.

"Many of our customers that have been at this for a long enough time, they have a really good understanding of what is and isn't possible," Griffin said. Those customers work with Seegrid to choose the right applications, environments, and facil-

David Griffin, chief sales officer at Seegrid, said the company's robots deliver an ROI to its customers most often by reducing the number of employees required. Source: Seegrid

ities to implement automation, knowing that not all processes can be automated.

Many trucks doing many things at the same time

Griffin said lots of customers start by trying to automate the hardest tasks in their workflows, falsely assuming that automated lift trucks can do everything a person can. Although robots can't handle overly complex tasks, they can still add value for industrial customers.

"Why would you choose not to automate 90% of your processes because there's 10% that's just too difficult?" Griffin asked.

Repetitive tasks are the best candidates for automation, especially because they're boring and mundane for people. Griffin said automated lift trucks handle repetitive tasks very well, allowing warehouse operators to call upon their employees for tasks that require human capabilities and thinking, improving labor productivity.

While sensing, picking and placing pallets is a necessary capability, Griffin said appropriate fleet management software to coordinate vehicle activities is also necessary if facility operators want to deliver precise pallet conveyance.

"Can you get the right truck to the right place to handle the activity?" Griffin asked. "Can you optimize the job throughput?"

Strong fleet orchestration software is necessary to deliver repeatable and precise automated pallet movements, especially at a commercial scale. At a local level, each lift truck needs to safely handle pallets and navigate. But from a throughput perspective, facility operators don't choose automation because they want one robot - they want to add an entire fleet of autonomous vehicles to improve speed and accuracy.

"It's comparatively fairly easy to get one truck to do one thing, one time," Griffin said. "To get many trucks doing many things at the same time is quite the challenge. That is where the [fleet management] software comes into play."

Computer vision delivers a new level of operation discipline

The strength of automation - more precise pallet placement - can actually be a hindrance to implementation. Griffin said automation requires a level of operational discipline that industrial facilities and their operators might not be equipped for.

In manual forklift operations, pallets can be placed "close enough" to a target location. But because automated lift trucks work best when loads are more consistently placed, they may struggle to pick pallets placed by manual operators.

"If you want to automate it, you have to be more disciplined with what you're putting and where you're putting it," Griffin said. "The level of rigor that's required for automation is hard for customers to get used to."

AI and computer vision systems enable automated lift trucks to deliver precise pallet placement, as well as adapt to imperfect loads, and real-world

Tom Panzarella, chief technology officer at Seegrid, said the company is solving industrial problems with the small-scale data sets it has developed. Source: Seegrid

Automated lift trucks can deliver precision, but warehouse operators also need to adapt their facilities and connecting workflows to interoperate with robots. Source: Seegrid

dynamics present in industrial environments. From a technical capability standpoint, Panzarella said human vision is far more sophisticated than today's computer vision systems - especially with regards to object detection and localization.

Humans only need to see a handful of examples to learn what a pallet looks like. We can easily differentiate palletized loads from obstacles. And, humans are really good at identifying fork pockets in pallets, or in any other carrier that is pickable by a fork truck that might not be a pallet.

"You have to teach a computer, 'This is what a pallet looks like,' to include all of its permutations," Panzarella said. "Getting a computer to [reliably detect pallets in real-world production environments] is non trivial."

Automated lift trucks rely on sensors to collect data about their surroundings, which don't immediately make it clear where pallets are located. Compared to human vision and intuitive perception, which can seamlessly locate objects, machine vision requires more discreet steps.

"What the computer gets is just a digital sampling of the space," Panzarella said. "It is the job of the software algorithms processing the sensor data to precisely localize the pallet in real-time."

Cameras and sensors provide context

Seegrid uses a variety of cameras, lidar, and other sensors to gather information about the environment enabling the AMRs to accurately pick, transport, and place pallets.

To facilitate feedback to its pallet manipulation stack, Panzarella said Seegrid uses time-of-flight cameras and lidar to estimate the pose of a pallet when picking or the facility infrastructure (e.g., tables and racks) when placing.

Pallets in the real-world are often damaged or presented to the AMRs with high levels of variability. Computer vision systems need to be resilient enough to tolerate these disturbances to reliably determine the position and orientation of the pallet as well as estimate the location of the fork pockets. One particular challenge Panzarella noted is occlusions, often from facility infrastructure, that blocks the camera's line-of-sight to the pallet.

To get the best view of pallets, Seegrid places sensors between the forks. Panzarella said, in general, aligning the camera with the center of the pallet provides the most favorable, unoccluded view of the fork pockets

"Depending upon how your algorithms work, the pose of the camera with respect to the pallet could significantly affect your systems ability to properly estimate the fork pockets."

Additionally, Panzarella said that image resolution, camera optics and its field of view impacts the distance at which a pallet can be seen by an AMR.

Sensors are not all created equally either. Depending upon the type of sensor, the underlying physics, and vendor-specific quirks the data will be different.

As a result, a software algorithm developed for one sensor may not work with a different piece of hardware. "There are so many variables that do not make pallet detection a one scoop of vanilla ice cream-type problem," Panzarella said. "You have got to take in all the context and constraints of the problem you are trying to solve."

AI and machine learning software help solve industrial problems

Panzarella said Seegrid takes a "belt and suspenders" approach to functional safety, building its vehicle hardware and software over and above regulatory requirements and specifications. Sometimes this approach can present challenges.

For example, if a piece of debris (e.g., slip sheet) is present between the AMR and the pallet or occludes the fork pockets, Seegrid's automated lift trucks identify it as an obstacle and stop. This safety feature can help prevent injuries because the robot will stop for any obstacle, which could include people or limbs in the way.

"The edge of the technical problem right now is classifying

things like those obstructions to say, 'Well, that's actually an obstruction I can drive through and I should drive over,' whereas something else, 'That's not something I should drive through or drive over,'" Panzarella said.

"I think there's still a lot of room for technical development in that space," he added. "The balance you've got to strike is uptime and availability of the vehicles actually doing the work while also doing it safely."

Training AI software systems to support the variety of pickable objects, not just pallets, isn't straightforward.

Panzarella said it's unscalable for humans to describe the salient features that define all pickable objects to a computer because of the diversity of load types Seegrid deals with in the manufacturing industry. Instead, Seegrid is employing deep learning-based feature detectors to surface those salient features through examples and data.

However, machine learning algorithms might not produce outputs that meet the safety requirements of what automated lift trucks require. So rather than treating its neural network as a black box and accepting the output as truth, Seegrid is applying a hybrid-AI approach. It validates the output of the neural network using classical computer vision techniques in real-time.

"We're solving industrial problems with the data sets we have," Panzarella said, noting that the AI and data sets Seegrid is using are different from the massive, generalized AI models described in popular media. "Industrial use-cases typically are not afforded access to internet-scale data. Relatively speaking, we are dealing with small data."

Data sharing to demonstrate what's possible

As ever-advancing technology is deployed into industrial environments, facility operators will expect them to behave in predictable ways, while decision makers will want to keep pushing the technology to the highest edge of performance.

Automated lift trucks can deliver precision, but Optimizing throughput requires getting the right truck to the right place at the right time. Fleet management is a critical component of process automation. Source: Seegrid

While technology has been modernized, Panzarella said people need to get comfortable with new mindsets regarding data sharing. Safety and performance can only improve if data sharing policies and operational processes catch up.

"If you want 'artificially intelligent autonomous machinery optimizing your workflows,' you need to give it its nourishment - and its nourishment is data," he said. "You need modern policies in place allowing for access to data from the field so that the models can learn and improve over time."

Data is a useful tool not just for development, but also for eliciting capabilities to customers. Griffin said Seegrid's customers make significant investments in automation systems.

Customers want to know if their robots are performing sufficiently to accomplish their business cases. They want to see which robots are doing what jobs so they can evaluate throughput and efficiency gains.

"From a data perspective, anything that we as an industry can provide to the customers to let them know how automation is performing is super helpful," Griffin said.

In terms of return on investment (ROI), Griffin said many customers can perform straightforward calculations to determine if automation is helping. In many cases, reduced staffing is a key performance indicator that demonstrates the benefits of deploying robots.

But in some situations, ROI calculations become complicated. Some customers don't choose applications where added value can be clearly determined. Griffin said some of Seegrid's customers are interested in testing new technologies, and less interested in proving a business case.

Regardless, adding robots to operations has demonstrated clear benefits in the long run.

"Seegrid over time has sold thousands of robots," Griffin said. "And the reason we sell thousands of them is because we save our customers a lot of money." •

RGo Robotics Perception Engine to power Onward Robotics' fulfillment center automation

Vision and AI offering to power Pyxis robot

BY ROBOTICS 24/7 STAFF

RGo Robotics, a provider of AI-powered, location-aware artificial perception platforms, announced that its Perception Engine will power the Pyxis robot from Onward Robotics.

The companies said their partnership can enable humans and robots to interact in fulfillment and distribution centers, providing breakthrough throughput and rapid return on investment.

Perception Engine and Pyxis partnership

RGo's vision and AI offering for localization, obstacle detection and scene understanding achieves highly consistent accuracy, according to the company. It can operate reliably in challenging environments like narrow, repetitive aisles in fulfillment centers where robots need to travel in close proximity to shelving units and humans.

With Perception Engine, Onward's Pyxis platform can provide uninterrupted operations of its fleet of robots, delivering breakthrough productivity and customer satisfaction, the company said. Onward Robotics is a Pittsburgh-based organization that rebranded from IAM Robotics in 2023.

RGo Robotics Perception Engine will power the Pyxis robot from Onward Robotics. Pictured above is a robot operating at RGo's MODEX 2024 booth. Source: Donald Halsing, Peerless Media

"I'm proud our team met Onward's stringent requirements for a highly reliable solution that works effectively in dynamic environments with low error rates and high uptime," said Amir Bousani, co-founder and CEO of RGo Robotics. "It demonstrates the high reliability of our 3D vision and AI perception technology and shows it's ready for prime time."

Additionally, RGo Perception Engine gives Onward the ability to quickly and easily set up new customer sites with a robot fleet in just hours, shortening time-to-value and reducing deployment costs. RGo's Perception Engine dynamically adapts to changes in the environment, eliminating disruptive re-mapping when layout changes occur.

"Onward Robotics is set to revolutionize fulfillment and distribution center automation by optimizing humans and robots for continuous, rapid fulfillment," said Lance VandenBrook, CEO of Onward Robotics. "Flexible and adaptable perception is critical for achieving business success. Working with RGo allowed us to release our solution in record time while our team focused on core differentiating features." •

Orbbec Gemini 330 series Stereo Vision cameras integrate with NVIDIA Isaac Robotics platform

Cameras deliver high vision results for AI-based perception workflow for AMRs

BY ROBOTICS 24/7 STAFF

The Orbbec Gemini 330 series of Stereo Vision cameras integrate with NVIDIA Isaac. Source: Orbbec

Orbbec, a Michigan-based provider of 3D vision systems, announced that its Gemini 330 series Stereo Vision 3D cameras are now integrated with the NVIDIA Isaac Perceptor, a reference workflow for AMRs built on GPU-accelerated Isaac ROS.

These cameras can enhance depth quality and provide longer-range sensing in varied lighting conditions, which lets Isaac Perceptor - whose general availability was announced by NVIDIA at COMPUTEX - output 3D reconstruction and obstacle cost maps of any unstructured environment.

Gemini 330 series provide clearer view

The Gemini 335, 335L, 336 and 336L cameras operate in both passive and active laser-illuminated modes to ensure high-quality depth and RGB data output, even in challenging lighting conditions. The depth algorithms are processed in the camera by Orbbec's latest depth engine ASIC, which the company said eliminates the burden on the NVIDIA Jetson Orin module-based compute for such operations.

The cameras include internal IMU and temperature sensors and have a working range of 0.2-10 meters, about 7.9 inches to 32.8 feet, global shutter image sensors, wide field-of-view lenses, high frame rates, low latency and precise multi-camera synchronization.

Orbbec also announced the Gemini 336 and 336L variants for improved performance in indoor environments by adding NIR bandpass filters. This reduces the potential of "holes" in a depth map due to glare from shiny floors and other reflective surfaces and "ghost" images from repetitive patterns in the environment.

"The integration of Orbbec's cameras with NVIDIA Isaac Perceptor will provide robot developers the precise Depth+RGB vision capabilities necessary to enhance the performance and reliability of AMRs across various sectors," said Amit Banerjee, head of partnerships at Orbbec. "This collaboration extends beyond physical applications, with Orbbec camera simulation models also available through the NVIDIA Isaac Sim platform and NVIDIA Metropolis framework to ensure customers can fully utilize the capabilities of NVIDIA-accelerated technologies from physical run-time models to physically based simulation environments."

In addition to AMRs, the Gemini 330 series cameras are suited for robot arm applications that utilize AI vision for bin-picking, palletization, scanning and sorting applications, especially where reduction in glare and resulting holes from glossy surfaces are important. •

Pudu Robotics launches T300 industrial conveyance robot

Food and beverage service robot provider debuts first product for industrial environments

BY ROBOTICS 24/7 STAFF

AMR provider Pudu Robotics announced the launch of its first robot designed expressly for industrial applications - the PUDU T300 - which debuted at Hannover Messe 2024.

PUDU said its T300 features maneuverability with an ability to navigate efficiently through narrow passageways commonly found in industrial facilities. The PUDU T300 also includes "map-and-go" functionality that allows for immediate use without network connectivity.

The company said manufacturers worldwide are struggling to adapt to changing market demands and production variability. As a result, creating more agile, responsive and flexible production lines has become crucial.

The PUDU T300 is specifically designed to fill this need in the material handling and internal logistics of discrete manufacturing, handling conveyance tasks like delivering supplies to production lines, transferring materials between different production areas and assisting in the delivery of samples for quality control inspection.

The PUDU T300 industrial delivery robot is equipped with SLAM navigation and a 23.6 inch wide base, allowing it to provide flexible materials conveyance in industrial facilities. Source: Pudu Robotics

SLAM navigation allows flexible operations

PUDU said its T300 is designed to alleviate potential labor shortages by automating the delivery and transport of materials, allowing human workers to focus on more skilled and higher-value tasks. By taking over the transportation of heavy or hazardous materials, the PUDU T300 can also improve safety by reducing

the risk of workplace injuries associated with industrial work.

"There is a huge demand from industrial clients for automated, flexible robotics solutions that can operate continuously to meet high production rates and improve operational efficiency," said Felix Zhang, founder and CEO of Pudu Robotics. "As manufacturers struggle to attract and retain talent, the T300 fills the immediate gap by seamlessly integrating with facilities' current processes as well as optimizing operations to spur sector-wide innovation."

The PUDU T300 is built on the company's proprietary PUDU VSLAM+, a visual positioning system that the company said enables marker-free navigation. This machine vision system ensures the PUDU T300 can quickly adapt to changes in production layouts without the need for reconfiguration or site remodeling.

PUDU T300 features include:

- **Maneuverability:** The PUDU T300 can navigate spaces as slim as 23.6 inches, and cross 0.7 inch thresholds and 1.3 inch gutters.
- **Navigation and Deployment:** The PUDU T300 supports a fusion of laser SLAM and visual SLAM for positioning, providing environmental adaptability, especially in high-ceiling factory scenarios. The robot can update its map in real-time based on actual site changes.
- **loT Capabilities:** The PUDU T300 includes interoperability features such as secure door access, elevator control, a self-configuring network with call options and production line material requests via an app to integrate into production processes.
- **Multimodal Interaction:** Operation indicator lights and traffic signal light design display the PUDU T300's position and cruising intentions, with collaborative robot features including customizable buttons and audible alerts.
- **Charging:** The PUDU T300 features automatic recharging and quick battery swapping capabilities, allowing for continuous 24/7 operation.
- **Safety Compliance:** The PUDU T300 adheres to ISO 3691-4 Industrial Safety Requirements and includes lidar, depth camera, collision protection edges and emergency stop buttons.

PUDU said its T300 can be used to improve production lines across the entire manufacturing sector, including 3C electronics manufacturers, automotive parts processing facilities, metalworking and semiconductor fabrication plants.

In addition to its latest materials conveyance robot, PUDU also produces robots for food and beverage retail, restaurant order delivery, as well as cleaning service industry applications. •

Slamcore's visual SLAM can improve safety and throughput

Slamcore's visual SLAM can improve safety and throughput

BY DONALD HALSING

Simultaneous localization and mapping (SLAM) can be a powerful tool, delivering information for both robot navigation and operations management. Reliable visual SLAM can run on inexpensive hardware, making it relatively easy to deploy and scale.

In 2016, Andrew Davison, Stefan Leutenegger, Jacek Zienkiewicz and Owen Nicholson co-founded Slamcore while researching "spatial AI" machine vision for robots at Imperial College London.

Leveraging his experience of transforming early-stage technology startups into production systems, Nicholson said the team spent the next few years spinning out from the university, building their core technology and developing a product that can have a real impact on the world.

Now, Nicholson is the CEO of Slamcore. He said visual SLAM technology has been implemented in the consumer space for quite a while, in products including autonomous vacuums as well as virtual reality and augmented reality headsets. However, he said visual SLAM has been slow to enter the industrial space because, "It's harder in many ways."

Slamcore Aware, a hardware and software package for manual warehouse vehicles, was launched at MODEX 2024. Source: Donald Halsing, Peerless Media

The challenges of creating vision-based SLAM for industrial applications

Nicholson said implementing visual SLAM in logistics warehouses and manufacturing facilities is challenged by the scale of industrial environments.

"Knowing where a vacuum cleaner is in a front room is difficult," he said. "But knowing where an AMR is in a one million square foot warehouse is literally orders of magnitude more intense."

Compared to measurement-based systems, like lasers or lidar, vision-based systems can be a computationally expensive way of providing information.

slamcore

Owen Nicholson, CEO and co-founder of Slamcore, said the company's visual SLAM software can produce a "spatial-temporal" digital twin. Source: Slamcore

"And if you're not careful, the computation and the memory requirements to do that in real time can explode, especially at the scale of a factory or a warehouse," Nicholson said.

"You can do it in a way where you take shortcuts on accuracy and reliability," he added. "But at the end of the day, if these systems don't work and they're not bulletproof, then you haven't got a product."

Another challenge is that warehouses might have inconsistent wireless network connections, or none at all. Nicholson said Slamcore decided to develop software for edge computing, with additional data management and sharing features enabled through the cloud.

On the edge, Slamcore's software solves critical problems, such as determining if a robot is about to crash into something, or finding the quickest path between two points.

"What we're finding actually is the challenge - and this is partly why it is such a challenge - is because it has to run on the edge. You can't just cheat a bit and spin up another AWS core."

The overall challenge Slamcore needed to address was how to deliver a workable visual SLAM for real-world industry beyond proof-of-concept. And, it had to perform on hardware at a reasonable cost.

Off-the-shelf hardware keeps costs low, deployments fast

Implementing vision-based navigation systems requires delivering both software and accompanying hardware. But building custom sensors can drive up the cost significantly.

"We've got a firm belief that the only way robotics are going to scale is if we use hardware which is readily available," Nicholson said.

Slamcore turned to the consumer electronics market to source its cameras because the high production volume keeps hardware costs down. The company focused on making consumer-grade, off-the-shelf hardware industrially robust.

Nicholson said using off-the-shelf hardware was a commercial decision, not a technical one. Better hardware would enable Slamcore to build better visual SLAM software, but more affordable hardware makes sense for commercial applications.

"One of our things we've been very strict about is using affordable hardware," Nicholson said.

Slamcore is developing two product lines:

- A software-only system
- And a hardware-provided one

While providing software alone got the spatial awareness product into robot users' hands, Nicholson said that process requires calibration to get systems running.

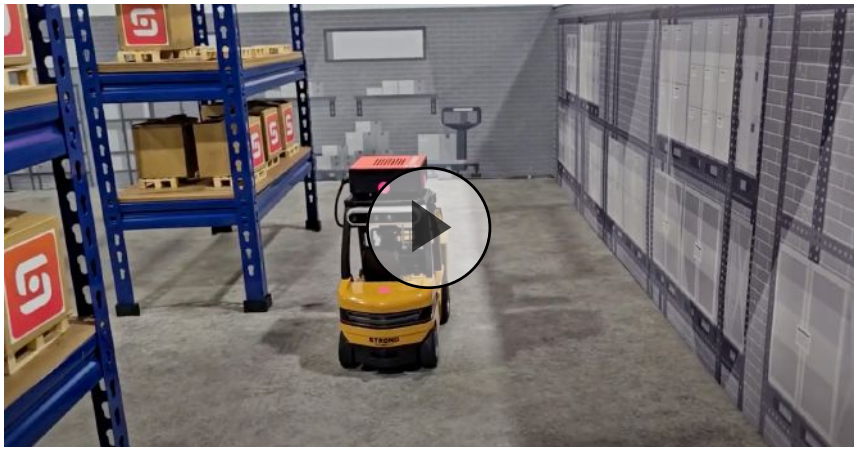
Instead of installing and fine-tuning the software for legacy hardware, Slamcore can get new deployments up and running in a couple hours. "We did trials in the last month, where we had people on site and systems running by the end of the day - actually by the end of the first morning shift - which is kind of unheard of in this space," Nicholson said.

In terms of technical specifications, Slamcore normally shoots video at 30 fps with relatively low-resolution cameras, such as those outputting 1024 by 768 through VGA. "You don't need anything more expensive than that, and that's what keeps costs down," Nicholson said.

Visitors to Slamcore's MODEX 2024 booth got an opportunity to operate model forklifts equipped with Slamcore Aware. Source: Donald Halsing, Peerless Media

One feature that slightly raises costs is global shutters. Nicholson said rolling-shutter cameras make sense for consumer-level SLAM applications. But within the industrial space, the potential value both in operational cost savings and injury prevention justifies a few extra dollars for global shutters.

"This could ultimately improve your efficiency by 20% for the entire site, and it could reduce your number of accidents… by enough to really care about," Nicholson said.



Vision-based localization can boost autonomous fleet scaling

Nicholson said some SLAM systems need a "teach and repeat" operational style, meaning they need to re-map when changes occur. "It's very hard to scale in that way."

Slamcore's hardware boxes can be mounted on existing vehicles that are already deployed. As the vehicles move around the facility, the system collects enough data to create an initial map to work off.

"Once that's done, it's done for life, and you don't have to do any remapping," Nicholson said. "You can then bring online as many systems as you want, with just a single click to transfer the data from one box to another."

Nicholson said positioning is the fundamental backbone of a spatial awareness system, for tracking both robots and manually-operated vehicles. "And actually, you need to do both."

He added the most important assets for warehouse operators are manual forklifts, which move most of the value of goods.

"That's what's stopping us from scaling with a lot of robots," Nicholson said. "You can't have robots just running around, doing their own thing and slowing down… manual forklifts."

For example, if a robot's localization fails and it gets lost - blocking a drive aisle or input and output bays - that could bring a customer's entire production line to a standstill. "That trial is over. They're not going to scale anymore," Nicholson said.

To help end users scale their AMR fleets, Slamcore's spatial awareness systems can track the location of all vehicles in a warehouse - both manual and automated - which can enable fleet orchestration from a safety-first point of view.

"If we only care about the robots, then we are missing the big picture," Nicholson said.

Deep learning, object recognition to improve throughput

Heterogeneous fleets of manual vehicles, autonomous vehicles, and people on the floor can allow warehouse operators to maximize throughput. But if robots lack the ability to understand what objects are around them to adjust their behaviors, engineering controls need to be implemented, which can actually hinder efficiency.

Engineering controls might include creating robot-only zones, or setting speed limits on autonomous vehicles. Nicholson said the current speed limits on robots are nowhere near the fastest speeds they can travel at, but restrictions are required for safety.

AGVs use relatively simple localization systems, such as following a line or markers on the floor. Nicholson said although line following is a good localization technique, AGVs don't have great perception abilities.

Object recognition allows computer systems to identify and label items within images. AGV operators can add Slamcore's hardware box and cameras to their machine to add on the perception of a fully-autonomous robot, including both localization and object recognition.

"Vision really comes into its own, because you get so much more spatial data from a stream of images than you do from a bunch of laser measurements or from other ultrasonic measurements."

Slamcore's proprietary AI

stack takes in images and outputs object positions with labels. Nicholson said deep learning and generative AI are making it easier for computers to identify objects.

"There's lots of companies out there who do labeling of images," Nicholson said. "But if you don't know where that object is, you really limit the amount of value you can bring."

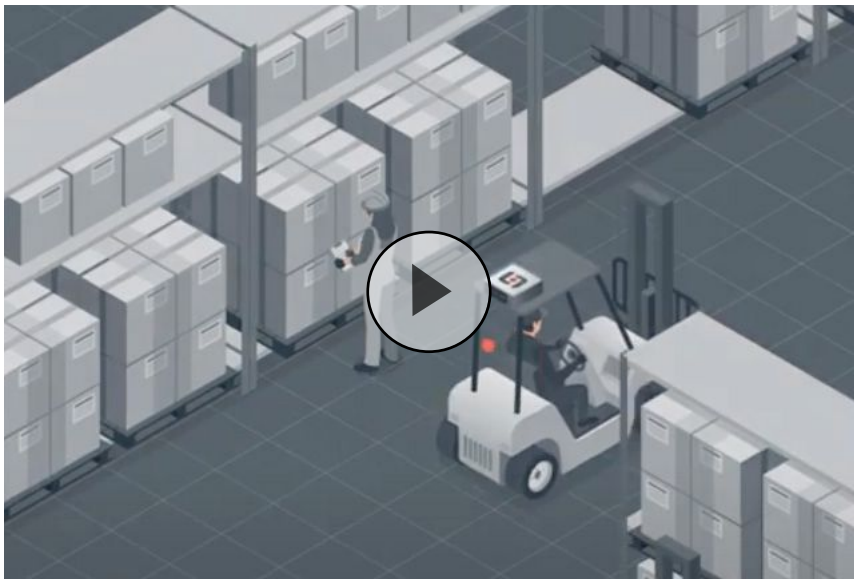
Because Slamcore's software is foundationally a localization system, the computer knows where the cameras are within the facility space, and therefore can tell robots both what things are in front of them and how far away they are. Based on that information, robots can modify their behaviors to operate safely.

If Slamcore's software identifies a person, the robot might stop, slow down, or move out of the way. But if it detects a pallet, the robots don't need to slow down, allowing them to operate at higher speeds without engineering controls.

"That's the real value of being able to identify the difference between objects in real time for the robot," Nicholson said.

But Slamcore's goal isn't just to improve the capabilities of one robot. Position and object identity information can be shared across an entire fleet of vehicles in a warehouse. Fleet management and orchestration software can use real-time data to set up dynamic zones around obstructions with temporary speed restrictions.

Obstructions could be a stray pallet or box. But if it's a person who entered an area they weren't meant to be in, information can



be relayed to both robots and human operators so they can know what to expect when they enter that area.

Dynamic zones have the potential not only to improve path planning by routing around obstructions - improving conveyance and picking efficiency - they can also bolster safety.

Object recognition can help increase precision

Slamcore's algorithms analyze each frame of video before the next one is captured, quickly contextualizing the environment surrounding vehicles. That context includes localization, object detection, and object recognition.

Nicholson said object recognition can have a knock-on effect for positional accuracy. The whole point of SLAM is to create a map as vehicles move around an area. But measuring against other moving objects can create errors.

Lasers are great for capturing distance and angle measurements. But laser-based navigation systems can struggle in dynamic environments because they don't have context to know if what they're measuring against is stationary or in motion. That can make it hard to localize where vehicles are located within a facility.

Visual AI enables navigation systems to identify which object a measurement was taken from, whether it be a person, another vehicle, or a part of the building. Doing so allows navigation software to ignore static objects and focus on tracking dynamic objects.

Slamcore Aware for manual vehicles can provide positional accuracy within 20 centimeters, or within eight inches. Nicholson said customers who request accuracy within two centimeters - or within an inch - use additional inputs such as wheel odometry.

"I'm not a vision fundamentalist. I believe vision should always be present," Nicholson said. "But it's not the only answer."

He added accuracy within two centimeters can enable AMRs to work really well. Although that level of accuracy is possible with vision alone, fine-tuning and reliability become more difficult to maintain.

"We believe in, 'Vision plus other sensors,' if you want to go down to that level of accuracy," Nicholson said. "Vision alone isn't the answer to full autonomy in this commercial, scalable way."

That being said, spatial awareness systems like Slamcore can complement other sensors by reducing the precision necessary for those systems - and drive down costs.

Instead of relying on lasers that can measure close and far distances to localize machines precisely, Nicholson said vision-based SLAM running on cost-effective hardware can be paired with light lasers in the $100 range to achieve the same level of precision.

Developing visual SLAM required Slamcore to consider what the robots need to function, what facilities need to operate, and what the warehousing industry needs to improve safety and performance. Nicholson said lasers and lidar have been critical to the success of the industry, and SLAM machine vision is the thread that pulls everything together.

"If I was going to have a life-or-death decision on a sensor, I'd rather it was a laser than a probabilistic AI engine from a computer vision algorithm," he added. "Or at least I want a few more years of testing in the field before I make that the goal."

Generative AI can predict and prevent future accidents

The term digital twin can mean different things to different people. Nicholson said the value proposition of a perfect 3D reconstruction is not entirely clear to him, but a "spatial-temporal" digital twin can provide clear advantages.

"What I'm interested in is a digital twin which is much more a spatial-temporal representation of the location of every vehicle and every piece of material in real time," he said. "It's really useful because you can do your real time orchestration, but also [look at] history."

Nicholson described a warehouse fleet with machine vision equipped on every vehicle as a kind of "macro sensor," with lots of cameras roaming around the warehouse that function as one big real-time data collection system.

Each camera knows where it is within the building, and together they are all constantly spatially indexing the whole facility, which can be used to map the location of inventory to form a database of information over time.

Slamcore's spatial-temporal digital twin doesn't require a database with petabytes of data because everything is logged in a simple format. Currently, that data includes an object name, a coordinate, and a timestamp. Because the data is numerical at its core, it's easily searchable in real time.

Nicholson said generative AI is the perfect tool to extract meaningful information from the digital twin. Because all the information is interconnected through time and location, operators can use generative AI to ask questions about things like bottlenecks, pick time, and stocking strategies.

"You can start to add abstract questions to this because it'll have enough data to see over the last year across this site, 'I know over the 1,000s sites I've been deployed on, I've seen these trends,'" he said.

With enough data, generative AI could also pull out trends about what sequence of events created future ones. Running in real time, it could start to predict seconds into the future, and maybe even a minute. "And then I think we're probably going to start to hit the limits of what's even possible," Nicholson said.

Generative AI analysis could potentially predict accidents in real time if it sees a sequence of events that previously led to an accident. "That could massively reduce safety incidents, especially if you bring in near-miss data," Nicholson said.

Predictive analysis would be difficult to sell as a standalone product. Doing so would require convincing customers to put hardware in the field with the promise of generative AI in the future.

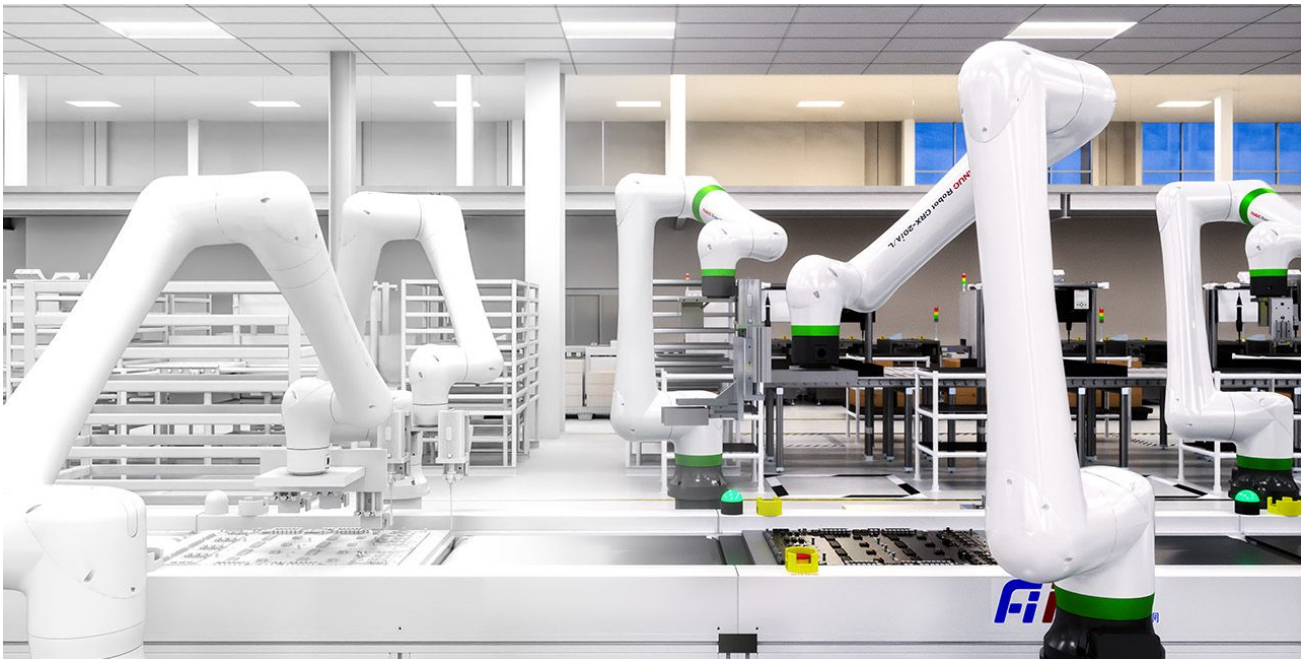
But until generative AI can deliver that level of foresight, Nicholson said the machine vision cameras deployed by Slamcore are already providing useful localization and mapping data.

"Operations guys are saying, 'Awesome. I want my entire fleet to have this, because this will actually help me right now,'" Nicholson said. "But it's laying the foundation for something much bigger." •

NVIDIA AI, Omniverse supercharge Taiwanese electronic makers' robotic factories

NVIDIA technologies enable companies to digitally build, simulate an operate factory digital twins

BY ROBOTICS 24/7 STAFF



NVIDIA Omniverse and other technologies were the center of attention at COMPUTEX 2024 in Taiwan. Source: NVIDIA

At COMPUTEX in Taiwan, NVIDIA announced that major Taiwanese electronics makers are using the company's technologies to transform their factories into more autonomous facilities with a new reference workflow. The workflow combines NVIDIA Metropolis vision AI, NVIDIA Omniverse physically based rendering and simulation, and NVIDIA Isaac AI robot development and deployment.

By using the workflow to build digital twins for real-time simulation of different factory layouts, manufacturers can optimize space, processes and efficiency without costly physical changes, NVIDIA said.

The news came from NVIDIA founder and CEO Jensen Huang's keynote demonstration at COMPUTEX 2024.

Electronics manufacturers adopt NVIDIA technology to build robotic facilities

Delta Electronics, Foxconn, Pegatron and Wistron are using the reference workflow to build, simulate and operate their robotics-enhanced facilities.

During a COMPUTEX keynote, Huang demonstrated how Foxconn, one of the world's largest electronics manufacturers, develops digital twins of its factories on NVIDIA Omniverse, a platform for virtually integrating 3D data from industry tools such as Teamcenter from the Siemens Xcelerator platform.

"AI for manufacturing is here," said Deepu Talla, vice president of robotics and edge computing at NVIDIA. "Every factory is becoming more and more autonomous due to the transformational impact of generative AI and digital twin technologies. With NVIDIA Omniverse, Metropolis and Isaac, the industrial ecosystem can accelerate its adoption of autonomous technologies, helping advance operational efficiencies and lower costs."

Omniverse helps Foxconn's teams optimize equipment layout for operational flow and AI cameras that will monitor worker safety with NVIDIA Metropolis. Foxconn can then use the factory digital twins as virtual training environments to simulate, test and validate its AMRs built on NVIDIA Isaac Perceptor acceleration libraries, as well as its AI robot manipulation arms, which are powered by NVIDIA Isaac Manipulator AI models.

NVIDIA offerings in use at multiple organizations

"AI and robotics are poised to revolutionize manufacturing, enhancing safety on factory floors and driving significant operational efficiencies," said Young Liu, CEO and chairman of Foxconn. "By integrating NVIDIA Omniverse, Metropolis and Isaac into our operations, we can create sophisticated digital twins of our factories to train robots, optimizing workflows with unprecedented precision and reducing costs."

Delta Electronics, a manufacturing company in electronics and IoT-based smart green solutions, is using NVIDIA Isaac Sim, an extensible robotics simulation platform developed on Omniverse and OpenUSD, an open and extensible ecosystem for 3D worlds, to virtually integrate its demonstration production lines. It then generates physically accurate, photorealistic synthetic data for training computer vision models for its NVIDIA Metropolis-powered automatic optical inspection (AOI) and defect detection offerings.

Pegatron, a Taiwan-based manufacturer and service provider, is deploying an NVIDIA Metropolis multi-camera workflow and launching a new suite of services that connects its NVIDIA Omniverse and Metropolis factory digital twin workflow to NVIDIA NeMo and NVIDIA NIM to help factory operators "chat" in real time. The technological advances will help improve worker safety and productivity in Pegatron's massive factory network that spans over 21 million square feet and produces over 15 million assemblies per month.

Digital twin factories through NVIDIA

Wistron, a global organization in electronics manufacturing, has built digital twins of its factories to accelerate the production of NVIDIA DGX and NVIDIA HGX servers. Now, it is extending its use of Omniverse to develop digital twins of the data centers that are used to test and ensure the quality, performance and energy consumption of newly assembled NVIDIA HGX systems.

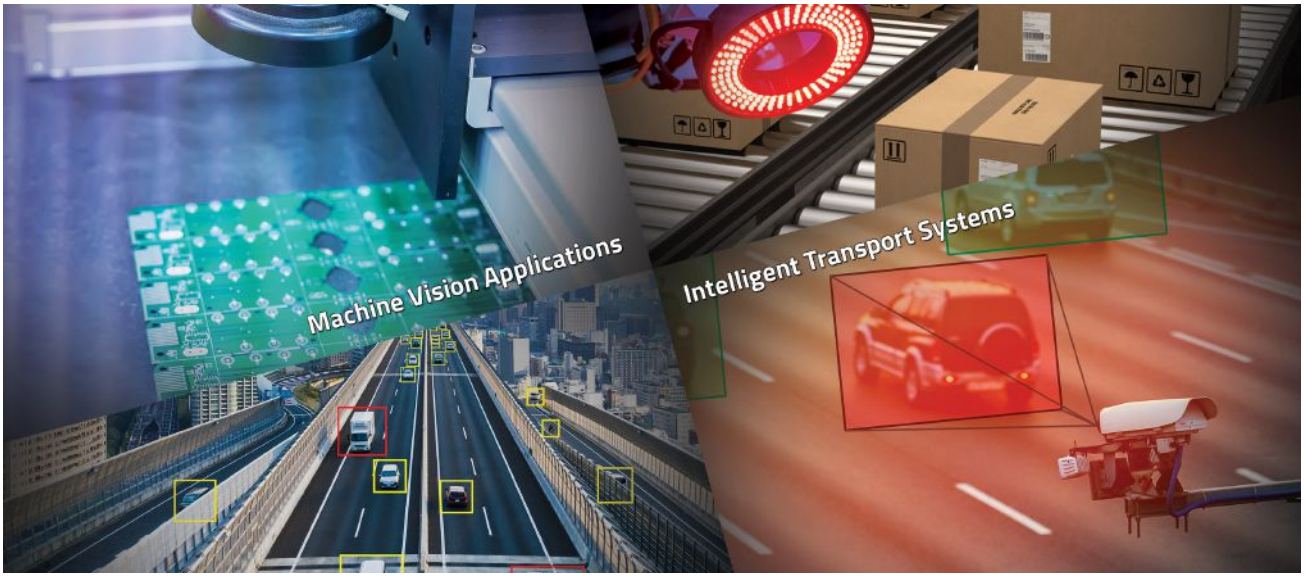
Using NVIDIA Omniverse to simulate its facility and workflows first, Wistron brought its factory online in half the typical time - just two and a half months instead of five - and increased worker efficiency by more than 50% through testing and optimizing layouts.

"The combination of NVIDIA Omniverse and NVIDIA Metropolis allows us to test new layouts virtually to identify new processes and monitor real-time operations using live IoT data from every machine on the production line," said Alec Lai, president of global manufacturing at Wistron. "Digitalizing our factory planning process has reduced end-to-end cycle times by 50%." •

OMNIVISION launches three new image sensors for machine vision applications

Company forms new Machine Vision Unit to focus on various industries

BY ROBOTICS 24/7 STAFF



OMNIVISION announced the release of three new image sensors for machine vision applications. Source: OMNIVISION

OMNIVISION, a California-based global developer of semiconductor offerings, recently launched three new image sensors for machine vision applications.

The company announced two new CMOS global shutter (GS) image sensors for machine vision applications. OMNIVISION has also created a new Machine Vision Unit, which will focus on creating innovative offerings for industrial automation, robotics, logistics barcode scanners and intelligent transportation systems (ITS).

OMNIVISION also announced the new OG09A10 CMOS GS sensor - the company's first large-format GS sensor for factory automation and ITS. The large-pixel, 3.45 µm backside-illuminated (BSI) stacked global shutter sensor, with its low readout noise and high quantum efficiency (QE), can deliver excellent image quality, making it ideal for machine vision applications that require the ability to capture clear images of high-speed moving objects, the company said.

CMOS global shutter sensor details

OMNIVISION's new GS sensors feature 2.2-micron (µm) BSI pixels for high resolution in a compact design. The high-resolution, small-format GS sensors provide higher shutter with the ability to capture high-speed moving objects clearly and accurately at high frame rates. They also feature high sensitivity, low noise and enhanced near-infrared (NIR) QE for low-light performance.

Compared to the previous-generation 2.5µm frontside-il-

luminated (FSI) GS sensors, the 2.2µm BSI GS sensors can achieve 1.08x sensitivity with an f/2.0 lens and 2.16x sensitivity with an f/1.4 lens. The new OG05B1B is a 5-megapixel (MP) resolution CMOS monochrome GS sensor in a 1/2.53-inch optical format (OF). The new OG01H1B is a 1.5 MP resolution CMOS monochrome GS sensor in a 1/4.51-inch OF.

"We see a huge demand in the machine vision market for 3D cameras and CMOS image sensors," said Michael Wu, senior vice president, global sales and marketing, OMNIVISION. "With our strong technological backbone in Nyxel, BSI and GS technology, we bring great innovation to the industry. Our new Machine Vision Unit will focus on understanding our customers' needs and product roadmaps and address them with novel vision solutions."

Both image sensors feature OMNIVISION's Nyxel NIR technology, which boosts QE to 700-1050 nanometers - enabling the capture of brighter images from farther away - PureCelPlus-S stacked-die architecture for image sensor performance, and CSP package technology for the smallest possible dimensions.

Key features of the OG05B1B GS image sensor:

- 2592 x 1944 resolution (5 MP)
- Frame rate of 60 fps
- Shutter efficiency of 106 dB
- Interface: 4-lane MIPI & DVP
- External trigger snapshot mode enabling back-end exposure control for improved accuracy

- Nyxel boosting QE from 700 to 1050 nm, 58% QE @850 nm
- OG05B1B GS image

Key features of the OG01H1B GS image sensor:

- 1440 x 1080 resolution (1.5 MP)
- Frame rate of 120 fps
- Shutter efficiency of 106 dB

- Interface: 4-lane MIPI & DVP
- External trigger snapshot mode enabling back-end exposure control for improved accuracy
- Nyxel boosting QE from 700 to 1050 nm, 58% QE @850 nm

OG09A1B mono GS image sensor details

The OG09A10 is a 9 MP GS sensor with a 1-inch optical format. The sensor's 3.45 µm pixel is based on OMNIVISION's patented PureCelPlus-S stacked-die architecture for image sensor performance. The OG09A features Nyxel NIR technology for crisp, clear images in low-light conditions. Dual Conversion Gain High Dynamic Range (DCG HDR) technology further extends the GS image sensor's dynamic range capabilities that can reproduce artifact-free, low-noise images in challenging lighting conditions.

"Charge-coupled device (CCD) image sensors are being replaced with CMOS image sensors, resulting in volume growth of the machine vision market," said Richard Liu, technology and market analyst for the photonics, sensing & display division of Yole Group. "CMOS greatly simplifies the complexity of industrial cameras. Compact cameras, including smart cameras, can more easily be developed and are more suitable for use in various industrial environments. With this being the case, Yole expects the global industrial camera market to grow from $3.6 billion in 2020 to $5.5 billion in 2026, at a 7.4% compound annual growth rate (CAGR)."

Key features of the new OG09A1B mono GS image sensor include:

- Shutter efficiency of 106 dB
- 90% QE response
- 76 dB dynamic range with DCG HDR support
- Frame rate of 60 fps at 12-bit (8x8 Region of Interest (ROI) can reduce data bandwidth at even higher frame rates)
- 4096 x 2160 resolution
- External trigger mode enabling backend exposure control for improved accuracy
- Support for 16-lane LVDS interface to 1.05 Gbps •

OptiFact platform from ABB Robotics streamlines factory data collection, visualization and analysis

ABB says pilot projects demonstrate that OptiFact helps decision making, optimizes factory operations

BY ROBOTICS 24/7 STAFF

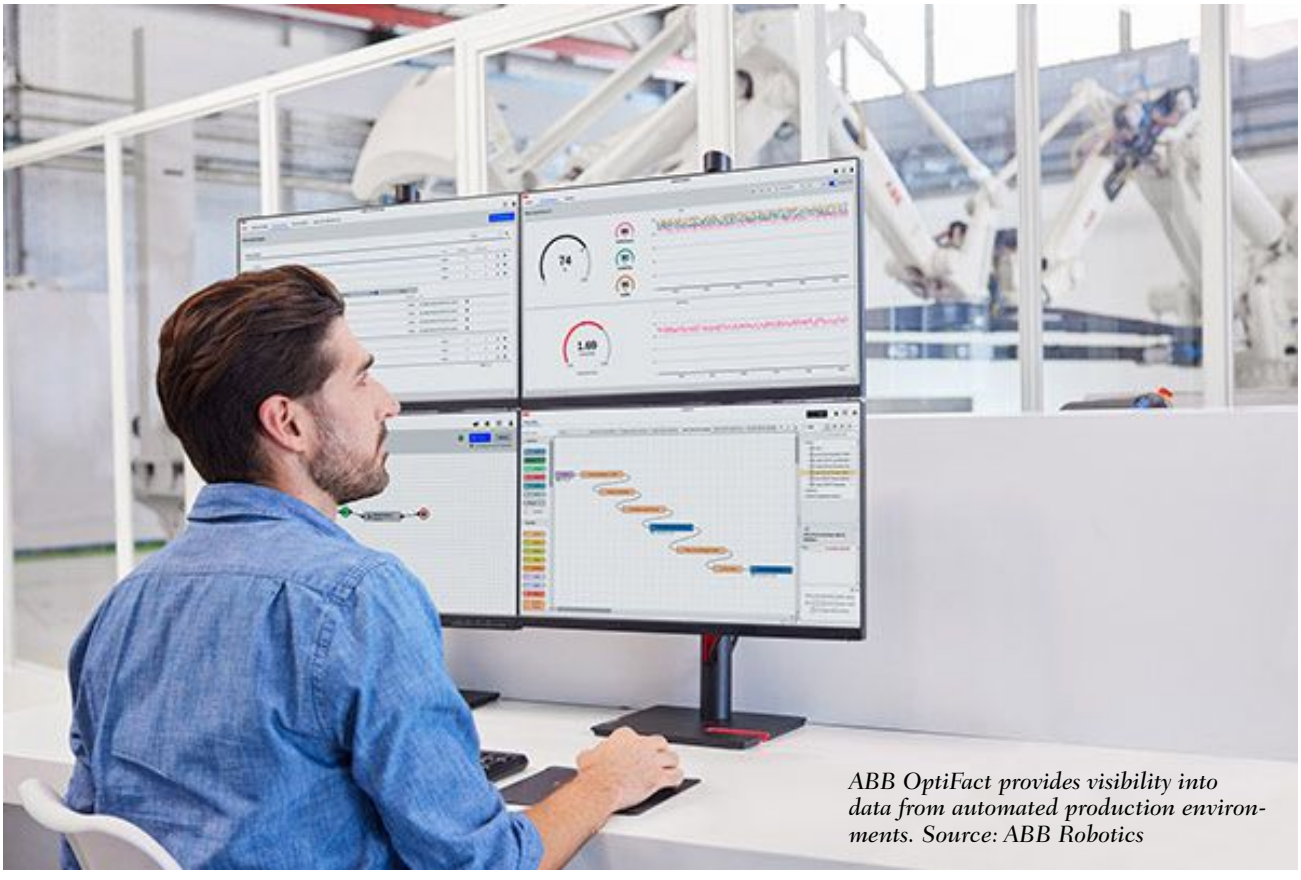


ABB OptiFact provides visibility into data from automated production environments. Source: ABB Robotics

Robotics has added to increasingly complex production environments, driving demand for tools to enable plant managers to collect and use data gathered as a side product of automation, said ABB Robotics. The company has released its modular OptiFact software, which is intended to streamline data collection, visualization and analysis in automated facilities.

The number of robots sold worldwide has almost tripled over the past decade, according to the International Federation of Robotics (IFR). "Digitization, the acceleration of sustainable manufacturing, and the pandemic have all contributed to the increased demand for automation," ABB said in a release.

"Across industries, we see a dramatic increase in the digitalization of manufacturing as companies seek to increase the flexibility, efficiency, and sustainability of their operations in the face of changing consumer

behaviors and long-term global skilled labor shortages," said Marc Segura, president of ABB Robotics. "At ABB Robotics, we are enabling this shift with software products that businesses need to accelerate their growth in today's fast-changing market."

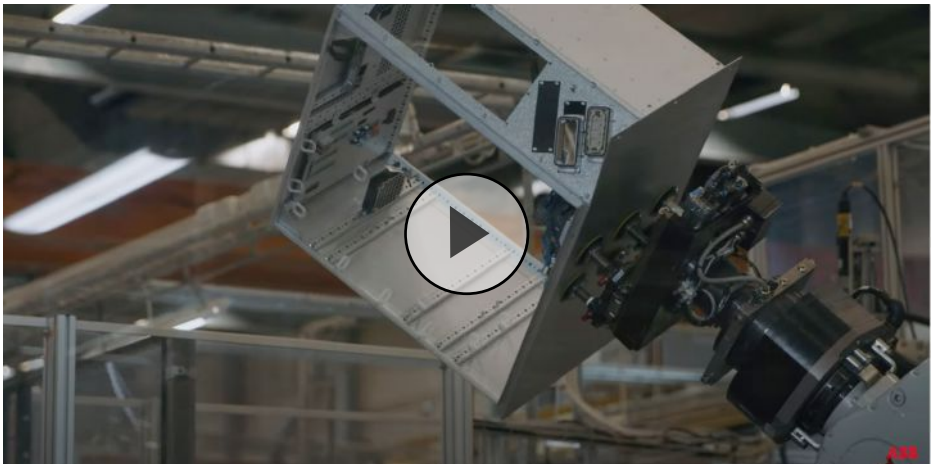
OptiFact analyzes data to provide agility

OptiFact is designed to enable users to collect, manage, and analyze data from hundreds of factory devices, including ABB robots. Factory operators can use the platform to determine KPIs including cycle time and overall equipment efficiency (OEE), ABB said.

By speeding up diagnostics and decision making, OptiFact can increase production-line uptime with less engineering effort, claimed the Auburn Hills, Mich.-based company. This product can enable manufacturers to keep up with customer demand, it said.

OptiFact can help businesses of all sizes imagine new digitally enabled processes, realize them on the factory floor and simplify operations to increase productivity and flexibility. Manufacturers can use it to determine the root cause of production errors and use ABB's RobotStudio Cloud to make adjustments to programs and develop an improved solution, according to the company.

RobotStudio's desktop, cloud and augmented reality (AR) viewer are intended to help users adapt existing robots or plan new deployments of ABB industrial robots for new tasks. ABB said



features such as Automatic Path Planning allow robots to determine the most efficient paths and avoid collisions with existing obstacles.

"Offering a true 'what you see is what you get' user experience with 99% accuracy between the robot's digital twin and its real-world deployment, RobotStudio speeds design and commissioning time by up to 50%," ABB said.

Application-specific, AI-driven technologies such as ABB's Item Picker offer features to facilitate robotics deployments, it added. "Best-in-class motion control cuts the power requirements of pick-and-place operations by up to 17%, speeding tasks by 13%.".

In addition, ABB said its VSLAM uses artificial intelligence for accurate navigation in dynamic indoor environments.

Different environments increase productivity

Several production facilities have deployed OptiFact, reported ABB. At one highly automated automotive factory, it collects and analyzes process cycle times and other KPIs, providing visibility into operations and saving up to 25% of experts' time, it asserted.

As a result, ABB said its customer has deployed more than 580 robots in its operations.

OptiFact has also proven its value for small and midsized enterprises (SMEs), said ABB. Another pilot demonstrated the platform's ability to identify bottlenecks in production lines involving up to 20 robots. The customer's digital team integrated OptiFact in just two months from first contact to final delivery.

Once deployed, OptiFact simplified data collection and the visualization of KPIs and programmable logic controller (PLC) alarms. By addressing operational inefficiencies, the facility increased production time by up to 20%, ABB said. •