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Cameras Augment RFID Forklift Solution at Innolux

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With readers on forklifts and video integrated with stitching, EPC Solutions Taiwan is building a system for the flat-screen manufacturer that provides an image of its warehouse floor, as well as data about the precise locations of products and materials.

Sep 26, 2021 LCD panel provider Innolux is deploying cameras with a forklift-based RFID solution at some of its Taiwan factory storage warehouses to gain real-time insight into the location of each LCD panel and touchscreen located there, as well as visuals. The deployment includes RFID readers on forklifts, tags on products and supplies, and location data linked to camera imagery to provide a real-time, camera-based view into the location of every item in the warehouses.

The company first deployed RFID in 2016 to track goods arriving and leaving through dock doors (see RFID Brings Identification to LCD Manufacturer's Automated Storage and Retrieval and RFID Brings Visibility to LCD Flat Display Manufacturer). The RFID and camera technologies and the software platform were provided by EPC Solutions Taiwan. In March 2021, the company expanded that solution to bring RFID reading functionality to the forklifts that move goods around the warehouses.

Innolux is one of the world's largest manufacturers of thin-film transistor (TFT) LCD displays, including television panels, desktop monitors and touchscreens. The company operates 14 plants in Taiwan, with four other sites located in China, and its employees number more than 68,000. While the RFID technology automated data collection at dock doors and enabled automated storage and retrieval, Innolux sought to gain highly specific and error-free data indicating where each piece of inventory was located within its warehouses.

A position tag is located on the ceiling.

The facilities are highly active, with each site averaging three million in and out events per year. Innolux wanted to know the exact locations at which the goods were stored, as well as every time they were moved, and so it began working with EPC Solutions Taiwan to expand the RFID technology it already used. That meant deploying UHF RFID readers on the forklifts (there are two or three at each warehouse), as well as installing cameras to display images of each product's ID number wherever they were stored for redundancy.

In that way, if an item was moved and its tag read was missed, or if tagged items were moved to a prohibited area in error, the cameras could detect that action, even if no RFID tags were interrogated. "Innolux requested us to develop this system since their 2D-3D floor map could not reflect the current situation in real time," says Aden Yin, EPC Solutions Taiwan's principal engineer.

Each warehouse has goods stored on five levels of shelving throughout floor spaces measuring approximately 70 meters by 50 meters (230 feet by 164 feet). The ceilings are located about 6 meters (19.7 feet) above the floor. To identify the zones in which goods were placed, the company needed a UHF RFID position tag, which it wanted to have mounted above the forklifts. However, Yin says, the ceiling space was consumed above 3.5 meters (11.5 feet) by pipes and cabling. Therefore, EPC Solutions Taiwan chose to install the position RFID tags, as well as cameras, on walls and beams at a height of 3.5 meters.

The tags can delineate storage spaces of 1.5 meters by 1.2 meters (4.9 feet by 3.9 feet). To read the tags, the firm installed an Alien Technology ALR-F800 UHF RFID reader on each smart forklift, along with four EPC Solutions Taiwan HLA-PA9580 antennas, with an industry PC (IPC) device linked to the vehicle's ignition. The IPC controls vehicle operation, while also computing and filtering tag reads and forwarding the data via Wi-Fi. The reader has four built-in ports, with one antenna dedicated to reading position tags, angled to receive transmissions from the ceiling. A second antenna is dedicated to reading the RFID tag in the operator's ID badge, while the remaining two antennas read product tag IDs.

When LCD panels or other products are assembled and packaged, an Impinj 4QT UHF RFID tag is attached to each unit. The items are then placed in storage. New raw materials are tagged upon receipt and are then put away in the warehouse. By tagging both materials and products, the company can easily access supplies for use in manufacturing, as well as goods for shipping to customers. When an order is received, the warehouse operator also receives a shipping notice indicating which items need to be collected. The employee presents a badge with a built-in UHF RFID tag to the smart forklift reader, which captures the badge's unique ID number and forwards that data to the EPC Solutions Taiwan software via Wi-Fi, leveraging Cisco Wi-Fi nodes.

Left: a cylindrical antenna is installed on a forklift. Right: an antenna checks a driver's ID.

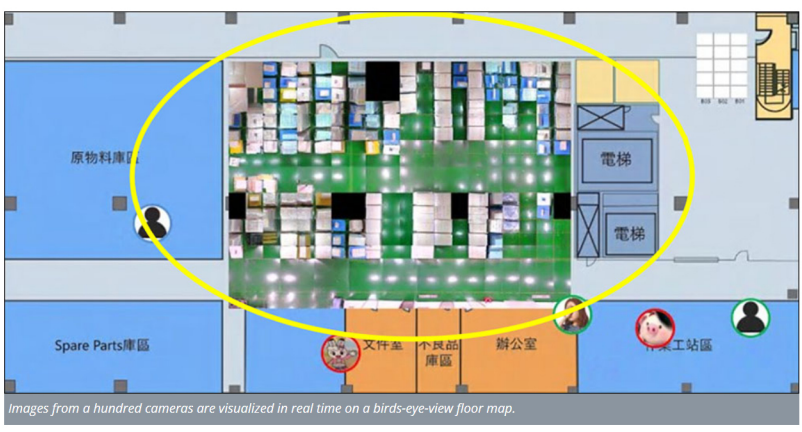
The software, residing on a local server, confirms the operator's ID, thus validating whether that individual is qualified to drive the forklift. If the identity is authorized, the system, via the IPC, activates the forklift engine and the software stores the employee's ID. The software then boots up a touchscreen on the forklift and displays instructions for the worker to choose operation functions, which come in three categories: shipping, receiving and rearranging.

When fulfilling an order, the operator would select "shipping" and key in the shipping notice number. The RFID data provides the solution with the locations of the items required and displays each product on a map of the warehouse, based on the position tag ID with which it is associated. The map is provided with camera visualization so operators can view an image of the locations where items are stored, as well as watch their own progress as they navigate toward those products.

The cameras each cover a 6-meter by 6-meter (19.7-foot by 19.7-foot) area. EPC Solutions Taiwan's software uses what the company calls "stitching technology" to assemble those images together as a single, complete floor map. The facility manager can thus see a visual of the entire floor and zoom in to identify each item on that map. The driver then follows the instructions on the screen to pick up those goods. As the forklift retrieves each item, the onboard reader interrogates the product's RFID tag and the ceiling's position tag to confirm that the correct product has been picked up.

With regard to receiving, as products are placed in storage for the first time, operators receive a notice and validate their ID on the forklift reader. They choose the operation function, the system displays the location where each item should be stored, and they can then follow instructions to put the goods away. The reader interrogates the tags on the goods, along with a position tag near the ceiling. In that way, the system knows where each item was placed, based on when the product tag ceased being read, which would indicate the forklift has left it there.

The deployment posed several challenges for EPC Solutions Taiwan, Yin recalls, such as surmounting the distance between the position tags and the forklift RFID reader antenna. "We found that if [we used] a normal antenna to scan the tag on the roof, the data [was] not so precise," he says. "So we developed a cylindrical antenna [installed on the forklift] to confine the area of RF wave radiation and to limit the reflecting wave." The antenna developed for this application is 20 centimeters (7.9 inches) in height and diameter. The company also used a reflection metal sheet, installed behind the position tag, to enhance the reflection power's directivity.



Images from a hundred cameras are visualized in real time on a birds-eye-view floor map.

The cameras provide a real-time image that enhances the 2D and 3D graph floor map of the storage area. The images are stitched together and displayed as a single bird's-eye view of the floor map. Forklift operators and other users can move their cursor on the screen at any point along the map to display an image of the products, including their label-displaying name, ID number and product pedigree, along with the date.

The solution was initially piloted at a single site, where it was then deployed in October 2020. To date, nine sites have been using the technology, and the camera-visualized floor map was taken live at one location in June of this year. "The system helps us to improve the accuracy of inventory," says Stone Shih, Innolux's RFID project leader, "not only quantities but also position." The company can now remotely view a real-time image of its floor map at any time, he adds, and from anywhere.

Following the pilot, the company found that the technology has reduced its manpower requirements by 26 percent, by reducing the need to search for goods. The system typically saves workers 2.3 hours of labor per day, Yin says. "We will have more sites going live in the following months," he states. In the meantime, the camera-based visualization system is expected to be launched at a second site in October.