Enabling modern retail and logistics automation

Giovanni Campanella
Systems engineer
Worldwide Industrial Systems
Texas Instruments

The world of commerce is changing rapidly, and it will change even faster in the next few years. Today consumers expect a consistent buying experience across all retail channels – in store, online and on mobile devices. This multichannel approach is called an omnichannel model.

From traditional retail to omnichannel retail, technology plays a huge role in the revolutionization of the standard brick-and-mortar location (plus warehouse) to give consumers a seamless shopping experience.

Providing a seamless experience affects every aspect of a supply chain – products, inventory, warehouses, fulfillment, picking, packing, shipping, transport and distribution – changing the way logistics centers and stores operate by:

- Speeding up the checkout process.
- Maintaining accurate inventory management.
- Detecting out-of-stock items.
- Personalizing advertisements and discounts.
- Automating prices.
- Improving picking speed and accuracy.

The technology areas that will enable these advancements are:

- Artificial intelligence.
- Sensor fusion.
- Augmented reality.

Speeding up the checkout process

There are several ways to speed up a checkout process in a store:

- Equipping stores with self-checkouts.
- Providing sales associates with a handheld point-of-sale (POS).
- Eliminating cash registers.

Let's walk through each of these processes.

Self-checkout

Self-checkout machines provide a mechanism for shoppers to process their own purchases.

Two priorities when designing self-checkouts are security and fast and accurate object recognition. Some of the main security challenges at checkout include scan avoidance, unpaid merchandise, passing items around the scanner, leaving unscanned items in the shopping cart and covering up the barcode while scanning.

Fast and accurate object recognition comes into play when checking out items that don't have a barcode, such as fruits and vegetables. It takes a long time for shoppers to pick the right product from the inventory available at the grocery store.

Machine learning can overcome these challenges by accurately classifying, recognizing items during checkout, adding a layer of reliability to the process.

Figure 1. *Omnichannel retail.*

Handheld POS

Another way to speed up the checkout process is by equipping sales associates with handheld POS solutions. Handheld POS solutions encompass portable and mobile POS platforms that:

- Enable store-wide checkout with minimal wait times.
- Commonly accept magnetic strips, card chips, and NFC payment types found in conventional tabletop POS solutions.

Both portable and mobile POS platforms perform key functions found in traditional POS solutions. However, portable POS solutions are all-in-one handheld solutions that commonly perform receipt printing. On the other hand, mobile POS solutions are cheaper than portable POS solutions and work by pairing a mobile device, such as a phone or tablet, with a card reader, but generally do not perform receipt printing.

Cashier-free stores

Finally, the ultimate way to speed up the checkout process is to eliminate the process completely by having cashier-free stores and no cash registers. Shoppers can enter in the store, buy items on site in the isles as they go and just walk out.

View the mobile POS reference diagram and mobile point of sale (mPOS) power reference design.

Cashier-free stores must identify shoppers upon entering the store and track them throughout their shopping experience, recognizing the products that they choose from or replace back onto the shelves.

To identify shoppers before they begin shopping in the store, 3D biometrics identification and authentication implemented with a DLP® Chipset comes in handy. In order to recognize and detect the products placed on the shelves, sensor fusion and artificial intelligence play a big role. When combined with cameras, Texas Instruments (TI) sensor solutions, such as **time-of-flight sensors**, enable accurate object recognition and detection of products on shelves.

A structured light system based on TI DLP® technology enables very fast, high-accuracy scans of the product with millimeter-to-micron resolution.

Data acquired by sensors and cameras powers artificial intelligence models used to classify, localize and detect the object.

View the white paper, "High-accuracy 3D scanning using Texas Instruments DLP technology for structured light."

Sitara™ AM57x processors are good examples of processors running artificial intelligence at the edge. These processors have multiple high-speed peripherals for interfacing to multiple sensors – like video, time of flight, light detection and ranging, (LIDAR) and TI mmWave sensors – as well as dedicated hardware in the form of C66x digital signal processor cores and embedded vision engine subsystems to accelerate machine learning algorithms and deep learning inference.

The "Machine learning inference for embedded applications reference design" demonstrates how a Sitara AM57x system-on-ship brings deep learning inference to an embedded application.

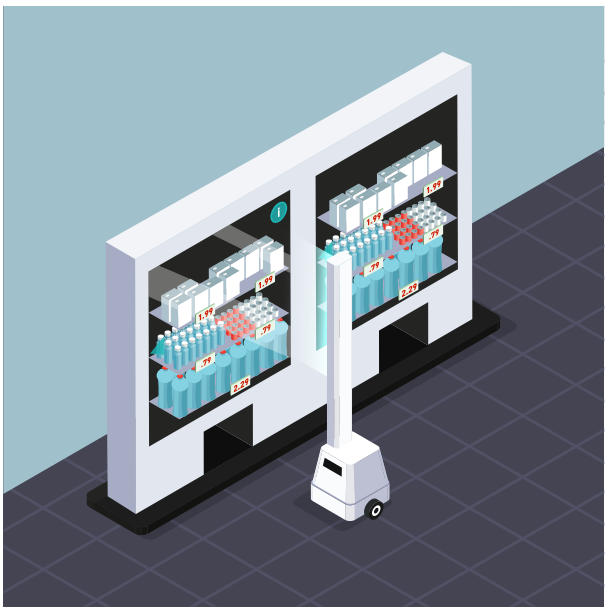

Figure 2. Inventory robot scanning shelves.

Accurate inventory management and out-of-stock detection

According to IHL Group, consumers learn than an item they'd like to purchase is is out of stock as often as one in three shopping trips.

Accurate, real-time inventory data is the crux of a successful omnichannel network and can be enabled either by using inventory robots or a combination of sensors and cameras on shelves. Inventory robots are mobile units that operate in warehouses, distribution centers or stores. The robots typically move within aisles of grocery stores and warehouses and need sensors and cameras for localization, mapping, collision avoidance (especially with humans) and shelf scanning.

Autonomous inventory robots detect out-of-stock items, missing or misplaced labels, incorrect prices and misplaced products, ensuring accurate and reliable on-shelf inventory data in real time and improve operational processes and in-store conditions.

Inventory robots can also help reduce inventory audit times and notify store associates of issues, such as missing products that they can't find on the shelves, as they occur.

View this logistics robot CPU board reference diagram.

When using inventory robots isn't possible, proximity and position sensors like time-of-flight sensors or ultrasonic sensors can be positioned on shelves to enable out-of-stock detection.

Price automation and advertisement and discount personalization

It takes a couple of weeks to completely re-price everything in a store by hand with new paper tags. Not only is this time-consuming, but it is costly and hard on the environment due to the enormous amount of required paper required.

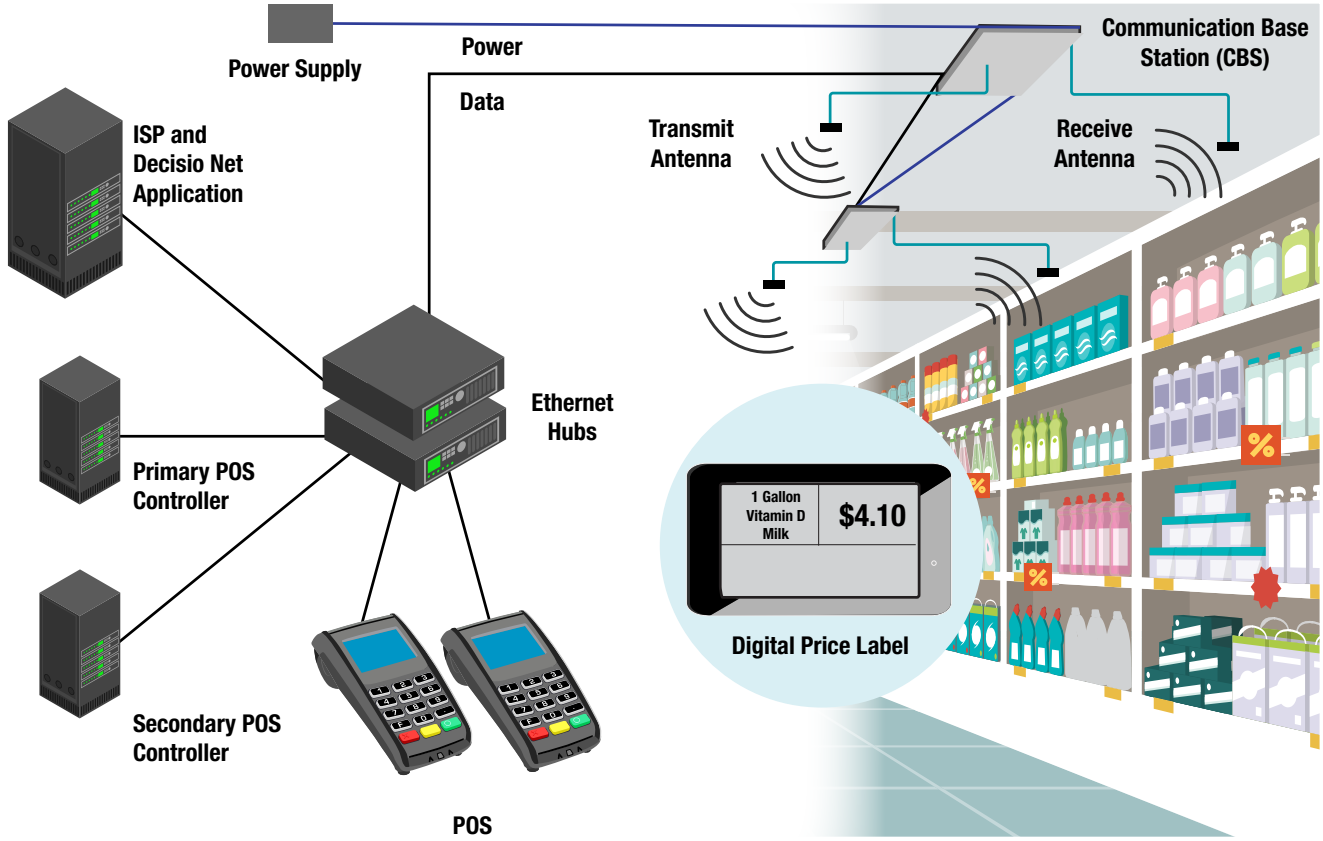

Figure 3. *Store architecture.*

Electronic shelf labels (ESLs) and digital shelf displays eliminate the manpower needed to re-price items, reduce paper use, and conserve printing costs, in favor of better store profitability and a better customer experience.

ESLs and digital shelf displays connect shoppers at the shelf, offering more effective advertisements based on customer preferences and needs by connecting to the shopper's smartphones and learning from previous behaviors and interests, helping with product selection by indicating the exact location of a specific product (like a printer cartridge) either with the phone or a light that switches on, and facilitating the payment process by enabling shoppers to scan price tags and pay with a smartphone.

View the ESL reference diagram to learn more about these systems.

Accelerating the picking process

One of the segments of omnichannel retail is online commerce. To meet customer expectations for fast delivery, sellers have to improve picking speed and accuracy as well as reduce costs.

Besides order picking based on paper, order picking in warehouses is supported by these technologies:

View the augmented reality glasses reference diagram.

- Pick-by-vision. A warehouse management system (WMS) sends instructions to the picker, who is wearing smart glasses that give visual picking guiding instructions based on augmented reality. The pick is confirmed when the picker presses a button on the smart glass, makes a specific gesture or scans a barcode from the picked object.

View the headsets/headphones and earbuds reference diagram.

- Pick-by-voice. Pick-by-voice systems give audio instructions to the picker, who is wearing a headset with a microphone and a small computer. The picker gets audio instructions from a WMS and gives verbal commands to confirm action.
- Pick-to-light. Stock locations have light nodes or small screens and connect to a WMS. They light up and show the number of items to pick up. A picker confirms the picking task by pressing a button.
- Scanning picking. The picker uses a barcode scanner to capture information and communicate with a WMS. The WMS returns instructions displayed on a barcode scanner. The picker confirms a pick by scanning the product and entering the amount picked. In order to improve picking speed and accuracy, wearable barcode scanners like ring scanners and smart gloves are becoming more popular because they keep the hands free while scanning, while still enabling pickers to lift boxes.

View the barcode scanner reference diagram.

Conclusion

Omnichannel retail requires upgrading every step of the retail supply chain with the technologies mentioned here. Only by doing this will retailers be able to offer a dynamic, personalized and seamless shopping experience, giving shoppers what they want, when they want and how they want.

Learn more about retail and logistics automation systems content from TI that will enable you to develop applications for omnichannel retail.

Additional resources:

- Learn more on how to bring machine learning to embedded systems.
- See more 3D machine vision applications for DLP systems.

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Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265