Intelligent Shelf Compliance Solution
Minimizes Inventory Distortion

EXECUTIVE SUMMARY
How do you make sure all your packaged goods are available on shelves and in the right locations? Planogram and promotional display models show where products should be placed for maximum sales, but verifying that products on shelves match planograms is a very laborious, time consuming and expensive process and consequently, is not performed frequently. Automating this task, the shelf compliance solution harnesses the latest digital image recognition technology to ensure product placement on store shelves fits planogram models. The solution enables retailers to minimize inventory distortion, defined as the absolute value of the sum of out-of-stocks and overstocks, which ultimately increases sales revenue by reducing lost sales (out-of-stock) and minimizing seasonal discounting (overstocks).
KEY BUSINESS OBJECTIVES
Implement a more effective and less-cumbersome shelf and display compliance process.

WHO WILL BENEFIT FROM THIS SOLUTION
The shelf compliance solution automates what today is typically a highly manual task. Automating this process, thus allowing it to be performed more routinely, can provide advantages to customers, retailer and brands.

Consumers will experience an improved in-store look and feel because store shelves will be better organized with less chance of out-of-stocks. It won’t be necessary to wait for a clerk to restock the shelf from backroom inventory since they will have already received and responded to an alert.

Retailers will require fewer employee resources to perform self-compliance tasks, yet can deliver more accurate and real-time shelf compliance reports to product manufacturers.

Brands will get quick, quantitative data to demonstrate shelf compliance, which they count on to maximize brand awareness and sales.

MEETING NEW MARKET DEMAND
Large retailers and consumer packaged goods (CPG) brands put considerable effort into figuring out the optimal placement of products on store shelves with the goal of optimizing sales. They develop planograms — diagrams or models showing how product should be placed on store shelves (i.e., where and how many) — and then stores are expected to implement and maintain the planograms, and demonstrate compliance.

Planograms are an effective tool for minimizing inventory distortion, resulting from in-store inventories not matching consumer buying patterns, a situation that “costs retailers collectively nearly $800 billion globally. Or put another way, same store sales could increase 9.2 percent if this problem was completely fixed.” However, achieving sustainable planogram compliance is not easy because it’s predominantly a manual task requiring a lot of labor hours.

With so much money at stake, why hasn’t this problem already been adequately addressed? “As chains expand, store performance management gets much, much harder. This begins to explain why out-of-stocks continue to run at 8.2 percent, unchanged in 15 years, yet 78 percent of items sell fewer than three units per week,” reported James Tenser, Principal at VSN Strategies.

Now, image processing technology is automating shelf compliance and enabling retailers to keep an optimal level of inventory on hand with less effort.
THE BUSINESS CHALLENGE

Today, shelf compliance is a largely manual and complex effort, thus creating some major business issues for the retail industry, including:

• **Labor Intensive**: The task of monitoring planogram compliance on a regular basis can consume a significant amount of personnel resources, particularly in U.S. supermarkets, which on average carry an incredible 38 thousand items.4

• **Underperforming Generic Planograms**: In an effort to simplify the production and monitoring of planograms, some large retail chains use generic or mix-and-match planograms. However, individual stores have “unique physical characteristics and fixture layouts, so a standard plan can never match reality. No matter how much effort went into producing planograms for generic store types, compliance rates were very low and unacceptable – never greater than 30 percent,”5 reported one of the world’s largest retailers.

• **Nonproductive Promotions pending**: “Approximately 50 percent of authorized retail promotional displays are not erected or erected late, amounting to an estimated $25 (USD) billion of ineffective spending annually by consumer packaged goods (CPG) manufacturers,” according to a working paper published by the In-Store Implementation Sharegroup.6

• **Moving Target**: Merchandise resets requiring product “cut-ins” and product section “drift” make it difficult to accurately report on the consistency between the way products are actually laid out on store shelves and planograms.

SOLUTION OVERVIEW

AndyVision, pictured in Figure 1, is a research project that explores technologies required to perform the shelf compliance tasks described previously. It has made video fame, moving around the Carnegie Mellon University Store in its red sweatshirt without crashing into anything because of sonar-based proximity sensors. The creation of Priya Narasimhan and Carnegie Mellon’s robot design team, AndyVision exemplifies advances in digital image processing capable of simplifying shelf compliance. This research project funded by Intel illustrates how cutting-edge technology can be applied in the future to the retail environment.

Priya Narasimhan is a Carnegie Mellon University (CMU) professor who heads the Intel Science and Technology Center in Embedded Computing. She and her team interviewed retailers to best tailor the robot to mitigate two inventory problems: lost sales due to out-of-stock items and shoppers leaving an item in an unrelated aisle after deciding not to purchase it – no one wants to see a tin of salmon dropped off next to roach-killer aerosols. The CMU robot addresses both issues and more.

According to Professor Narasimhan, AndyVision demonstrates how a computer-vision system could be an alternative to using wireless RFID tags to track inventory. The robot uses a combination of image processing algorithms running on a low power Intel® processor that is easier to implement than RFID tagging.

![Figure 1. AndyVision at the Carnegie Mellon University Store](image-url)
Typical Retail Deployments
At this early stage, it’s unclear how the problem of image collection will be solved in a typical retail setting. Although a mobile robot is highly effective at capturing images, it could be too invasive for shoppers, especially for stores open 24 hours a day. Another option is to attach cameras to a small number of shopping carts and collect images while customers push them through the store. It may also be possible to use existing surveillance cameras, or sensors mounted in ceilings and product shelves.

Image processing requires a significant amount of computing power, thus it’s likely to run on a backroom server. The processing responsibilities could also be split up, as is the case of AndyVision, which pre-processes images locally. The fully processed images may be used to perform a wide range of tasks:

• Recognize individual products and map to a planogram
• Detect when an item needs to be replenished
• Make sure items are oriented correctly (i.e., facing forward)
• Identify product placement issues, such as:
  – too much space between
  – incorrect number of rows for an item

This shelf compliance solution helps address several challenges facing retailers and their IT departments by:

• Automating planogram and promotional display monitoring
  > Cameras positioned throughout the store can continuously perform shelf compliance without human intervention.

• Creating and monitoring store-specific planograms
  > Digital imaging solutions can process images from cameras to create a planogram that the solution can also continually monitor for compliance.

• Providing timely compliance reports
  > Digital imaging-based compliance solutions (i.e., cloud-based) can deliver compliance updates to CPG brands on a daily basis, enabling them to verify they are getting the product placement they are paying for.

• Identifying new products or shelf configuration changes
  > Camera-based systems can alert retailers and CPG brands when a new product has been added to the shelf, prompting planogram changes. Likewise, the solution can inform retailers when a product has been allocated too much or too little shelf space.

TECHNOLOGY
AndyVision is part of the Retail 2020 project, which is exploring technologies that can transform the retail landscape. It is an example of a relatively simple robot, based on existing technology, capable of doing valuable autonomous work in a commercial environment.

The robot determines the identity of objects using image-processing and machine-learning software to read barcodes and text, and recognize shape, size and color. The robot can also determine when items are in the wrong place, like a brightly-colored laundry detergent box surrounded by bottles of bleach; it can also infer the box is a particular brand detergent by processing the color image. This is possible because the robot first creates an image database of the store layout and stocked shelves, and then compares the database to actual stock placements as it moves around the store.

Underneath AndyVision’s sweatshirt is a Microsoft* Kinect* sensor, used to scan store shelves to count items (using contextual object recognition) for inventory. The robot wirelessly alerts store staff to low stock, no stock or items that have been misplaced. Moving around on three wheels, AndyVision steers clear of obstacles, thanks to sonar technology.

For retailers looking for assistance in deploying the capabilities discussed in this solution blueprint, the Intel® Retail Solutions Partner Network comprises industry-leading vendors with expertise in many key areas, including hardware, software, content creation, deployment and networking.
EMPOWERING A NEW WORLD OF RETAIL INNOVATION

The retail industry is in the midst of a dramatic information revolution that is laying the groundwork for new consumer experiences, enhanced productivity, reduced inventory distortion and brand optimization. Intel is addressing this transformation with the Intel® Intelligent Systems Framework, a set of interoperable solutions designed to facilitate connecting, managing and securing devices in a consistent and scalable manner.

What can emerging intelligent retail systems do? Imagine an intelligent store where incoming weather data indicates a severe storm approaching. The store’s digital signs and kiosks immediately begin promoting items commonly purchased during storms, like umbrellas, and prices are adjusted to reflect the predicted increase in demand. Price updates are transmitted to electronic shelf labels and the back office. Data from checkout confirms umbrella sales are increasing, causing immediate alerts to the stockroom. The store’s warehouses and key suppliers send shipments to replenish the shelves.

The Intel Intelligent Systems Framework helps simplify the deployment of intelligent systems and enables retail OEMs to shift their investments from achieving interoperability to unlocking the value of data. The framework features fundamental capabilities, delivered by components that address connectivity, manageability and security, including software and middleware from Wind River* and McAfee*.

For more information, visit www.intel.com/content/www/us/en/embedded/intelligent-systems.html.

SUMMARY

Digital imaging technology running on Intel® processor platforms is being used to automate the valuable, yet onerous task of shelf compliance. This enables stores to more easily follow well-thought out planograms designed to maximize profitability and minimize inventory distortion. Automated shelf compliance is best accomplished with Intel® processors that deliver the high performance needed to perform compute-intensive image processing software.

RESOURCES

Intel® Retail Solutions Partner Network
Redefining what’s possible, leading solution providers have come together to address the specific needs of retailers, whether it’s consulting, content creation and management, retail systems, hardware customization, deployment support, network management or cloud-based services. The Intel® Retail Solutions Partner Network provides one-stop shopping for cutting-edge technologies that deliver new consumer experiences, enhanced productivity, reduced inventory distortion, brand optimization and more. To learn more, visit intel.com/retailsolutions.