Advanced Image Matching Techniques

for Planogram Compliance

As smart retailers world-wide move away from designing one-size-fits-all planograms to creating store-specific localized versions, they are confronted with an exponential surge in the number of planograms. A large pharmacy retailer in the US predicts that in the next five years, the number of unique planograms they are likely to create will exceed 100,000—up from the current 30,000.[1] This trend will only aggravate the already existing malady of planogram non-compliance—planograms go out of compliance at the rate of 10% every week. A study conducted by the National Association for Retail Merchandising Services (NARMS) revealed that, on an average, the compliance was only 70%, resulting in retailers incurring huge losses in their annual sales. A 100% reset planogram compliance could improve sales by as much as 7.8% and profits by 8.1%, in just two weeks.[2]

Most retailers rely on manual compliance checks to inspect their in-store shelves. In our recent engagement with a large home improvement retailer based in the US, the CXO stated that the company employs more than 2500 associates in their stores nationwide to carry out routine planogram checks.

Manual processes for measuring compliance, analyzing SKU availability, and determining brand competition and performance are not only time consuming and error prone but also limit the store associates from taking up customer facing activities. To overcome these limitations, several retailers are using image processing techniques that leverage digital and mobile technologies. However, these techniques are constrained by challenges specific to the retail industry.

Conventional Image Processing Techniques: Why they Don't Work Well

Using conventional image processing techniques to recognize on-shelf products is ineffective due to several factors such as varying in-store illumination levels, product packaging patterns, surface and styles; frequently changing product packaging; multiple product orientations on shelves; constraining in-store spaces; and varying camera resolutions and height of store associates. These factors not only affect the image quality but also cause distortions. Typically, the shelf image captured by a tall person tends to be stretched from the top as compared to the bottom portion of the shelf and vice-versa. How can these geometric distortions be removed from the images?

Typically, a planogram depicts an arrangement of different products at various locations on the shelves. When the products are grouped together based on attributes such as brand, size, and flavor, how can all the products in a shelf be identified individually from an image of the shelf?

Intelligent Image Matching Techniques: **The Way to Go**

There is a dire need for new algorithms that are intelligent enough to scan any type of retail product—small or large, same SKU but different packaging, dull vs. glossy packaging, regular vs. irregular shapes, and so on. Such algorithms must be capable of working with non-standard conditions of SKU image capture.

Here are a few approaches to deal with unique retail challenges specific to image processing of store shelves:

- Lighting and packaging variations.
- Geometric distortions to images.
- Numerous product sizes and shapes.

- Simultaneous identification of multiple products.

Lighting and packaging variations. The typical illumination variations and specular reflection challenges caused by product packaging surfaces can be minimized using advanced color imaging techniques such as 'Lab Color Space Analysis'.

Geometric distortions to images. The geometric distortions of shelf images caused due to factors such as varying heights of store associates can be removed with the help of a user-guided, un-skewing mechanism, termed 'perspective back-projection'.

Numerous product sizes and shapes. The algorithm should follow an 'all-in' approach with a basic assumption that any of the individual SKUs from the reference image repository will be available at any/all positions in a shelf image. The shelf image should then be dissected into smaller pieces, guided by the dimensions of the individual SKU images. Each of these cropped portions can then be matched with the individual SKU images to ascertain if the correct product is stocked on the shelf.

However, there is a challenge when a sub-image is cropped from the shelf image—the scale transformation between individual SKU images from the reference repository and the captured shelf image is unknown. These challenges can be addressed through local scale transformation. Image matching of cropped portions with the individual SKU images can be accomplished with advanced imaging techniques and by comparing the color signature, shape-based features, and probable text portions of the two entities being analyzed.

Simultaneous identification of multiple products. One-to-many matching combinations (cropped portion from the shelf image to individual SKU images from the reference repository) may lead to possible identification of multiple products at the same location. Recognizing same, similar, or different products at all possible locations on the shelf at one go poses a multilocational width-guided constraint optimization problem.

This problem can be solved by assigning a global matching score for arrangements of products on the shelf. This global score is based on

all possible local matching scores between the cropped images of the shelf and the reference images from the repository. A graph-theoretic algorithm that utilizes the global match ensures that all the products on the shelf are identified simultaneously.

When the image processing algorithms are integrated with computer vision and machine learning techniques, it ensures that with every matching activity, the image processing accuracy of the algorithm increases. This requires the generation and maintenance of an image repository that contains high-quality images of individual SKUs in different orientations. Over time, the repository will bring in synergies in product identification of the same product across planograms of different stores of different retailers.

When this intelligent image matching algorithm is integrated with the retailer's enterprise mobility platforms, it enables store associates and auditors to instantly generate several configurable reports on planogram compliance, gap compliance, and SKU performance (see Figure 1).

User engagement, adoption, and process compliance can be enhanced through gamification. Further, a high degree of automation can be achieved by using static on-shelf cameras, CCTV sensors, drones, and robots to capture images.

Intelligent store-shelf inspection applications offer the following benefits:

- **Automated planogram compliance.** Identification of products and their respective position on the shelves with sophisticated image processing helps generate more accurate planogram compliance reports. Even a slight increase in planogram compliance can help retailers achieve significant increase in the annual category sales.
- **Shelf replenishment management.** By continuously monitoring shelves, the planogram compliance application provides constant updates on which of the items are moving quickly, thereby enabling inventory refilling by drones and robots.
- **Planogram effectiveness measurement.** Continuous monitoring enables retailers to measure the impact of planogram non-compliance on sales and provides crucial inputs to the planogram planning system for the next planogram reset and/or revision cycle.

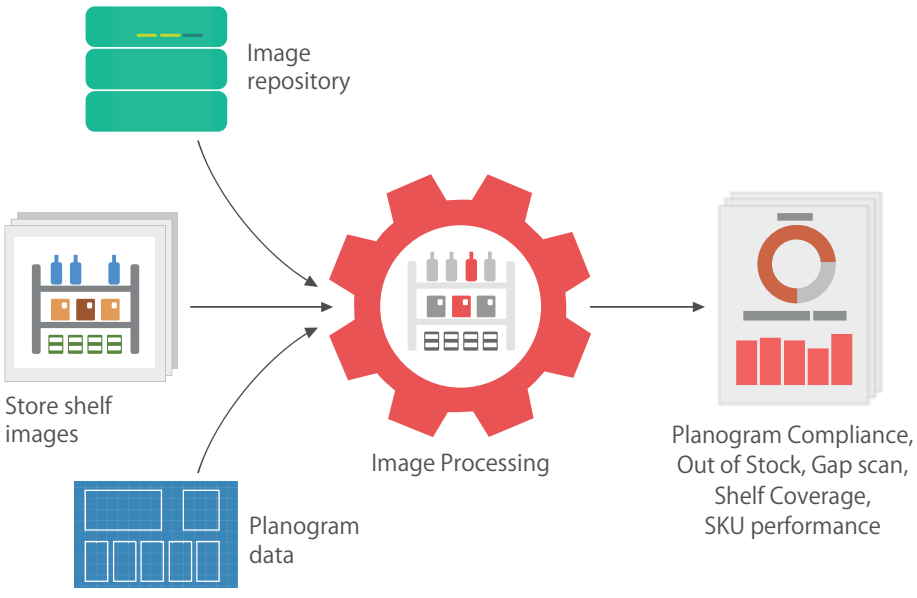

Figure 1: Planogram compliance application

Intelligent Image Matching Techniques: Driving Value in CPG

A quick and accurate means of product recognition extends numerous opportunities to the CPG industry. Bundling the application with the mobile devices of field staff or auditors will allow them to leverage the solution for:

- Measuring retailer compliance to vendor agreements (allocating the right percentage of shelf displays, providing appropriate brand visibility).
- Determining brand competition (availability of competitor brand products on the same planogram).
- Enabling promotion effectiveness (ensuring availability of newly launched products, promotional items, bundled items at the correct location on the planogram and store).
- Identifying the percentage of occupied shelf space and monitoring inventory availability.

Sustainable Planogram Compliance: Drive Better Outcomes

Today, shoppers spend mere seconds in front of in-store shelf-displays. This makes it critical for retailers to see the shelf as a customer would. While planogram automation has helped ease the onerous task of shelf compliance to some extent, retailers are realizing that they must go beyond planogram creation to achieve sustainable compliance. Planograms supplemented with advanced image processing techniques and sophisticated new machine learning algorithms is the silver lining the industry is looking for. With intelligent store-shelf inspection solutions that do the 'thinking' on their behalf, retailers are poised to hit the sweet spot—achieve total compliance and realize customer-centric assortments while driving higher productivity, vendor accountability, and brand optimization.

[1] *Based on TCS interaction with the client in 2014*

[2] *"Achieving Sustainable Compliance Getting Beyond the Planogram to Maximize Profits"; Published 2011, Accessed December 2016*

http://www.gladson.com/Portals/0/Gladson's%20Achieving%20Sustainable%20Compliance%20White%20Paper%20Final_without%20cover%20page.pdf

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