e-con Systems™
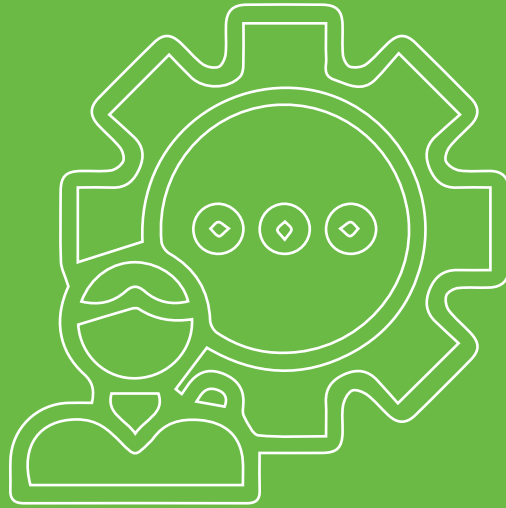Your Product Development Partner

How embedded vision is optimizing **retail store management** and enhancing **customer experience**

Whitepaper ▶

TABLE OF CONTENTS

1. SETTING THE CONTEXT

96%

More than **96% consumers** adopted **virtual shopping** after the pandemic hit

60%

expect to keep up with the **online shopping** momentum beyond the pandemic

82%

of millennials prefer **in-store shopping**

1.1 The new way of shopping

The COVID-19 resurgence transformed the shopping behavior of consumers for good. According to Mckinsey's research, over 96% of consumers adopted virtual shopping in all its forms, and 60% expect to keep up with their online shopping momentum even beyond the pandemic. Safe, touchless, effortless deliveries coupled with uninterrupted data and smartphone proliferation have fuelled this drastic shift in retail dynamics.

1.2 AI-enabled experiences

Nearly 82% of millennials prefer in-store shopping even as they currently shop online due to the pandemic. Not just millennials, even Gen X, and Gen Z customers crave physical shopping experiences and sensory gratifications in the form of touch, smell, and vision. Whether in-store or digital, retailers must deliver Artificial Intelligence (AI)-enabled sensory experiences that evoke emotional connections with the customer.

Mood Media Research shows that multi-sensory experiences increase sales by at least 10%. Also, by 2025 retailers will spend US$34 billion on Artificial Intelligence (AI), which is a drastic jump from US$4 billion in the pre-pandemic 2018.

Retailers of all scales must gear up to leverage computer vision, deep learning, augmented reality (AR), and other AI-based technologies to deliver a winning combination of digital and physical experiences.

1.3 Move to phygital

Though consumers prioritize safety and convenience by shopping online, their experiential sensory needs have driven the adoption of phygital shopping. Offering the best of physical and digital retail, phygital format leverages AI to enhance operations, security, payments, and customer experience.

Curbside pickup, grab and go, just walk-out, and cashier-free shopping are examples of the latest phygital trends. They facilitate consumers to do their research from home, pay online, and visit the store to collect delivery. Or they can walk directly into the store, get product information from displays, choose and buy the product, pay online, and then make a self-checkout without any cashier or store representative interference.

Providing such intelligent retail experiences is necessary if you want to thrive in today's complex, competitive business climate.

1.4 Evolution of Smart Retail

Now that consumers have gazillion options and choices, their loyalty to brands depends on smart customer experiences. According to a recent PwC survey, over 92% of consumers admitted to switching brands when faced with unsatisfactory customer experiences.

Hence businesses are adopting a smart retail strategy to reduce customer attrition. Slated to be on a high growth trajectory with the

Smart Retail Devices - Projected Market Size (in $ billion)

28.82 — 2020

CAGR of 17.2%

74.68 — 2027
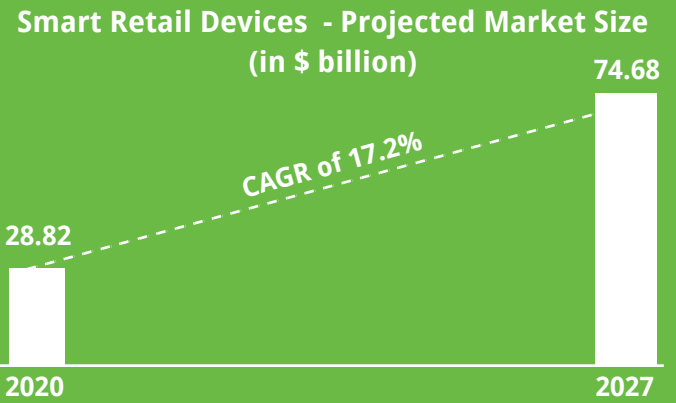
global smart retail devices market expected to reach $74.68B in 2027 with a CAGR of 17.2% from 2020, smart retail is a significant long-term investment for brands.

Wonder what smart retail is?

Smart retail is the amalgamation of modern technology (AI-based) with traditional retail. It uses sophisticated cameras, sensors, and AI algorithms to enhance customer experience and optimize cost, operations, supply chain efficiency, security, and surveillance. Smart retail relies on Closed Circuit Television (CCTV) cameras, smart Internet Protocol (IP) cameras, and embedded vision cameras to capture images and videos. The data extracted from these videos and images empower employees to tread through operational and customer experience challenges.

66%
consumers are interested in using **AR while shopping**

2 in 3
customers say **shopping tech** improves customer experience

Use of technologies like augmented reality (AR) and virtual reality (VR) is also on the rise in smart retail. According to EarlyMetrics, 66% of consumers are interested in using AR while shopping. Also, 2 in 3 customers say shopping tech improves customer experience. Technologies like computer vision, cutting-edge cameras, and video analytics also play a critical role in smart retail delivering crucial customer intelligence and vital insights that help personalize and enhance individual shopping experiences.
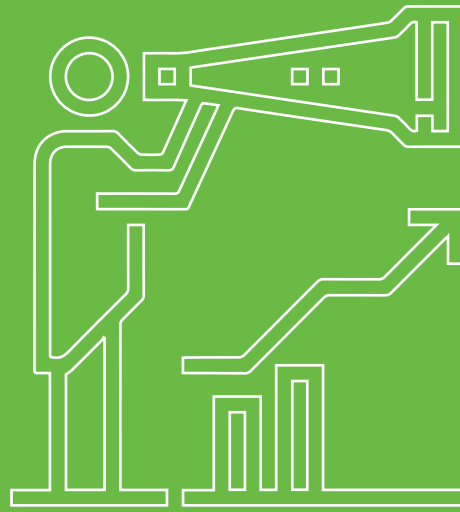
2. EMBEDDED VISION, THE FUTURE OF SMART RETAIL

2.1 How embedded vision contributes to smart retail

For smart retail to get smarter, retailers need to invest in powerful embedded vision cameras. Embedded with computer vision and AI algorithms (built by smart retail solution providers), vision cameras accelerate retail automation, improve sales and profit margins, and reduce wastage.

According to a Retail Info Systems (RIS) technology study titled 'Retail Accelerates', just 3 percent of merchandisers had already leveraged computer vision in 2019, while 40 percent planned to start or finish implementing this tech by the end of 2020. While this implementation could take different forms which are not limited to embedded vision, the following advantages of devices with embedded vision could see its usage and application surge in the retail space:

40%

merchandisers planned to start or finish **implementing AR in retail**

Compact size   **Light weight**   **Low cost**   **Low energy consumption**

With the above advantages, embedded vision cameras help to optimize and expedite the following retail functions by leveraging computer vision:

- **Inventory and warehousing**
- **Shelf management**
- **Digital signage**
- **Payments**

- **Store operations**
- **Data collection**
- **Security**
- **Compliance**

Embedded vision cameras deliver video analytics and insights that help optimize operations, cut costs, enhance customer experience, and achieve profitability. They play a critical role in resolving operational issues and transforming customer and employee experiences. By facilitating a frictionless self-checkout experience, they enable unparalleled levels of personalization.

As the cameras monitor store activities, detect suspicious behavior, and enhance security, security-related tasks can be easily automated. This will lead to employees getting more time for customer-centric activities.

2.2 The growth potential of vision cameras

Besides the tremendous benefits and applications, the following factors contribute to the demand for embedded vision cameras in smart retail.

e-Point of Sale terminals integration

Wider thermal imaging adoption

Enhanced sensor accessibility

Mobile access compatibility

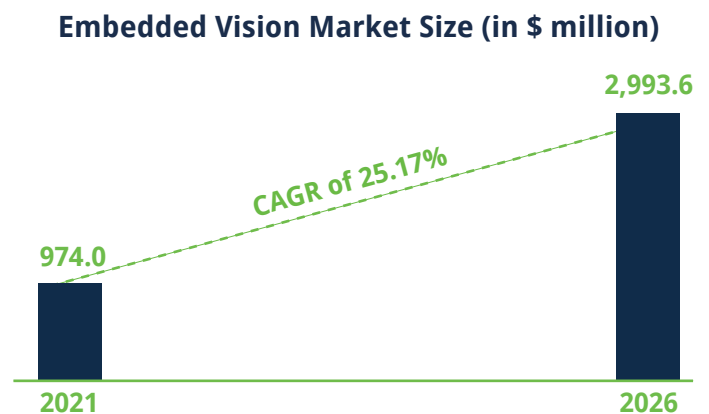**Innovative video analytics capabilities**

360º vision and de-warping

Several market research firms provide considerable evidence to substantiate the tremendous growth of embedded vision cameras. Senior research analysts from 360-degree Market Updates predict that the global Embedded Vision Cameras market size will reach USD 2993.6 million by 2026 from USD 974 million in 2021 at a CAGR of 25.17%.

Tractica expects the video analytics hardware, software, and services market revenue to triple to over US$3 billion in 2022, from US$ 858 million in 2015.

Global Market Insights attribute the anticipated demand of embedded vision cameras to technological advancements such as 4K resolution, edge-based video analytics, and H.265 high-efficiency video encoding.

Embedded Vision Market Size (in $ million)

2,993.6

CAGR of 25.17%

974.0

2021

2026

So, embedded vision is here to stay, and is likely to spread its presence across multiple industry segments, especially retail.

3. HOW EMBEDDED VISION CAN BUILD THE RETAIL STORES OF TOMORROW

So far we have learnt that changing customer expectations and technology landscape are increasing the need for embedded vision across the whole spectrum of retail shopping. Now let us dive deep into how embedded vision contributes to this change.

Embedded vision transforms retail customer and employee experience predominantly in 3 different ways:

Driving operational efficiency and business agility

Enhancing in-store experience

Teleexistence or remote store management

Let us have a look at each of them in detail.

3.1 Driving operational efficiency and business agility

Embedded vision cameras optimize operational efficiency and business agility through seamless video and image capture, processing, and analytics. Using vision cameras inside a retail store helps gather customer intelligence for the following purposes:

Video cameras deliver

98% accuracy
in People Counting
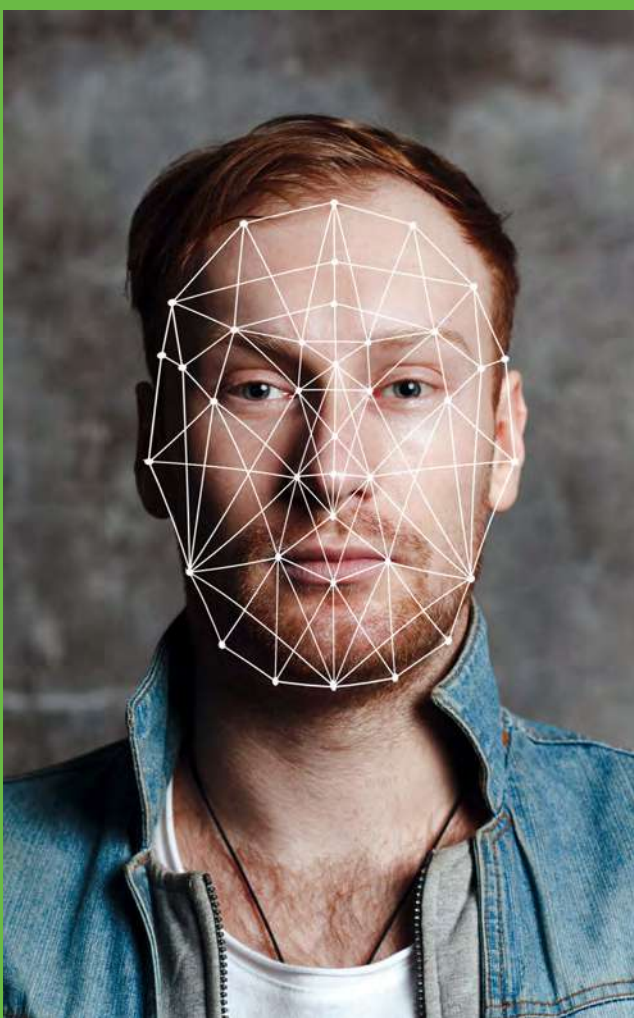
- **People counting**

Research shows that video cameras deliver 98% accuracy in people counting. Embedded vision cameras record videos of people entering the retail store to track customer footfall and traffic trends.

- **Heat mapping**

Heat map is a visual representation of a shaded matrix in color codes. In-store images captured by vision cameras are assigned colors that help to track movements and traffic volume. These heat maps assist in improving store layout, sales, and conversions by identifying hot spots, dead zones, and customer preferences.

- **Facial recognition**

Facial recognition plays a significant role in enhancing personalized recommendations and services while increasing sales and reducing costs. Embedded vision cameras and sensors facilitate easy facial recognition to make attendance, employee management, customer tracking, fraud prevention, and cardless payments a hassle-free process. According to Markets and Markets research, payments by facial recognition are expected to hit $7.7 billion worldwide by 2022. Also, as per an independent study done by the US National Institute of Standards and Technology (NIST) between 2014 and 2018, facial recognition systems got 20 times better at finding a match in a database of 12 million portrait photos. The failure rate fell from 4% to 0.2% over the period, which is expected to go down

even further. The use of embedded cameras along with deep neural networks plays a significant role in achieving these.

- **Queue detection**

The vision camera images and videos count the number of people standing in queues. When the store staff sees the possibility of the queue crossing the threshold, they intervene to expedite checkouts and payments.

- **Smart advertising**

Interactive screens are usually placed around the store to display smart customized advertising to target customers based on demographic profile and purchase history. The vision cameras around the screen recognize the faces and identify details such as age, gender, purchase history, and time spent at different parts of the store. These data help retailers to personalize marketing campaigns.

Smart advertising was valued at

$655

million in 2018

According to Grand View Research, the global smart advertising market size was valued at USD 655.1 million in 2018 and is expected to register a CAGR of 19.4% from 2019 to 2025. With the use of embedded cameras, smart advertising is likely to find its way into more innovative applications in the future.

- **Customer surveys**

Vision cameras have the capability to gather information on customer experience, emotion, and satisfaction rating. The videos can be analyzed to help plan, execute, and analyze marketing campaigns that build sales and revenue.

3.2 Enhancing in-store customer experience

Vision cameras converge efficiencies in the following areas to elevate customer experiences.

Retail store optimization   **Smart checkouts and carts**   **Digital kiosk automation**

Inventory monitoring   **Store monitoring**

AR-enabled virtual mirrors   **Intelligent recommendation engines**

3.2.1 Going cashier-less

Faster deliveries and secure, quick checkouts are time-tested loyalty-enhancing factors. The cashier-less store format facilitates an easy grab-and-go experience by simplifying faster and secure checkouts. Powered by embedded vision cameras, the cashier-less design takes a futuristic approach to deliver enhanced customer experiences and elevate customer journeys.

Embedded vision supports cashier-less store formats by using facial recognition cameras, shelf sensors, and scanners for barcodes, QR codes, and RFID tags. These functions accelerate store operations and reduce human dependencies. As the image and video feed enters the AI-based checkout system, it expedites scanning and payment.

The embedded vision cameras and sensors enable customer and product tracking that reduces the scope for manual errors even when customers misplace items while shopping. They also deliver accurate omnichannel workflows for back-office personnel to monitor product movement and customer preference.
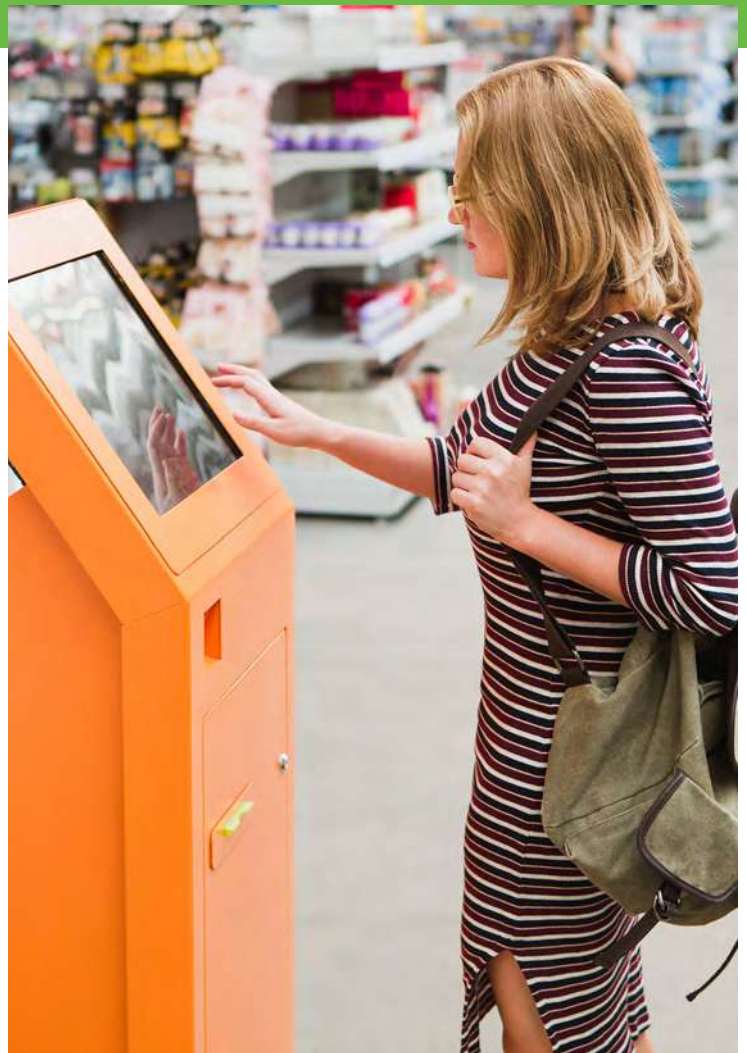
As customer facial identification, tracking, and product recognition are significant retail processes, the choice of camera is crucial. Usually, retail solutioning companies with expertise in smart checkout systems, shelf management systems and digital signages partner with specialized camera companies which have sound knowledge in choosing the right vision camera. In addition to delivering optimized hardware platform solutions and custom carrier boards to facilitate PoE, camera interface, and sensor support, these camera companies also educate smart retail solution providers about the ideal camera position, Field of View (FoV), and supporting device quality.

For instance, e-con Systems has a wide portfolio of embedded vision cameras built specifically for the retail space. e-con's cameras perform well in low lighting conditions, and come with High Dynamic Range (HDR) capability along with low power consumption advantages. The ARM-based vision cameras are compatible with all popular ARM platforms – such as NVIDIA Jetson, Google Coral, NXP Freescale, Rockchip and Raspberry Pi – with the capability for edge-level processing for carts, wi-fi streaming, and much more.

3.2.2 Reinventing self-service kiosks

As safety and convenience have gained prominence in today's world, self-service is meant to thrive. Hence retailers are reinventing self-service to suit the purposes of the new-age customers. Contactless kiosks, digital signages, and infinite aisle ordering powered by AI are a must-have for retailers in this era.

Gone are the days when kiosks were guzzling coins to dispense soda and chocolates. Today, interactive smart digital kiosks are used for dispensing money, gadgets, food, making keys, and even exchanging mobile phones.

Embedded vision systems play a critical role in automating these kiosk operations, analytics, and security using vision cameras and sensors for facial and biometric identification. It enhances customer experience and automates retail kiosks by facilitating barcode/QR code reading, product information recognition, advanced personalization, and security. Whether it is indoor or outdoor kiosks, embedded vision cameras and sensors are a necessity to handle the imaging and video capture requirements.

But retail solution providers need professional assistance in comprehending imaging factors such as high dynamic range, high frame rate, focus type, depth-of-field, etc. Smart retail solutioning companies that power digital signages and kiosks need not have the capability to choose the right vision camera for the kiosks. They partner with multi-camera experts like e-con Systems to enable digital kiosks with embedded vision cameras for facial recognition that adapt to a wide operating temperature range, 1080p with YUV format, and day/night lighting conditions. e-con's camera portfolio includes products with a wide FoV that enables accurate facial recognition from a distance of upto 30 feet. The high dynamic range feature ensures the ability to capture images and videos in varying lighting conditions. e-con Systems also helps with pre-compliance emission testing processes and FCC certifications.

3.2.3 MANAGING INVENTORY
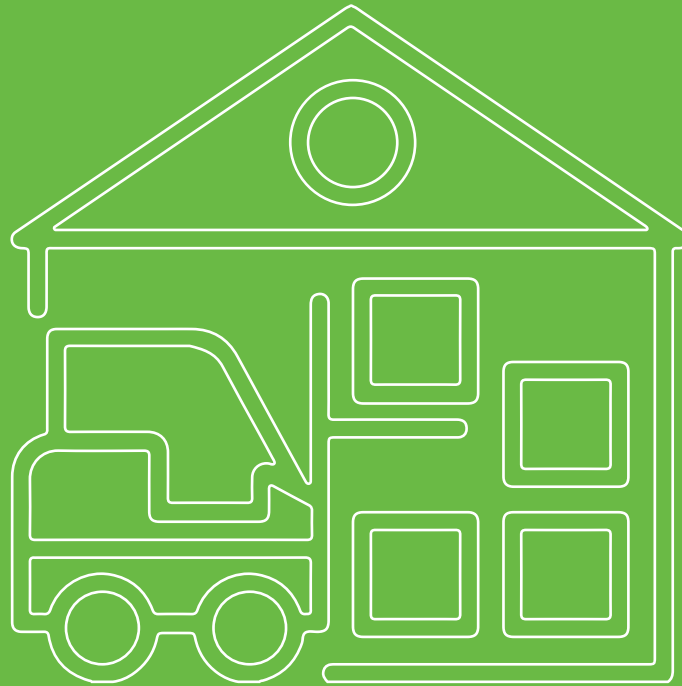
Optimizing inventory management is one of the biggest challenges that retailers face today. Inventory management encompasses the entire cycle of sourcing, procuring, supervising, controlling, order fulfillment, and delivering the stock for sale.

Embedded vision cameras deliver insightful images and videos that optimize inventory management, shelf management, payment process, data collection, and compliance. Retailers can leverage the power of videos and images to extract, analyze, and identify patterns to automate the inventory management processes shown below.

01 STOCK MANAGEMENT AND REPLENISHMENT
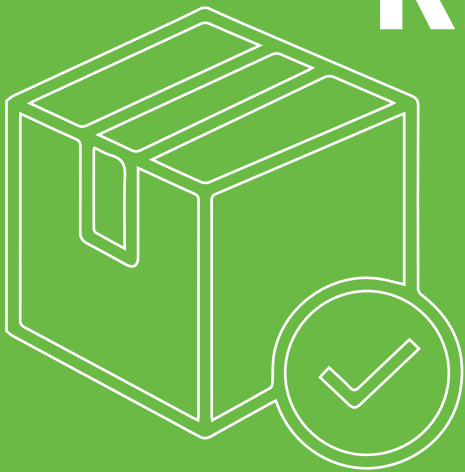
Embedded vision systems help expedite the stocktaking and counting process. Cameras capture the current inventory level and share the details with the inventory replenishment department whenever the stock goes below the optimal level. It also assists in placing an automated purchase order for stock replenishment.

Also, many retailers today use telepresence robots to automatically replenish retail shelves. This helps to improve productivity with employees having the ability to control and maneuver the robot remotely during non-working hours. Cameras are a must for these telepresence robots to perform the required tasks without fail.

DIMENSIONING 02

Measuring the individual dimensions of regular and irregular-shaped items is a tedious process when done manually. Embedded vision sensors and cameras expedite this process and provide precise measurements. As it leaves no room for human errors, there is increased accuracy in pricing, packaging, delivery, and final customer experience.

03 BARCODE SCANNING

Embedded vision-enabled bar code readers and scanners are a boon to the retail industry. It reduces manual errors and the grueling hours put into image processing, locating, and decoding the bar code.
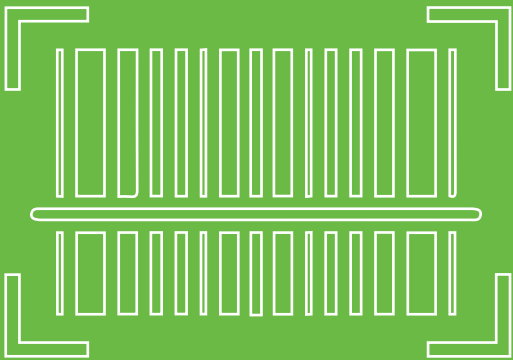
DAMAGE DETECTION 04

Inspection becomes a hassle-free process with embedded vision cameras. They are capable of capturing deviations and anomalies that are too small for the human eye to detect. They significantly improve quality control by completely eliminating the probability of stocking and delivering damaged products.
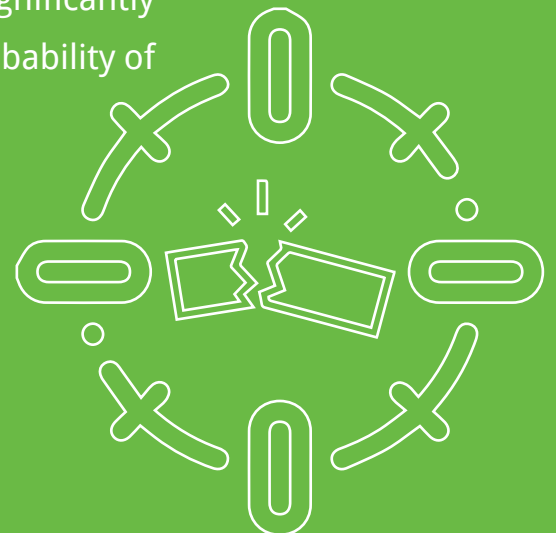
05 STOCK PICKING AND LOCATING

Finding a product in a store or warehouse is a laborious process if you have to rely on human memory. An embedded vision camera eliminates this problem by capturing images and videos that enable employees to instantly locate and pick a product.
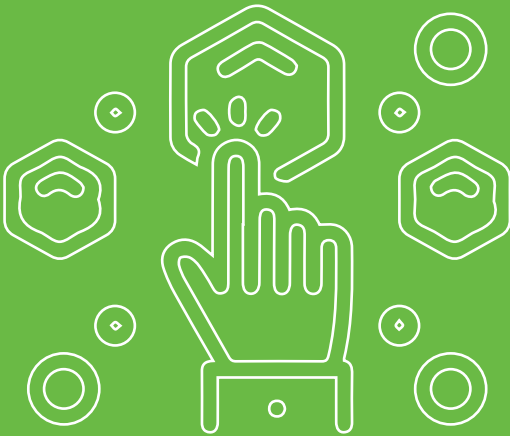
IMPROVE SECURITY 06

Embedded vision cameras also help retailers improve safety by monitoring movement to spot suspicious behavior, pilferage, and theft.

3.2.4 Improving sales and store layouts

Embedded vision has made the dream of smart retail come true. Vision camera-enabled mobile apps and facial recognition systems recognize individual customers even as they enter the store. The images and videos assist in analyzing their shopping patterns and activities. This analysis helps retailers offer customized discounts and offers to valued customers on regular purchases. Thus retailers experience increased sales and enhanced customer loyalty and affinity.

Whenever customers enter the store, cameras help count their numbers and track their movement from aisle to aisle. These images and videos help retailers identify the kind of products customers gravitate towards. Based on this information, retailers alter the store layout by placing expensive items in the front and dire necessities at the rear end. By optimizing store layout and product placement, retailers realize improved sales and revenue.

3.2.5 Virtual mirrors and recommendation engines

Equipped with embedded vision systems, cameras, and augmented reality (AR), virtual mirrors and recommendation engines help enhance personalized customer experience. A regular mirror with a background display, virtual mirrors are the next biggest trend in the in-store customer experience. Embedded cameras in the mirrors capture images and videos of customers consensually and predict how the shopper could look after styling.

For example, suppose a customer tries on a bag before a virtual mirror. In that case, the camera enables the mirror to recognize the bag. And based on the image analytics, the recommendation engine suggests clothes, jewelry, footwear, and other accessories that complement the look.

These virtual engines build customer affinity, increase sales, enhance customer experience, and generate greater customer delight and loyalty.
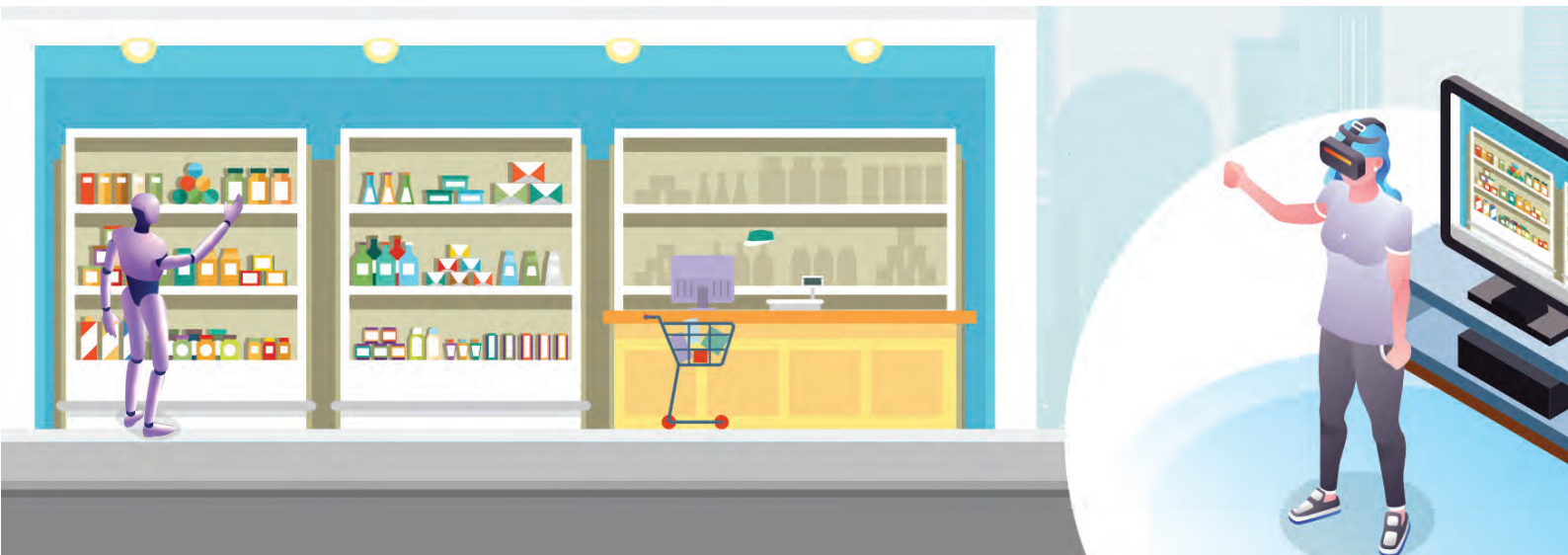
3.3 Teleexistence or remote store management

Teleexistence robots have been becoming popular in retail store environments owing to their convenience of use without having to have a human physically present in the premises. Teleexistence or Telepresence robots perform various tasks under the supervision or control of a human operating them remotely.

With the pandemic imposing restrictions on the number of people who can work in a store at a given time, managing store activities remotely has become more important than ever. Also, covid has inflicted fear in many and work from home is defining the new age workforce. Given these, the ability to partially operate stores using vision guided Teleexistence robots is a blessing. This also offers retailers an option to perform certain tasks during non-working hours where the supervisor can operate the robot from the comfort of his or her own home.

These robots are predominantly used for picking and placing objects in retail stores for stock replenishment and inventory management. Hence they require cameras for object detection, navigation & depth mapping, and barcode reading. Teleexistence robots are also used for remote communication between multiple retail stores in the form of remote store walkthroughs, monitoring, and staff & customer interaction using Avatar robots. This also requires cameras that provide reliable video streaming for a seamless experience for the stakeholders.

4. CONCLUSION

Top-performing retailers worldwide are fuelling their smart retail strategy and phygital journeys with embedded vision cameras. Vision cameras help optimize retail operations, enhance customer experience, and make data-driven decisions from the insights derived from vision systems.

For the past couple of decades, e-con Systems has designed, manufactured and supplied cameras for numerous retail solution providers with extensive customization and end-to-end integration support. We have built cameras for several retail products such as smart checkouts and carts, digital signages or self-service kiosks, shelf monitoring systems, store monitoring, and much more. Such solutions have helped retailers increase revenue and sales, improve customer experience, and gain intelligence about customer journeys and preferences.

Our camera portfolio for retail also includes solutions for access control and border management, entrance gates & check-in kiosks, smart ATMs, gaming kiosks, sports broadcasting, smart classrooms etc.

Partner with us

Want to build vision based systems to optimize retail operations and enhance customer experience?

Write to us at: **camerasolutions@e-consystems.com**

About the authors

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Ranjith is a camera solution architect with over 16 years of experience in embedded product development, electronics design, and product solutioning. In e-con Systems, he has been responsible for building 100+ vision solutions for customers spanning multiple areas within retail including self service kiosks, access control systems, smart checkouts and carts, retail monitoring systems, and much more.

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Head of Content Marketing

Christy Bharath has over 12 years of specialized experience in branding, business communication, content marketing, and technical content writing. He has written numerous pieces spanning topics such as camera technology, embedded vision, and various other technologies. A published writer, a popular blogger, a script consultant, and a coach for budding writers, he is passionate about birdwatching and nature conservation.

About e-con Systems

e-con Systems™ strives to become a global leader in the embedded vision space through continuous innovation, and helping its customers accelerate product development and reduce time to market. It has built over 250+ product solutions and shipped over millions of cameras around the globe. What sets the company apart is its deep expertise in building customized product designs while ensuring rapid prototyping and custom modifications in hardware as well as software.

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