Computer Vision Through the Eyes of Retail

04.16.2024

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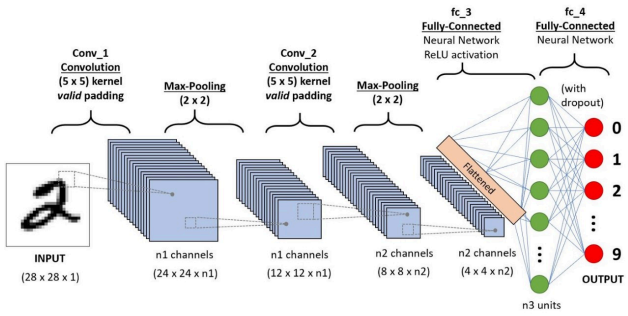
Introduction

In recent years, the retail industry has witnessed a significant transformation with the emergence of computer vision technology. This technology, driven by machine learning and neural networks, particularly convolutional neural networks (CNNs), has enabled the development of innovative solutions such as cashierless stores. These stores, powered by computer vision, have the potential to revolutionize the retail experience by automating tasks traditionally performed by human cashiers.



One of the key components of computer vision is deep learning, which allows machines to learn from large amounts of data and make decisions based on patterns and features identified in the data. CNNs, a type of deep learning model, are particularly well-suited for image recognition tasks, making them ideal for applications in retail where visual information is abundant.

The use of computer vision in retail goes beyond just cashierless stores. It also extends to areas such as inventory management, customer behavior analysis, and personalized marketing. For example, retailers can use computer vision to track the movement of customers within a store, analyze their browsing and purchasing patterns, and use this information to optimize store layouts and product placements.

Moreover, computer vision can help retailers improve security and reduce losses due to theft. By using computer vision algorithms to monitor in-store cameras, retailers can detect suspicious behavior and alert store personnel in real-time.

Overall, computer vision has the potential to offer significant benefits to retailers, including cost savings, improved efficiency, and enhanced customer experiences. However, it also raises important questions around privacy, security, and ethical considerations that must be carefully addressed.

Applications

Retail Heat Maps:

Computer vision-based heat maps employ real-time imaging to award movement and color assigned to each floor area based on the customer traffic compiled. By doing this, they are useful in analyzing customer behavior, testing new merchandise strategies, and experimenting with layouts. Retail heat maps can result in increased revenue generation due to the insights provided by its data

Inventory Tracking:

While labor scarcity commonly constrain retailers, properly apportioning staff remains crucial. To tackle inventory monitoring, computer vision cameras scanning barcodes and tracking stock motions could pinpoint where bins house what. Alternatively, assigning knowledgeable employees to constantly roam aisles, they might spot issues another role lacks time for, ensuring all proceeds smoothly. Together, blending people and programming parsing visuals may preserve optimal

performance even when personnel prove scarce.

Reduction In Overstocking:

Given that many outcomes compare real time results with previously collected data, computer vision helps in achieving more precise and consistent product forecasting and eliminates additional costs and risks that come with poor foresight. In addition, computer vision in retail inventory management is quickly becoming more user-friendly, cost effective, and accurate.

Inventory Auditing:

Department store inventory auditing can be achieved using computer vision technology. Employees will be supplied with a camera to take pictures of the shelves, then a computer vision can analyze this data and give information and analytics to store managers to audit and find any problems in-shelf consistency and act on such findings.

Improvement of On-Shelf Availability:

Computer vision technology in retail inventory management is a highly effective solution to the problem of the high out-of-stock rate, poor on-shelf availability, and disappointing consumer experience. These issues result in enormous losses for retailers and drive consumers to the organizations' competitors. Computer vision-based cameras could conduct quality inspections, detect product defects, project the number of items required, and prevent items with quality flaws from reaching the consumer. Additionally, they could perpetuate the automation by ordering new units of high-demand products from the supplier.

Benefits

Frictionless Shopping Experience

Since both consumers and retailers seek a frictionless shopping experience, computer vision not only is the technological foundation that makes this possible, but it drastically improves the current system. By eliminating long queues, manual scanning, and occasional human error, computer vision will be able to enable cashierless stores that redefine retail efficiency with predictability and increased accuracy. This is exceptional for large companies in the market since by creating a "Just Walk Out" system which charges you the bill right when you leave, it can attract more customers to a store which increases your competitive presence in the market.

Autonomous Inventory Management

As a result of computer vision, retailers can conduct live automated tracking of items on shelves. Algorithms scan the retail space without interruption, and when no items are in sight, they immediately catch out-of-stock positions or requests for re-place products. It helps restock instantly to avoid profit loss and ensure product availability.

In a 2021 pilot project by grocery chain Schnuck Markets, store robots were used to detect 14 times as many addressable out-of-stock items as hand scans, lowering out-of-stock incidences by 20-30%. Ultimately, this solution for in-store product auditing is entirely autonomous, effectively addressing prevalent human errors through system rules.

Quality Control

Computer vision is able to aid in quality control by detecting damaged or expired products. Specialized cameras can read packaging and expiration dates which removes the need for manual checks that are prone to error. By identifying and removing such products, retailers can minimize the risk of customer dissatisfaction and potential liabilities. With predictive analysis, stores can analyze historical and real-time data on customer behavior, seasonal trends, and external factors. This technology can also allow for stores to forecast demand with high accuracy which enables for smarter procurement strategies, reducing both overstock and stockout situations.

Streamlined Store Operations

Computer vision technology significantly reduces the need for extensive human staffing because of how it lends itself to multiple facets of retail operations. It can optimize the customer journey within the physical space through applications such as retail heat maps which use analytics to track customer movements, identify high-traffic areas, dead zones, and bottlenecks to adjust store layouts. The heat map's real-time data can prompt immediate pivot , allowing for signage to be adjusted or products to be swapped out. Computer vision-powered cameras can predict queue lengths and waiting times, enabling stores to dynamically allocate staff efficiently. Next, there's task automation which allows for computer vision-robots to execute a myriad of store upkeep activities, such as cleaning floors, checking temperatures, or verifying promotional offers. Lastly, computer vision cameras can ensure compliance with local occupancy regulations and manage store density by counting customers in real-time.

Loss Prevention and Security

Machine learning technology is precious for loss prevention strategies because it can monitor, analyze, and even predict behavior. In other words, the smart system can identify suspicious behavior patterns and is, therefore, an extra measure of accountability and theft deterrence. Such computer vision systems are perpetually self-improving: they learn from every interaction and become smarter and at the same time less prone to making a mistake, which means that it is less likely to be the reason for falsely accusing innocent customers.

Personalized in-store marketing

In the retail sector, computer vision is highly significant because it provides detailed metrics and statistics about how customers behave and get the shopping done. Moreover, when combined with smart devices and technologies, computer vision serves as a convenient interactive assistant that can guide customers to the products that align with their shopping lists or personal preferences. At the same time, computer vision and integrated smart technology facilitate personalized offers based on individual shopping bags, and the likelihood of a customer's return to the store significantly increases. As a result, thanks to computer vision, shopping becomes interactively synchronized with the shopping list and nutritional values, and the

augmented experiences, which creates a more personalized retail environment.

Risks

Privacy concerns

Since Artificial Intelligence is only now becoming so widespread and known, it poses a huge privacy conern. Monitoring people in workspaces and public spaces and storing large amounts of visual data raises privacy and data security questions, regarding the collection of personal information without consent.

Bias and Reliability

This oversight leads to biased algorithms based on unrepresentative training data serving communities of color and producing outcomes that target them. Such procedural biases can impact certain demographic groups more than others, create extremely high error rates for such groups, and result in very serious ethics, legality, and accuracy challenges". Biased algorithms at the time of their application in the real world cause disproportionate damage. Prejudiced data and outcomes harm individuals from certain demographic groups and can end up leading to misidentifications.

Security Risks

The use of computer vision in retail stores opens up a point of vulnerability for cyber attacks, increasing security risks. However, this risk can be relatively easily mitigated via the use of proper cybersecurity measures.

Case Study

Computer Vision Solution in Modern Warehouse Management System

A global logistics company with 400+ warehouses in over 60 countries looking to boost logistics efficiency on a large scale. They had an ineffective in-house logistics platform and approached N-iX for a game-changing solution. N-iX developed an innovative computer vision system for dock management that relied on industrial optic sensors and Nvidia Jetson devices to track goods impactfully. N-iX optimized the current algorithms and integrated CI/CD for Machine Learning, allowing them to evolve and improve over time. For warehouse cameras, the computer vision solution automated parcel recognition and barcode scanning while recording delivery statuses.

Benefits:

1. Reduced paperwork: Automation eliminates manual procedures and the amount of paperwork that employees must complete.
2. Inventory management: Minimizing the logistics of maintaining inventories in more than 400 warehouses around the world has led to an increase in their accuracy and efficiency.
3. Package detection: Real-time tracking has virtually enabled the detection of damaged packages; only intact goods are delivered to the customers.
4. Planning: Planning becomes effective, and no operational data is planned due to the slight time for failure manifesting.

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