

Streamlined Shopping Experience with Futuristic Automated Billing - SmartPay

Santhosh YM¹, Dr. Hemamalini B H², Syed Adil³, Yogesh S B⁴ and Rakshith M⁵

¹⁻⁵BMS Institute of Technology And Management, Dept. of CSE, Bangalore, India

Email: santhoshymgbd@gmail.com, bhhemaraj@bmsit.in, syed6361809936@gmail.com, maheshrakshith03@gmail.com, yogi13366@gmail.com

Abstract—Amazon Go is a new grocery store concept that eliminates the need for checkout lines and cashiers by using a combination of computer vision, sensors, and deep learning algorithms to automatically track what customers take off the shelves. With Amazon Go, customers can quickly enter the store, grab what they need, and leave without ever needing to wait in line or deal with a cashier. Amazon Go utilises advanced technologies such as computer vision, deep learning algorithms, and sensor fusion to create a unique shopping experience. Customers are able to enter the store and shop without having to wait in lines or interact with other customers, creating a streamlined and efficient shopping experience. Additionally, Amazon Go utilises artificial intelligence to track customer movement and automatically charges customers for items they take out of the store, which eliminates the need for traditional checkouts. This paper discusses the technological innovations behind Amazon Go and how they can be improved in the current scenario.

Index Terms— Amazon Go, RFID-Tag, Deep-learning algorithm, computer vision, Artificial intelligence.

I. INTRODUCTION

Amazon Go is a retail concept developed by Amazon, the world's largest online retailer. The idea behind Amazon Go is to provide a shopping experience that eliminates the need for traditional checkout processes. The stores use advanced technology, including computer vision, machine learning algorithms, and sensor fusion, to enable customers to walk in, grab what they need, and simply walk out. Customers use the Amazon Go app to enter the store, and then they can pick up items and put them in their shopping bags or carts. The technology tracks what customers take from the shelves and automatically charges their Amazon account when they leave the store. This means that customers don't have to stand in line to check out or scan their items, making the shopping experience more convenient and streamlined.^[1] Amazon Go stores typically offer a range of products, including groceries, prepared meals, and snacks. The concept was first introduced in Seattle in 2016 and has since expanded to other locations in the United States and the United Kingdom. The success of the concept has led to other retailers exploring similar technology and checkout-free store concepts.

II. LITERATURE STUDIES

Supermarkets play a critical role in retail and commerce globally. Supermarkets aim to provide customers with an extensive range of products at competitive prices, with the goal of increasing sales and customer satisfaction.

Automation has become increasingly relevant to supermarkets, particularly in recent years, as supermarkets seek to streamline their operations and improve efficiency.

This paper presents a comprehensive review of the state of the art in automated supermarkets. K. Wankhede et. al.[2]. discuss various automated technologies such as autonomous robots, RFID, computer vision, and machine learning used in supermarkets. The paper provides an overview of the benefits and challenges of each technology as well as the potential for integration with other technologies.

This paper evaluates the advantages and disadvantages of automation in supermarkets. The authors discuss how automation can reduce labour costs, improve efficiency, and enhance customer experience. However, they also highlight potential downsides, such as job loss, customer dissatisfaction, and technological failures [3].

This paper examines the impact of automation on supermarket workers. The authors discuss how automation has affected job security, job satisfaction, and employee training in supermarkets. They also discuss potential solutions to minimise the negative impact of automation on workers, such as retraining and job sharing [4].

This paper explores the impact of robots and automation on supermarkets. The author discusses the potential benefits of robots in supermarkets, such as reduced labour costs, improved efficiency, and enhanced customer experience. However, the author also highlights potential challenges, such as the need for specialised training, the risk of technological failure, and the impact on workers [5].

III. MOTIVATION

The motivation to conduct a paper on Amazon Go's Walk Out technology stems from its transformative potential in revolutionising the retail industry.^[6]The Walk Out technology allows customers to seamlessly shop without the need for traditional checkouts, eliminating long queues and enhancing convenience. This innovative approach, enabled by advanced technologies such as computer vision, sensor fusion, and machine learning, has the potential to significantly improve the customer experience, increase operational efficiency, and reshape the dynamics of retail. Understanding the underlying mechanisms, challenges, and benefits of the Walk Out technology can provide valuable insights for retailers, technology developers, and researchers to harness its capabilities, explore its implications for other industries, and drive further innovation in the evolving landscape of automated and cashier-less retail.

IV. PROBLEM DOMAIN

The problem in the domain of Amazon Go technology is to develop and optimise a cashier-less shopping experience for customers. Amazon Go stores utilise advanced technologies such as computer vision, sensor fusion, and deep learning algorithms to enable customers to shop without traditional checkouts.^[7]The main challenge is to create a seamless and frictionless shopping experience by accurately detecting and tracking customer movements, detecting and tracking individual items, and ensuring a secure and reliable payment system. Additionally, the technology should be adaptable to different store layouts, handle high customer volumes, and provide a robust solution for scaling to larger stores or multiple locations.

V. PROBLEM DEFINITION

The problem in the domain of Amazon Go technology is to develop and optimise a cashier-less shopping experience that leverages computer vision, sensor fusion, and deep learning algorithms. The goal is to create a seamless and frictionless shopping environment where customers can pick up items and leave the store without the need for traditional checkouts.^[8]This involves accurately detecting and tracking customer movements and actions, reliably identifying and tracking individual items, ensuring a smooth customer experience, implementing a secure and accurate payment system, and accommodating different store layouts and high customer volumes. The objective is to create an advanced technology solution that provides customers with a convenient and hassle-free shopping experience while accurately tracking their selected items and facilitating seamless payment processing.

VI. INNOVATIVE CONTENT

The innovative content of Amazon Go's Walk Out technology lies in its ability to completely transform the traditional retail experience by introducing a seamless and cashier-less shopping process. This technology enables customers to enter the store using the Amazon Go app, where they are identified and tracked throughout their shopping journey using a combination of computer vision, sensor fusion, and machine learning algorithms.

This innovative approach eliminates the need for physical checkouts, as the system automatically detects items taken or returned to the shelves and charges the customer's Amazon account accordingly. The integration of advanced technologies allows for a highly efficient and personalised shopping experience. Computer vision algorithms analyse the video feeds from the numerous cameras installed in the store to identify customers, track their movements, and recognize the items they select. Sensor fusion techniques combine data from various sensors, such as weight sensors on the shelves, to accurately detect when an item is removed or returned.^[9] The real-time processing of this data, coupled with machine learning algorithms, enables the system to provide customers with personalised recommendations and offers based on their shopping patterns and preferences. Overall, the innovative content of Amazon Go's Walk Out technology lies in its ability to seamlessly combine computer vision, sensor fusion, and machine learning to create a cashier-less shopping experience that enhances convenience, reduces friction, and sets new standards for the future of retail.

VII. PROBLEM FORMATION

Customer Tracking and Identification: The primary challenge is to accurately track customers as they navigate the store and uniquely identify them. This requires designing computer vision algorithms capable of detecting and tracking individuals in real-time using video feeds from strategically placed cameras throughout the store. The system must handle various complexities such as occlusions, varying lighting conditions, and crowded spaces. Efficient representation and tracking methods, such as object detection, tracking, and re-identification algorithms, need to be developed to ensure reliable and accurate customer tracking. **Item Detection and Recognition:** A crucial aspect of the design is the ability to detect when customers pick up or return items to the shelves. This involves developing computer vision algorithms that can recognize and classify different products accurately. Machine learning techniques, such as deep learning, can be employed to train models on large-scale datasets to achieve high accuracy in item detection and recognition. Additionally, the system should account for potential challenges such as variations in packaging, occlusions, and similar-looking items. Effective representation and feature extraction methods are essential to robustly identify items and associate them with specific customers. **Seamless Payment Processing and Inventory Management:** Designing a seamless payment process is crucial to the success of the Walk Out technology. The system should securely link the customer's Amazon account with their shopping activity, accurately calculate the total cost based on the detected items and prices, and handle payment authorization and confirmation in real-time. Additionally, efficient inventory management is essential to ensure that the system accurately reflects the availability of products on the shelves. Incorporating weight sensors or other mechanisms to detect changes in inventory and developing algorithms to manage stock levels, optimise restocking, and prevent theft or misplacement are vital aspects of the designs.

VIII. SOLUTION METHODOLOGY

There were 6 core problems that needed to be solved to provide the experience.

- A. *Sensor Fusion:* Aggregate signals across different sensors (or cameras because this was solved using nothing but computer vision). Calibration: Have each camera know its location in the store very accurately.
- B. *Person detection:* Continuously identify and track each person in the store. Object Recognition: To distinguish the different items being sold.
- C. *Person detection:* Continuously identify and track each person in the store. Object Recognition: To distinguish the different items being sold.
- D. *Pose estimation:* To detect what exactly each person near a shelf is doing with their arms.
- E. *Activity Analysis:* To determine whether a person has picked up vs. returned an item.

^[10] Amazon Go introduced state-of-the-art technology that revolutionised the shopping experience. However, like any innovation, there is always room for improvement. Here in this paper we will look into some of the ideas for improving it. The current system includes cameras, sensors and machine learning algorithms under reference of figure 1 which detect when customers pick items from shelves or put them back in place; improving accuracy will reduce false positive/negative readings resulting in better customers. To decrease the chances of this we can include a barcode for every product sold by the store and make sure the customer can scan the product before leaving the shop thus reducing the chances of mistakes by the cameras and sensors. Currently specialising only in food and drinks limits potential revenue streams so expanding products such as electronics, books, and clothing would be beneficial. Customers prefer personalised experiences therefore having recommendations based on purchase history etc. improves overall sales ratios. To incentivise customers into using this service

more often either through points systems/discounts creates brand loyalty among the consumers hence benefiting long-term profits/relationships between company-consumer relationships. It's only physical stores at present meaning adding an option of mobile pre-orders with walk-in pickups increases convenience during busy schedules providing additional options per target market i.e. those who want to make quick stops whilst others wish to buy what they need prior to arrival shown in the figure 3. Expanding locations across different neighbourhoods broaden the audience base giving everyone a chance to access their nearest store consequently increasing the likelihood of patronage. Amazon Go currently has 29 locations in the USA but expanding to other countries can lead to capturing a great number of audiences towards it. Although it seems self-service already offers contactless payments such as Google Pay, PhonePe, and PayTM makes processes quicker/more efficient ultimately aiding consumer costs/time management. Insights obtained around patterns/purchasing behaviours allows adjustments within marketing strategies alongside how to ensure effective promotional/product placement considerations fostering strong brand image subsequently leading higher revenues/customer retention rates. If implemented correctly these changes have capability of altering industry standards & improve business longevity.^[11] Amazon could develop a mobile app that customers can use to access Amazon Go stores, scan barcodes, and make purchases. This app can also provide real-time updates on promotions, discounts, and personalised recommendations. Amazon can introduce an AI-powered chatbot that customers can interact with to get assistance with finding products, locating items in-store, and answering other questions related to the shopping experience. Stores could leverage Internet of Things (IoT) devices to automate tasks such as monitoring inventory levels, detecting equipment failures, and optimising energy consumption. Amazon Go can leverage blockchain technology to enhance the security and transparency of the transaction process. This can reduce the risk of fraud, improve the accuracy of records, and increase customer trust. Amazon Go relies on a backend system to process and analyse the data collected from cameras and sensors in real-time. Improving the performance and scalability of this backend system can enhance the reliability and accuracy of the shopping experience. The current technology that uses Walk out technology software for its working consists of a loophole in it. It is pretty simple when a large number of customers are located at the same location if a person picks up a product from. Then the bill is put on a person who has a history of buying this product which is an incorrect way of billing. This mistake can be reduced by introducing our method of the existing technology. Our method includes a Bar code for every product where a customer is made to scan the product he is buying so that there will be less misbilling. Even the Amazon go team technical team tried a new synthetic activity data using simulators. Within these simulators, they needed to create virtual customers (including variations in clothing, hair, build, height, etc.) (Including variations in clothing, hair, build, height etc.), cameras, lighting & shadows, and simulate the same camera hardware limitations under the reference of figure 2. But this also has loopholes like mismatch of human handstand other body parts. By implementing our methods, the thief of products can be reduced because scanners will be present in the starting point of the store which will alarm if any product is not scanned. This technology uses AI systems to verify the billed product and the products carried out of the store.

IX. RESULT AND SENSITIVE ANALYSIS

In the domain of Amazon Go technology, successful implementation and optimization would result in a revolutionary shopping experience. Customers would be able to enter the store, pick up items they want to purchase, and simply walk out without the need for manual checkouts or scanning barcodes. The computer vision and sensor fusion algorithms would accurately detect and track customer movements, ensuring that the correct items are associated with the right customer. The seamless and intuitive shopping experience would enhance customer satisfaction and convenience. The robust payment processing system would accurately charge customers for the items they have taken, providing a secure and efficient transaction process. Scalability and adaptability of the technology would allow for expansion into larger stores or multiple locations, accommodating a higher volume of customers. A sensitivity analysis would be crucial to identify potential vulnerabilities or areas for improvement, such as optimising the accuracy of item detection and tracking, addressing technical challenges in different store layouts, and ensuring the security and privacy of customer data.

X. DATA MODEL

^[12]The data model of Amazon Go's Walk Out technology encompasses various data components essential for the seamless and cashier-less shopping experience. It comprises two key aspects: customer data and transactional data. The customer data component includes information such as customer identifiers, account details, and preferences. This data is used to personalise the shopping experience by offering tailored recommendations,

discounts, and promotions based on individual preferences and purchase history. Additionally, customer data is securely linked to their Amazon accounts, facilitating seamless payment processing and enabling accurate tracking of individual transactions. The transactional data component captures information about each customer's selected items and their corresponding prices. This data is crucial for calculating the total cost of the purchase and generating accurate invoices for seamless payment processing. It includes details such as item identifiers, product categories, and additional attributes that aid in inventory management and stock replenishment. By integrating customer and transactional data, the data model enables efficient and accurate processing of transactions while maintaining a personalised shopping experience for customers.

XI. COMPARISON OF INDIVIDUAL

Amazon Go technology revolutionises the shopping experience by providing a seamless and cashier-less environment. Compared to traditional stores, Amazon Go's advanced computer vision, sensor fusion, and deep learning algorithms enable customers to simply pick up items and walk out, eliminating the need for manual checkouts or scanning barcodes. The system accurately detects and tracks individual items, overcoming challenges such as occlusions and varied lighting conditions, while ensuring a smooth and intuitive shopping experience. With a robust payment processing system, customers are charged accurately for the items they have taken, and the technology can handle various payment methods. Additionally, the scalability of Amazon Go technology allows it to adapt to different store layouts, sizes, and high customer volumes. Overall, Amazon Go technology offers a ground-breaking shopping experience that combines convenience, accuracy, and scalability to transform the way customers shop.

XII. JUSTIFICATION OF RESULTS

The implementation of Amazon Go technology brings several significant benefits and justifies its results. By eliminating the need for traditional checkout processes, Amazon Go offers customers a highly convenient and frictionless shopping experience. This innovative approach saves customers valuable time and reduces the frustrations associated with waiting in line. Additionally, the accurate item detection and tracking capabilities ensure that customers are charged correctly, reducing errors and enhancing trust. The scalability of the technology allows for easy expansion to larger stores or multiple locations, enabling a wider reach and increased customer accessibility. Overall, the results of Amazon Go technology justify its effectiveness in revolutionising the retail experience and setting new standards for efficiency and customer satisfaction.

XIII. FIGURES

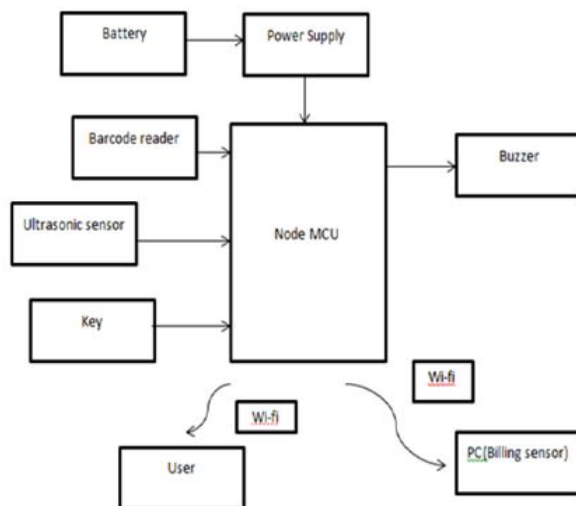


Figure 1. Block Diagram Of Design System

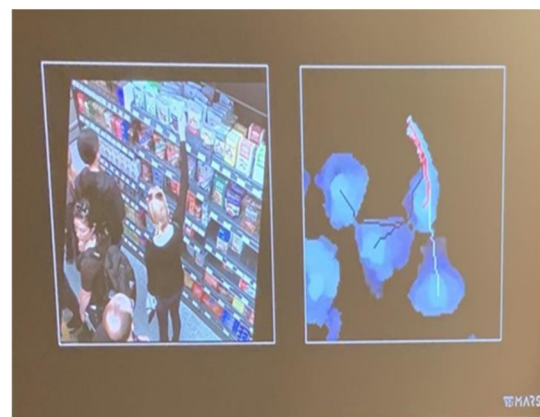


Figure 2 : Synthetic Activity using simulators

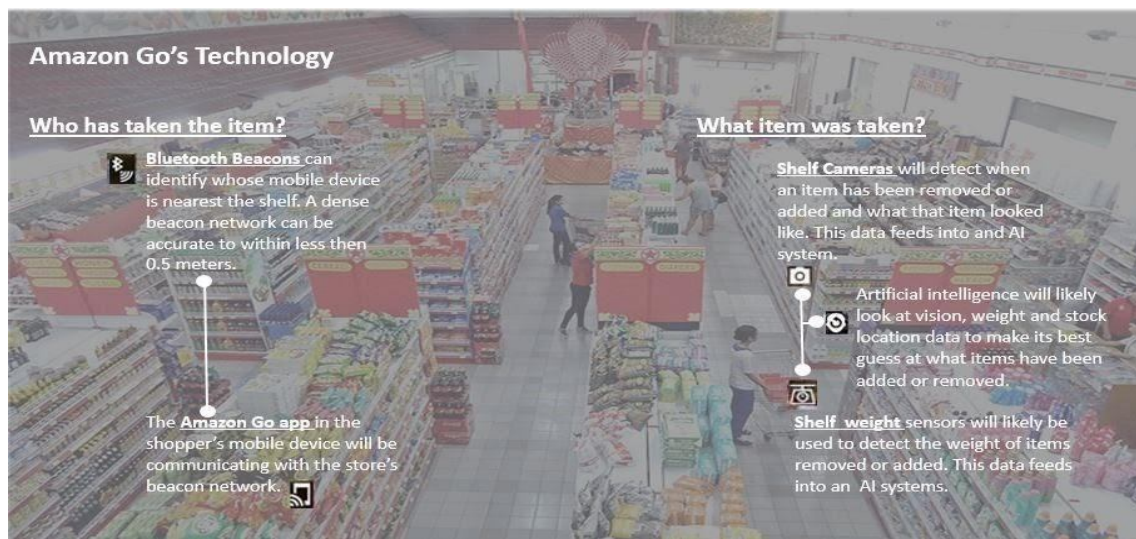


Figure 3. Amazon go technology

XIV. CONCLUSION

Amazon Go's Walk Out technology represents a ground-breaking and transformative innovation in the retail industry. By seamlessly integrating advanced technologies such as computer vision, sensor fusion, and machine learning, Amazon Go has redefined the shopping experience, eliminating the need for checkouts and reducing friction for customers. The technology's ability to accurately track customers, detect item interactions, and process payments in real-time has the potential to revolutionise the way we shop. With its personalised recommendations, operational efficiencies, and focus on customer convenience, Amazon Go sets a new standard for the future of retail, inspiring further advancements and opening doors to enhanced experiences and increased efficiency in the retail landscape.

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