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Shopping Trolley for Automated Billing System with Pick and Place Mechanism Using Image Processing

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ABSTRACT:- In the realm of individual E-business transactions, many people engage in purchasing various items from markets and shopping centers to fulfill their basic needs. Despite the numerous challenges faced by customers, a prevalent issue is the time-consuming process of waiting in line for billing, even when the purchase involves only a couple of items. This traditional method of queuing up, handling cash transactions, and the average time spent on each customer becomes particularly burdensome in crowded grocery stores and shopping malls.Customers, especially those inclined towards embracing new technologies, are eager for innovations that streamline the billing process, reducing waiting times and overall transaction duration. The primary objective is to meet the essential needs of customers and, importantly, alleviate the time spent on the billing process. The proposal is to transition from the conventional waiting-in-line approach to a system where the billing is completed within the shopping trolley itself.Supermarkets and general stores, having been in operation for decades, serve as go-to destinations for purchasing fresh fruits, vegetables, and a wide array of daily necessities. While these establishments have implemented various measures to deter shoplifting and enhance the overall shopping experience, the bottleneck of waiting in line for billing remains a significant drawback.This paper introduces a technological solution that facilitates a seamless shopping experience, utilizing Raspberry Pi and other advancements. The proposed system is well-suited for implementation in general shopping centers such as supermarkets, D-mart, Big Bazaar, and Walmart. The technology aims to significantly reduce time consumption, offering an enhanced shopping experience for customers.

Keywords:- Smart-Shopping, Raspberry-Pi, Shopping Trolley, Image Processing, Machine Learning, Artificial Intelligence.

I. INTRODUCTION

In the 21st century, technological advancements have reached unprecedented levels, driven by the centralization and modernization of Industry 4.0 technologies. Researchers and scientists are diligently working to make our surroundings smarter and more contemporary. The concept of supermarkets, shopping marts, and shopping malls emerged to enhance the shopping experience, providing a centralized location for obtaining essential items. With the advent of shopping centers like Walmart, D-mart, and Big Bazaar, coupled with the rise of online shopping, the economy experienced a significant boost during the Industry
4.0 era.

Traditional billing processes, marked by slow and inefficient paper billing, underwent a transformation with the introduction of bar-code scanners. However, as the volume of customers utilizing these billing systems increased, frustrations grew due to long waiting times in line for the billing process. Recent projects, such as smart carts using RFID and NFC, have been introduced, but many lacked the effectiveness required to keep up with modernization. In response to this, Amazon pioneered its own smart grocery store known as 'Amazon Go,' employing cutting-edge technologies such as computer vision, deep learning, and machine learning algorithms.

In light of these developments, our objective is to construct a comparable framework utilizing image processing and Raspberry Pi in a cost-effective manner. This initiative seeks to address the limitations of existing technologies and

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provide an efficient and modernized solution for the billingprocess in shopping environments.

II. LITERATURE REVIEW

A. Amazon-Go

The "Amazon Go" stores have been established in more than 12 cities worldwide, representing a groundbreaking concept where traditional checkouts are eliminated. Customers can enter the store using the Amazon Go app and Amazon Go shopping cart, select products, and simply leave without the need for a cashier or checkout process. This partially automated and human-supervised store utilizes the "just walk in and walk out" technology, combining ceiling cameras, computer vision, artificial intelligence, machine learning, andweight sensors to facilitate a seamless shopping experience [2].However, it's essential to acknowledge certain limitations. The estimated hardware costs for implementing such technology range from $1-1.5 million, posing a potential barrier for widespread adoption, especially in stores around the world or in economically disadvantaged regions. Addressing these limitations would require innovative approaches to cut costs and make the technology more accessible to a broader demographic.

B. Agar Sojitra, Rahul G.Patel

In [3], the proposed model introduces the use of NFC or RFID tags as an alternative to traditional printed barcodes and QR code scanners. This innovative approach aims to address the issue of long wait times during the billing process, enhancing the overall shopping experience for customers in malls or supermarkets. The model suggests incorporating NFC reader displays on shopping trolleys or carts to keep track of the running total and the cumulative cost of the items selected by the customer. Furthermore, the paper advocates for the integration of IoT (Internet of Things) systems, connecting all the shopping trolleys to a central server. This networked system not only enables efficient communication between the trolleys and the central server but also facilitates online payment options, contributing to a more seamless and positive shopping experience for customers. The emphasis is on reducing frustration associated with waiting times and introducing technological advancements to enhance customer satisfaction in retail environments.

C. RFID or NFC Cloud smart cart system

Utilizing RFID or NFC technology for the billing process of purchased items is proposed in [4]. The system involves the incorporation of a PCB (Printed Circuit Board), a Wi-Fi module, and a power supply within the shopping cart. The envisioned smart t rolley is designed to autonomously generate a bill directly from the trolley, offering a centralized and automated billing system. This innovative approach aims to streamline and enhance the billing process for a more efficient and convenient shopping experience.

D. Smart trolley with smart billing process

In [5], the authors introduce a novel system featuring a smart shopping trolley for an automated billing process, incorporating Raspberry Pi and an integrated billing system. The system is designed with additional functionality to calculate the total cost of products within the trolley and update this information on display screens for customers.When customers make purchases, the product information, including cost and other details, is displayed. After completing their shopping, customers press a key to signal the end of their shopping process. Subsequently, the billing counter displays the number of items and specific products inside the trolley on an LCD screen, promptingcustomers to finalize their billing process near the counter. The system ensures that the billing process only initiates if customers remove items from the trolley. However, the authors note certain drawbacks. Affixing RFID or NFC tags to some products can be challenging. Additionally, the communication between trolleys and the billing counter relies on ZIGBEE, which has distance limitations, posing potential barriers to seamless communication between the two components.

E. Automated billing for smart shopping using IoT.

In this study, a smart trolley system is proposed,employing Raspberry Pi for wireless communication between customers and data servers. Each individual trolley is equipped with a user- specific reader, and information about the trolleysis stored in the data servers. The operational framework involves customers selecting and inspecting products. The Raspberry Pi embedded in the trolley retrieves product details from the database and displays them on an LCD screen for the customers. The LCD provides real-time product information, including the total cost of the items within the shopping trolley, enabling customers to stay within their budget constraints. Upon approaching the counter, the database sends a notification to the counter's database, initiating the billing process. This wireless communication

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system enhances the efficiency of the shopping experience and facilitates a seamless billing process.

III. PROPOSED WORK

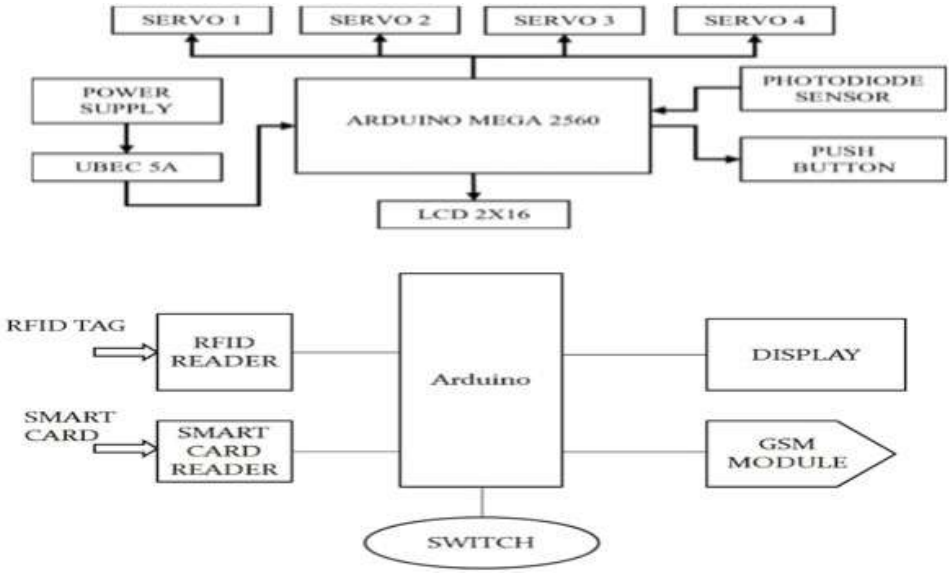

Figure 1:- Block Diagram of Smart trolly

The primary aim of the proposed system is to provide customers with cost-effective and easily accessible expertise and information about products, incorporating a streamlined process for shopping and billing. The electronic shopping store powered by Raspberry Pi is designed to enhance the overall shopping experience for both customers and consumers.

Upon entering the store, customers register themselves in the database, receiving a RaspberryPi basket for their shopping. Registration details include personal information such as name, billing address, contact details, email ID, and identity proof, along with transaction-related information like bank account and card details. Once registration is completed, customers can proceed with their shopping in the store. This system is also observable by unregistered individuals, often referred to as window shoppers.

As customers select products, the database identifies the product information, and customers verify their identity through a scanner. Scanning the products using the camera within the Raspberry Pi setup in the shopping basket transmits product details and content information to the database through Raspberry Pi via serial communication drivers. Raspberry Pi retrieves necessary product details from the database and displays them on the basket's screen.

Upon scanning an authorized card, the lock on the rack containing the products opens, allowing customers to take the selected items. Customers need to showcase the taken products before the camera, with the details sent to the database via the connected Raspberry Pi and camera. After confirming their bill, customers can review product details, complete the transaction process, and make the necessary online payment before leaving thestore swiftly.

This innovative approach ensures a quick and hassle-free shopping experience for customers in the electronic shopping store.[4]

Technology Used in the Proposed System

A. Image processing

To facilitate object identification in this project, the authors have employed image processing alongside machine learning. Leveraging image processing and machine learning, the camera within theRaspberry Pi can efficiently scan products presented in front of it. The Raspberry Pi utilizesthe database information of the shopping complex or mart to recognize product details.A significant tool in image processing, particularly for object detection, is the cascading classifier available in OpenCV. The authors have implemented object detection using this feature based on cascading classification, as proposed by Paul Viola and Michael Jones in their paper, "Rapid Object Detection using a Boosted Cascade

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of Simple Features" in 2001. This machine-learning-based approach involves training a cascading function from numerous positive and negative images in the database, enabling effective object detection.The algorithm initially requires a substantial set of positive and negative images to train the OpenCV classifier. The Raspberry Pi then extracts features at each stage of the classification, labeling regions as either positive or negative based on the current location of the sliding window. A positive label indicates the presence of the object, while a negative label suggests its absence. If the label is negative, and the classification for that region is complete, the detector slides to the next location in the database. On the other hand, if the label is positive, the classifier advances the region to the next stage, reporting that the object is found. The designed stages aim to swiftly reject negative samples, assuming that most windows do not contain the object of interest.

While true positive product hits are rare, it is essential to invest time in verifying and consolidating the database with high-definition images. A true positive occurs when a positive sample is correctly classified using image detection, whereas a false positive happens when a negative sample is mistakenly classified as positive, indicating the product is taken. Conversely, a false negative occurs when a positive sample is erroneously classified as negative, implying the product is already taken or bought. Object identification or detection stands out as a critical component of the proposed system, as it directly influences the billing process by dealing with the products consumers intend to purchase

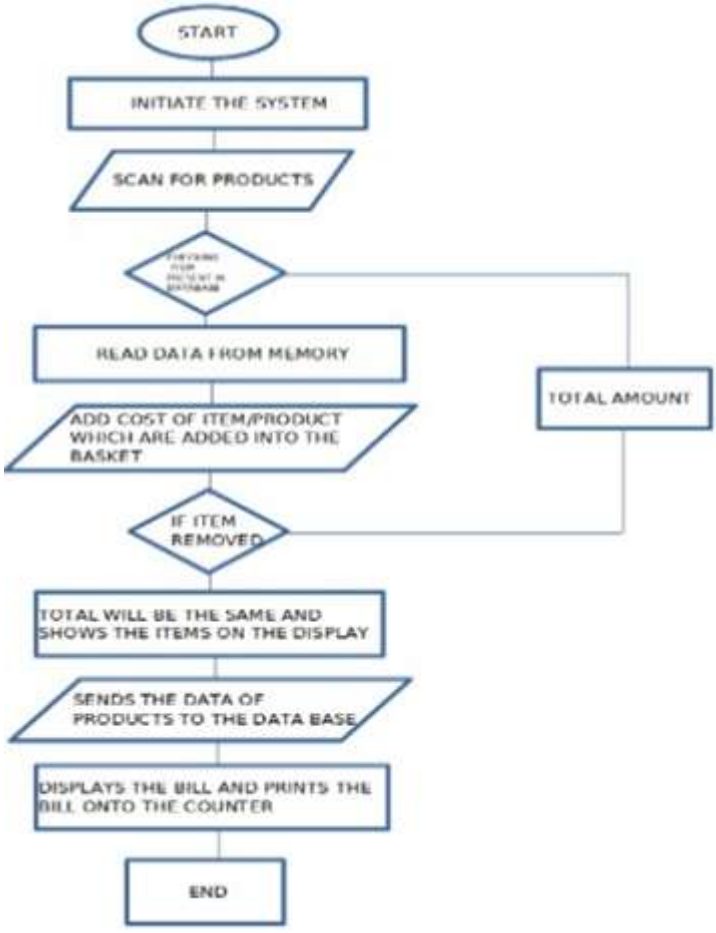

Figure 2:- Flow chart

IV. HARDWARE REQUIREMENTS

A. Web Camera

A webcam for a Raspberry Pi is a digital camera device designed to connect to and function with a Raspberry Pi microcomputer. These webcams are typically USB-powered and can be easily integrated into the Raspberry Pi's USB ports. They serve as an essential component for various projectsand applications that involve image or video capture, such as surveillance systems, home automation, video streaming, and more.

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Figure 3:- Web Camera

B. Raspberry Pi

The Raspberry Pi is a versatile, credit-card-sized single-board computer developed by the Raspberry Pi Foundation, a non-profit organization. Initially created to promote computer science education, the Raspberry Pi has evolved into a popular platform for hobbyists, makers, and professionals working on various projects. The device is designed to be affordable, accessible, and easily programmable, making it an ideal tool for learning about computing and electronics.

Figure 4:- Raspberry Pi

C. Shopping Cart

A shopping cart, commonly referred to as a shopping trolley in certain regions, is a specially designed wheeled vehicle created to enhance the shopping experience in retail environments. It serves as a practical and indispensable tool for customers, offering assistance in transporting selected items conveniently throughout a store. The primary purpose of shopping carts is to facilitate the gathering of goods as customers navigate through aisles and make their product selections.

Figure 5:- Shopping Cart

V. SOFTWARE REQUIREMENTS

A. Python programming language will be used forRaspberry pi configuration.

Python is a versatile and widely-used programming language that has gained immense popularity for its readability, simplicity, and extensive support forvarious applications. When it comes to configuring and programming the Raspberry Pi, Python stands out as a preferred language due to its ease of useand the Raspberry Pi's native support for Python.

B. HTML Language for designing the website.

HTML, or HyperText Markup Language, is the standard markup language used to create and structure content on the World Wide Web. It forms the backbone of web pages and is essential for designing and organizing the various elements that users interact with when browsing websites. HTML provides a systematic way to define and present content, ensuring consistency and compatibility across different browsers.

C. PHP Language to maintain the database.

PHP, which stands for Hypertext Preprocessor, is a server-side scripting language commonly used for web development. While HTML focuses on presenting content on the client side (i.e., in the user's browser), PHP is employed on the server side to generate dynamic content, interact with databases, and perform various server-related tasks. One of the significant applications of PHP is inmanaging databases, where it seamlessly integrates with database systems to retrieve, manipulate, and store data

D. Database Required SQLITE

SQLite is a lightweight, embedded, and

self- contained relational database management system (RDBMS) that does not require a separate server process and allows for a hassle-free integration within applications. It is a popular choice for mobile apps, embedded systems, and small to medium-scale web applications.

VI. RESULT

The Raspberry Pi offers several advantages over standardized RFID or NFC tags, which are prone totampering due to factors such as temperature, water exposure, physical wear and tear, and other environmental causes. The Raspberry Pi ensuresthe secure storage of product information, and the communication gateway in shopping trolleys or carts remains inactive until an item or product is scanned, and its information is accurately read by the Raspberry Pi camera.

This approach enhances security and prevents unauthorized access or tampering. Unlike traditional RFID or NFC tags, the Raspberry Pi's robust design mitigates the risks associated withenvironmental factors, ensuring the reliability ofstored information.

The information of items placed inside the trolley iscrucial for preventing theft or the removal of items that have not been properly scanned and charged to the customer. Attempting to remove an item triggers the same procedure, and the Raspberry Pi, serving as a database, stores this information locally on the database server previously set up for the Raspberry Pi.

By leveraging the Raspberry Pi's capabilities, the system effectively addresses security concerns and prevents unauthorized removal or manipulation of items. The implementation of a local database server ensures that transaction data is storedsecurely, providing a reliable and tamper-resistant solution. The overall result demonstrates the practicality and effectiveness of the working model in real-world shopping scenarios.

This innovative approach using the Raspberry Pinot only improves security but also offers a more robust and reliable solution compared to traditional RFID or NFC tags, especially in challengingenvironmental conditions.

VII. CONCLUSION

From the customer's perspective, the presented project has revolutionized the traditional method of purchasing products. The Raspberry Pi demonstrates significant advantages over scanner tags like RFID or NFC, primarily owing to its precision and rapid response facilitated by artificial intelligence and machine learning processes. The features embedded within the Raspberry Pi contribute to an enhanced shopping experience, offering improved efficiency that can be easily navigated by any regular individual accustomed to buying products.

Looking ahead, the future scope envisions the utilization of enhanced Raspberry Pi models tailored to specific products, operating with a high degree of accuracy. This advancement allows consumers to seamlessly access information about the products simultaneously. Furthermore, the integration of IoT (Internet of Things) can be leveraged for automating stock management, leading to efficient and real-time updates on product information. This not only streamlines inventory processes but also contributes to the automation of stock administration.

Based on a comprehensive literature survey and an exploration of various shopping systems worldwide, the authors conclude that the proposed system is reliable and, importantly, cost-effective. In comparison to the highly technical Amazon Go store and its associated shopping carts or trolleys, the presented model stands out as a feasible and economical solution for modernizing and innovating the shopping experience.

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