Autonomous Billing CartBot

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Incorporating cutting-edge technology, Automated billing carts (ABC) revolutionize the e-commerce landscape by seamlessly generating and delivering invoices to customers, while optimizing efficiency and accuracy for merchants. ABC is a system that enables carts in the market to generate and send invoices to customers for their purchases automatically. This system is fitted on the cart which consists of a low-power embedded system like esp32 for displaying bills and libraries like OpenCV for detection. It streamlines the billing process by automatically calculating the total cost of items, and taxes, and generating an invoice that includes all necessary information such as item names, quantities, and prices. Additionally, a smart cart control system which has a billing system embedded in it, uses Bluetooth and gesture recognition, that uses ADXL355 sensors to interpret gestures and acceleration, enabling remote control of the vehicle. Experimental results confirm precise control and robust performance, promising its stability and anti-interference capability. Automated billing carts benefit both customers and merchants. Customers can easily manage invoices online, while merchants save time and reduce errors. Additionally, these carts enhance fraud prevention, manual labour of pulling/pushing or holding the cart and record-keeping, ultimately improving customer satisfaction and boosting merchant revenue.

Keywords: esp32, Billing, Automation, Gesture recognition, OpenCV, Internet of Things.

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1 Introduction

In recent years, technological progress has been so rapid that it paved the way for innovative solutions in various domains. One such domain is the retail industry, which constantly seeks to enhance the shopping experience for customers while optimizing operational efficiency. As part of this drive, the concept of an autonomous billing cart has emerged, aiming to revolutionize the traditional checkout process. This research paper focuses on the integration of OpenCV for barcode detection and ESP32 for display within an autonomous billing cart system.According to Gao et al. (2007), the technology behind 2D barcodes is essential for mobile commerce as it offers an economical, effective, and precise solution for automating data collection and handling transactions [10]. Barcodes have found widespread application in retail environments, supply chain management, and product tracking, which makes them ideally suited for use in automated billing systems [10].

The pioneering autonomous billing cart merges sophisticated computer vision with the Internet of Things (IoT) to improve the shopping experience. By utilizing OpenCV, a popular computer vision library, the cart is capable of detecting barcodes in real time. The image processing features of OpenCV facilitate the recognition and extraction of barcodes from images or video feeds. When paired with libraries such as ZBar or pyzbar, it supports real-time barcode scanning for uses including automated billing, self-checkout, and inventory control [11]. This technology enables customers to load items into the cart without the need to individually scan each product at the checkout, thus lessening wait times and streamlining the billing process. Moreover, the addition of a gesture-controlled system enhances user comfort by reducing physical effort while shopping. The autonomous cart utilizes an ESP32 microcontroller, which includes Wi-Fi and Bluetooth connectivity, acting as the display module. This module supplies real-time information about scanned items, pricing, and a cumulative total. Furthermore, the cart connects to the store's backend system to guarantee accurate billing and effective inventory management. For gesture control, the system integrates a ADXL355 sensor, a three-axis accelerometer that captures motion data and performs multi-angle fusion for accurate directional commands. An Arduino microcontroller governs the movement of the cart based on the hand gesture signals received from the controller. The ADXL355 sensor sends commands through radio frequency, allowing the cart to be controlled remotely. By wearing the specified gear, users can navigate the cart wirelessly, thus improving both accessibility and usability.

This research paper investigates the deployment of an autonomous billing cart that combines OpenCV for barcode identification, ESP32 for display features, Arduino for movement control, and ADXL355 for gesture-based operation. The study analyzes the technical aspects of integrating these technologies and evaluates the system's practicality within a real-world retail setting. Critical elements such as customer satisfaction, efficiency at checkout, and potential cost reductions for retailers will be examined to assess the viability of widespread implementation. In conclusion, this research underscores the potential of merging computer vision and IoT technologies to create an autonomous billing cart that elevates the shopping experience while enhancing operational efficiency. By utilizing these innovations, retailers can enhance store operations, decrease checkout durations, and deliver a seamless shopping experience to customers.

2 Literature Review

S. Ullah et al. The paper provides a comprehensive overview of an intelligent shopping system based on the IOT, utilizing RFID technology. It addresses the need for a more intelligent shopping experience to cater to consumer demands. By integrating RFID into shopping carts, the authors aim to streamline the process, offering real-time product information. The system architecture involves RFID tags, readers, a shopping cart, and a backend server. RFID tags on products are detected and communicate with readers on the cart. Data is sent to the backend server for analysis, offering benefits like inventory management, improved customer experience, and reduced checkout time. Challenges like tag collision and privacy concerns are discussed with proposed solutions. Functionalities include item detection, real-time info display, personalized recommendations, and seamless checkout. Cloud computing and data analytics enable advanced features, demonstrated through experimental results showing improved efficiency, reduced checkout time, and enhanced customer satisfaction [1].

Shipra Aggarwal et al. In busy mega malls, customers often face lengthy queues during grocery shopping and purchasing daily necessities, resulting in valuable time wastage. To address this issue, researchers have proposed an automated billing system. The solution involves a smart cart equipped with a scanner that scans distinct codes and values of artifacts placed in cart. The item information is exhibited on the shopping trolley screen. Once the client completes shopping, they proceed to the billing counter and payment of the total bill displayed on the shopping basket screen. This paper examines relevant works conducted by a number of researchers in this field., focusing on key Smart Cart components such as microcontroller, transmission medium and scanning system. The goal is to explore and analyse the advancements and effectiveness of automated billing systems to enhance the shopping experience and reduce waiting times for customers at mega malls[2].

Meghana T K et al. The rapid advancement of technology has led to increased attraction towards electronic gadgets among people of all ages. Various industries, including supermarkets, now rely on electronic devices such as smart card readers, bar code readers and RFID scanners. However, the traditional billing process in supermarkets can be time-consuming, especially during busy periods. To address this, a smart shopping solution has been developed. Instead of barcodes, each product is equipped with RFID tag, and the Smart Trolley incorporates an RFID reader and LCD module. As customers place products in the shopping basket, the details of the products - including cost and sell-by date - are instantly displayed. The total cost is added to the till receipt stored in the microcontroller's memory. On completion, the purchase details are sent to the customer via the GSM module. Programming is done using the Arduino IDE software, and simulation results are checked using Proteus software before hardware implementation. This automated system for the improvement of the shopping experience reducing waiting times and providing real-time information to customers [3].

P. Chandrasekar et al. Modern embedded systems are often built around microcontrollers, which combine CPUs with integrated memory and peripheral interfaces. While RFID technology is widely used to help you streamline your inventory and supply chain, it also has the potential to enhance the shopping experience for customers. Additionally, ZigBee, based on the IEEE 802.15 standard, allows devices to data transmission over long distances by creating a mesh network. This paper introduces a Central and automated billing system that leverages RFID and ZigBee communication. Each product in shopping malls and supermarkets is equipped with an RFID tag for identification. Shopping trolleys are equipped with a Product Identification Device (PID) consisting of a microcontroller, LCD, RFID reader, EEPROM and ZigBee module. When customers place products in the cart, their information is read by the RFID reader, and the data is stored in EEPROM. Subsequently, EEPROM data is transmitted to the centralized billing system through the ZigBee module. The centralized billing system processes the cart details and EEPROM data, accessing the product database to calculate the total purchase amount for the cart. The primary objective of this paper is to create an automatic billing system that mitigates queuing issues in malls and supermarkets, resulting in a smoother and more efficient shopping experience for customers [4].

T. M. Choi et al. This paper delves into the analytical study of RFID technology's role in modern supply chain management, specifically focusing on a two-stage supply chain with a single manufacturer and a single retailer using the Vendor Managed Inventory (VMI) system. The study builds supply chain models for retail replenishment with and without RFID. It examines risk levels and expected returns. It proposes coordinating measures for both scenarios, facilitating comparisons between RFID adoption and non-adoption cases. The paper offers valuable managerial insights, such as the significant benefits of RFID adoption in terms of improved supply chain performance, risk reduction, and increased expected profits. Additionally, it identifies multiple return policies that effectively use RFID to co-ordinate the supply chain. The research underscores the advantages of manufacturers sharing the cost of RFID implementation with retailers, fostering better coordination and risk mitigation. Moreover, it demonstrates that under the co-ordinated return policy, the return rate may be lower for cases with RFID if the cost of the RFID tag is appropriately shared between the retailer and the manufacturer. These insights have noteworthy implications for both industry practitioners, academic researchers in field of supply chain management [5].

S. Chalasani et al. The focus of this paper centers on data models for storing data from Radio Frequency Identification (RFID) transactions and related data processing architectures. The supply chain under consideration involves manufacturer, distributor, retailer, and consumer. The paper elaborates on the specifics of the data that is generated by RFID transactions and proposes data models for its storage. Various organizations within supply chain can utilize data for diverse applications such as automated product ordering, replenishing and recalling. The paper offers models to predict data requirements stemming from RFID transactions and suggests ways to adapt existing enterprise applications for handling RFID data efficiently, leading to reduced storage needs. Additionally, the paper explores two supply chain applications, product recall and shelf replenishment, and presents analytical models for estimating the cost and time required to replenish shelves in a retail store. These findings aim to aid practitioners in designing and developing databases and applications to manage RFID data effectively while optimizing storage requirements [6].

Discussing the design of any unmanned vehicle controlled by hand gesture modules can be applied to the hardware and software design of an autonomous billing cart. The hardware components should comprise of the remote glove, which uses multiple sensors such as accelerometers and gyroscopes to detect hand gestures and to send the detected electronic signal to the controller. The controller being Arduino UNO, ESP32 or Arduino Nano can facilitate the conversion of the electronic signals transmitted and received, using transmitters like NRF 24L01, into actual commands to be followed by the actuators of the chassis. Every hand gesture controlled unmanned vehicle is observed to use the main components of a glove, a robotic chassis of the vehicle and an appendage to perform some task, such as robotic arm, cameras for computer vision purposes or grippers for pick and place operations. The modules applied to a car control system could be applied to the autonomous cart, this includes the glove based system and an obstacle avoidance system accompanied by infrared sensors with a set "safe distance". The data glove-based system relies on recognizing hand postures through gesture sensors. It comprises a main control chip, motion processing component, wireless module, and power module. The hand control end and the smart car control end are the two components that make up the system. Communication between the two ends can be facilitated by the nRF24L01 wireless module using Arduino. The software flow for the hand control terminal and smart car terminal involves initialization, channel reception, real-time data collection from the MPU6050 sensor, frequency modulation detection, and direction closed-loop control. Both terminals continuously accept channel information until received and perform frequency modulation processing if the connection fails until communication is successful [7].

Another prototype proposes using gesture-controlled unmanned vehicles for military applications. This system utilizes a remote glove equipped with NeoPixels for security. The remote glove typically includes H-bridge circuits along with infrared (IR) sensors, allowing a user to control the unmanned vehicle. To gain access, the user must enter a PIN. Upon entering the correct PIN, the NeoPixels will light up green, indicating access has been granted; if the PIN is incorrect, the NeoPixels will light up red [8].

Porter and Kim's research from 2008 on RFID technology for automated transaction processing in road pricing showcased its ability to streamline billing with minimal user involvement. Their fee collection system based on Vehicle Miles Traveled (VMT) was able to automatically recognize vehicles that had RFID on-board units, monitor mileage, and compute road usage costs. This system was connected to fuel station Point-of-Sale (POS) systems for immediate transaction processing. The research also investigated error management techniques, such as utilizing Received Signal Strength Indicator (RSSI) levels to associate vehicles with transactions. These concepts could be adapted for automated billing shopping carts to enhance efficiency and precision at retail checkouts. Furthermore, the study tackled data security issues, implementing protocols such as AES and CRC to ensure secure payment transactions [9].

Recent advancements in AI and IoT have led to the emergence of automated shopping solutions that improve billing efficiency and customer ease. A significant development in this area is the smart shopping cart, which employs deep learning for object detection using OpenCV and Python. By incorporating YOLOv3, an advanced deep learning model, a cart with a camera can identify items in real-time, automatically add them to a digital basket, and create a bill without the need for barcode scanning. This technology considerably shortens checkout durations and aids in establishing cashier-less retail spaces, increasing accuracy, efficiency, and cost-effectiveness. The combination of deep learning and IoT in smart carts marks a crucial advancement towards fully automated shopping experiences [12].

The proposed IoT-enabled shopping trolley system lays a solid groundwork for the creation of an Automatic Billing Cart by integrating technologies that boost shopping efficiency and decrease wait times. By utilizing RFID tags or QR codes, real-time billing, and cloud-based inventory management, this system automates the checkout procedure, minimizing human involvement and optimizing store operations. Additional functionalities like anti-theft systems and indoor navigation further enhance security and usability. Inspired by this model, the Automatic Billing Cart can incorporate wireless communication, embedded processing units (like Raspberry Pi or ESP32), and intelligent payment options to streamline the shopping experience even more. Addressing challenges such as product tagging, consumer adoption, and initial setup costs can refine its design, making it a scalable and economical solution for contemporary retail environments [13].

Low-power wireless sensor networks can significantly enhance energy efficiency and reliability in an Automated Billing Cart. The i-Bean Network, for example, utilizes a dual-processor design, narrowband radio communications, and low-duty cycle operations to reduce power usage and extend battery longevity. Similarly, integrating low-power wireless protocols like Bluetooth, Zigbee, or Wi-Fi into the Automated Billing Cart can allow for real-time data exchange while saving energy. A hybrid star-mesh configuration can further streamline communication between carts and a central server, guaranteeing smooth billing updates. By incorporating such energy-efficient strategies, the Automated Billing Cart can keep operational costs low while ensuring sustained performance in retail settings [14].

Ultrasonic sensors and RF-based wireless communication can also be effectively used to enhance real-time tracking and navigation in an Automated Billing Cart. Wireless luggage-following systems use HC-SR04 ultrasonic sensors and RF 434 MHz modules to detect obstacles and adjust movement dynamically according to the user's location. Similarly, an Automated Billing Cart can integrate ultrasonic or RFID sensors to recognize and identify products placed inside, while RF communication facilitates wireless data transfer to the central billing system. Moreover, controlling motors through PWM signals, as demonstrated in luggage follower systems, can be adapted for automated cart functions and product identification. By merging wireless tracking, real-time synchronization, and automated navigation, the Automated Billing Cart can eliminate checkout queues and improve the overall shopping experience [15].

3 Methodology

Two sections are included in this section, which explains the operation of the billing system and how to control a hand-gesture-operated cart. The operation of the two systems is essential for the overall implementation of the product and the completion of customers's total use of the system. In addition to enhancing the user experience, it is also important to understand how these systems are complex and ensure seamless integration and functionality in wider product coverage.

3.1 Working of Billing System

This flowchart shown in Figure 1 provides a clear understanding of how the billing system operates and guides users through the various processes to access the system step by step.

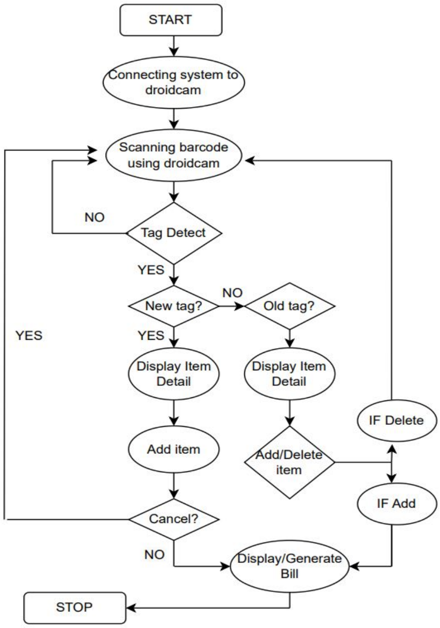

Figure 1. Flowchart of Billing system

Here is a more detailed explanation of the steps:

1 The process begins by connecting the system to the Droidcam. This is done by plugging the Droidcam into the computer and installing the necessary drivers and Python libraries for barcode decoding and communication with the ESP32 module. Once the Droidcam is connected and files are installed, the barcode can be scanned. The Droidcam emits a beam of light that is reflected by the barcode. The pattern of the reflected light is then used to decode the barcode. Scanned barcode data is sent to the computer using the ESP32 module's WiFi capabilities for further billing process.

2 Billing Process: The ESP32 module receives the barcode data and sends it over the WiFi connection to the computer running the Python program. The computer receives the barcode data and processes it accordingly. The billing process is further dependent on two possibilities which is Tag detection. If the tag is not detected, the user scans it again until it is detected. When the tag is detected, it checks for the tag being an old tag or a new tag to perform operations based on them as mentioned in the flowchart. The Python program retrieves the relevant product information associated with the scanned barcode from a database or inventory system. Based on this the total cost of the scanned products based on their prices and quantities are calculated. Then using this data we display the total cost and any additional information on the computer's screen or a connected display. If needed, the program can provide an option to generate and print a receipt or save the transaction details.

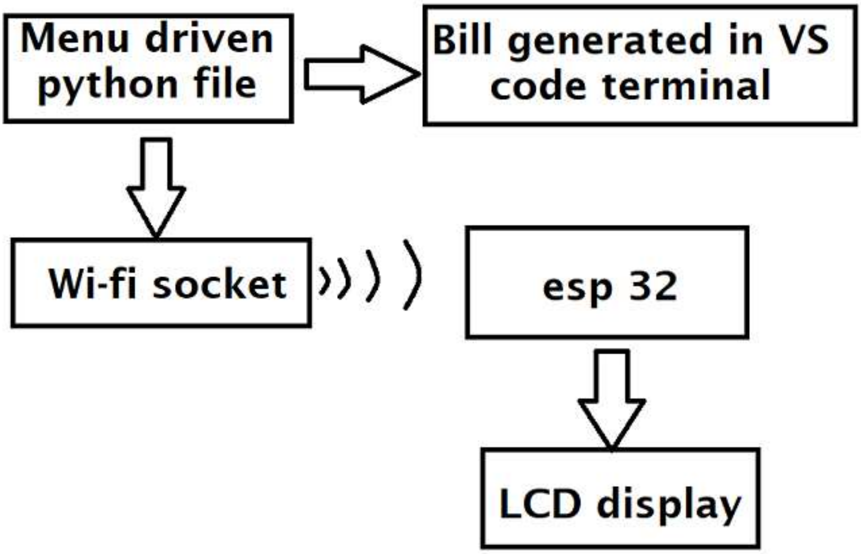

Figure 2. Birds eye view of the billing system

The diagram in Figure 2 above shows the schematic process of generating a bill from a menu-driven Python file to a bill generated in a code terminal and displayed as an output. The process begins with a menu-driven python file which has all the dataset of inventory items and the code for functions to perform after scanning the product. The connection between the Phone and ESP32 is through a Wi-Fi socket. The socket allows the python file to access the internet and retrieve data about items. It is taken care of by the ESP 32 module which has the built-in Wi-Fi functionality to connect to wireless networks and communicate with other devices over the internet. The ESP 32 allows the Python file to interact with the hardware, such as the LCD and the Wi-fi socket. And then the LCD is used to show the bill to the user. Furthermore, the system's application to a variety of areas, including retail and inventory management, is expanded with the addition of a droid cam for barcode scanning, with data transmission to the ESP32 and display on a mobile phone. Here we attach the computer executing the Visual Studio IDE with the ESP32 Wi-Fi module connected. Depending on the model of the barcode scanner, attach it to the ESP32 module either wirelessly or via a connected connection.

The process of generating a bill is as follows:

1 The user interacts with the menu-driven Python file.
2 The Python file generates a bill.
3 The bill is displayed in a code terminal and sent for display to the LCD module.
4 The image provides a good overview of the process of generating a bill using a menu-driven Python file. The image also shows the different components that are involved in the process.

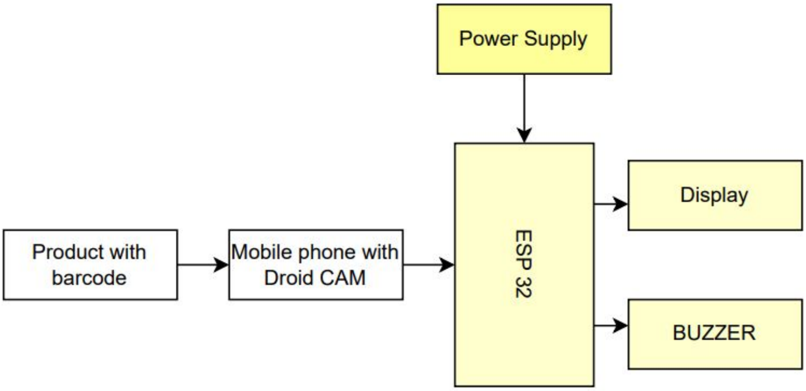

Figure 3. Hardware setup block diagram of the billing system.

The block diagram in Figure 3 shows the hardware required for the system to work. It shows how the product with a barcode is detected by a droid cam installed on a mobile phone. The system works as follows:

1. The product with the barcode is placed in front of the droid cam. The droid cam scans the barcode and sends the data to the ESP 32.
2. The ESP 32 decodes the barcode and sends the data to the mobile phone.
3. The mobile phone displays data of the product on display. The buzzer sounds to alert the user that the barcode has been scanned and the product has been added/removed.
4. This system can be used to scan barcodes in a variety of applications, such as retail, inventory management, and logistics.

3.2 Working of the Hand Gesture-Controlled System

The whole framework contains two principal parts: the hand control end and the cart control end. Programming configuration is executed on the Arduino module, while equipment modules are introduced on the cart and the control glove, working through the nRF24L01 remote module which is a wireless transceiver module used for communication. Information gathered by the ADXL355 three-hub disposition sensor concerning hand pose changes is communicated to the glove microcontroller for sifting and estimation. Simultaneously, Arduino coordinates with the the nRF24L01 chip. The control glove's nRF24L01 gets the sign and sends it to the cart microcontroller consisting of Arduino, which then changes the motor speed and direction as needed. The RF Receiver sends received serial data to the Decoder IC. The Decoder's function is to convert the serial data into parallel one and passed on to the motor driver IC. This data is acted upon, which sets the movement of the motors, and hence the cart moves in the desired direction.

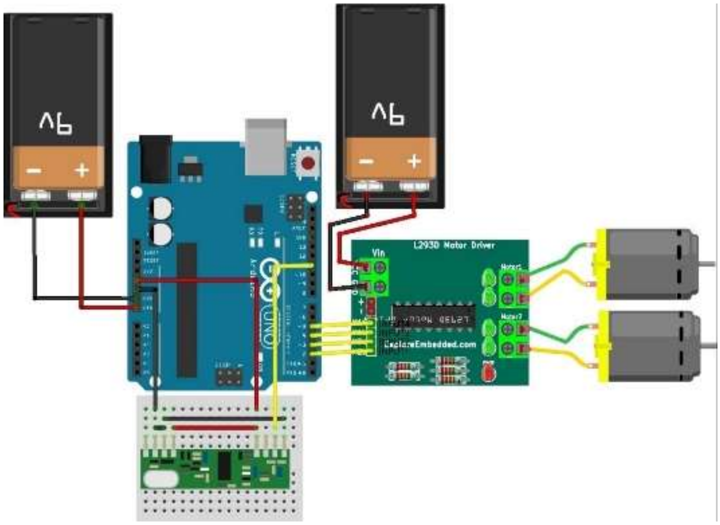

Figure 4. System circuit diagram of cart

Additionally, the infrared obstacle avoidance module helps control the vehicle from a distance. It turns on a blue warning light when the vehicle gets close to an obstacle, reminding the operator to take precautions.

As shown in Figure 4 we can see a system circuit diagram of the cart that has a billing system embedded in it. This cart, when receives a signal from the gesture control glove moves according to the gesture performed by the user in the said direction. It consists of an L293D motor driver that is attached to the wheels of the cart for the cart's movement.

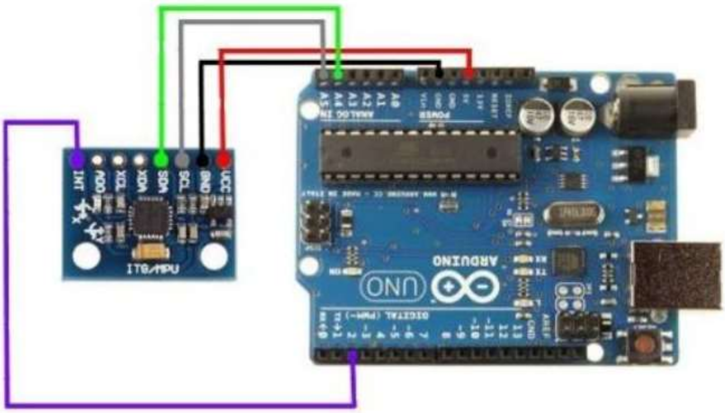

Figure 5. System circuit diagram of gesture glove

The diagram shown in Figure 5 illustrates the second system that of a gesture control glove for controlling the directions of the cart. It shows the interconnections between components in the circuit used to make the glove. It consists of an Arduino microcontroller that is used to receive the signal from the nRF24L01 module which gets the desired signal from the ADXL355 module that is responsible for predicting moment direction and speed. Additionally, a RF Transmitter, for transmitting signal to the Cart and a Power source is also connected to the circuit.

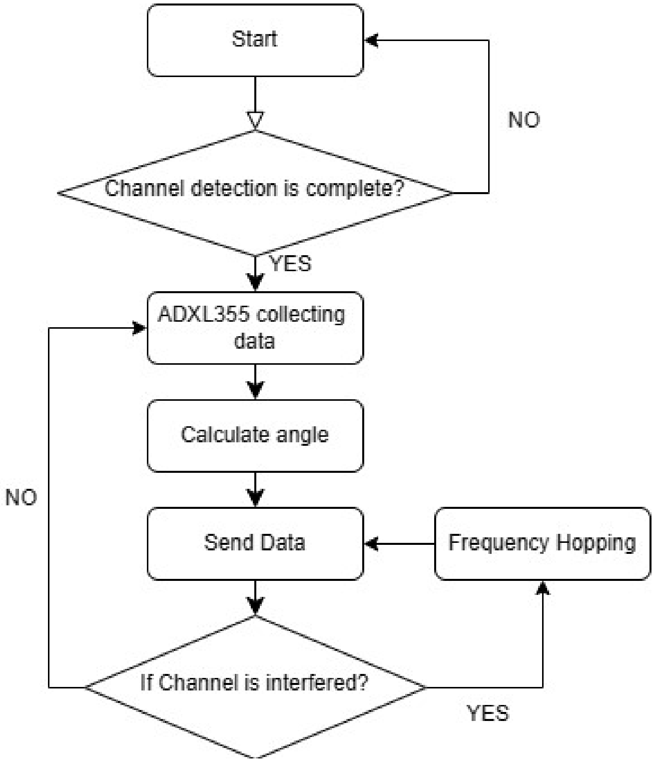

Figure 6. Software control of the gesture control glove

As shown in Figure 6, The hand control system works like this:

1 When the power is turned on, the framework fires up and checks assuming there's any recurrence adjustment.
2 On the off chance that there is, it gathers data about hand developments utilizing the ADXL355 module.
3 Then, it computes the point of hand movement utilizing the sensor's inside chip.
4 Next, it sends this point to the primary PC to check assuming there's a recurrence tweak. On the off chance that there isn't, it keeps gathering hand-development information. Assuming that there is, it continues to attempt to send the information until it goes through effectively.

Alongside it, Hand Gesture Controlled Cart can work in three parts.

1 Arduino receives data from the ADXL355 Sensor. After checking the predefined parameters, it is sent to the RF Transmitter.

2 The data sent by the Arduino and received by the RF transmitter, is required to be sent to Receiver on the cart. Data Decoding is done and appropriate signals are sent to the motor driver IC.
3 With this, the Wheel Motors of the Robot are activated. The accelerometer detects the motions horizontally and vertically and produces only constant analogue voltage levels. Comparator IC compares these voltages with the reference voltages. Variable resistors connected to the IC set the reference voltage. The values of these voltages are 1.7V and 1.4V.

4 Results and Discussion

The results demonstrate the successful implementation of an automated billing cart system using OpenCV for barcode detection and ESP32 for displaying the bill on an LCD display. The system proved to be accurate in detecting barcodes, ensuring that products were correctly identified and accounted for during the billing process. The real-time barcode detection capability of the system offers several benefits. It enables efficient tracking and management of products in the cart, eliminating the need for manual input or scanning of barcodes. This enhances the overall shopping experience by reducing waiting times at the checkout counter. The integration of the ESP32 microcontroller with an LCD display provides a user-friendly interface for customers to view their bills. The display presents the calculated bill in a clear and concise manner, ensuring transparency in the billing process. Additionally, the ESP32's computational capabilities enable fast and accurate bill calculation, enhancing the system's efficiency. The speed and efficiency of the system are crucial factors in ensuring a smooth and hassle-free shopping experience. The real-time barcode detection, coupled with rapid bill generation and display, minimizes customer waiting times at the billing counter, resulting in improved customer satisfaction and overall operational efficiency.

Figure 7. DroidCam scanning for product

The figure (as in Figure 7) above indicates that the DroidCam app is running. The text "111114" indicates that the barcode of the product that is being scanned is 111114. After successfully scanning the product, the text "Product detected" indicates that the barcode has been successfully scanned and decoded.

The image also shows a region of the barcode that is being scanned which is a UPC-A barcode, that is a common type of barcode that is used to identify products.

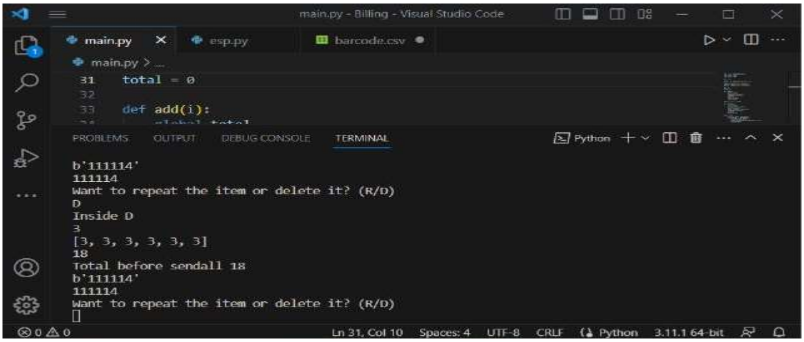

Figure 8. Add/Delete operation after scanning

The image in Figure 8 shows the item '111114' being detected and then displaying the product detail and option to add the item or delete it by performing the operations.

Figure 9. Working prototype of the device

In Figure 9, we see how the bill amount is generated after each scanning the product for updating and deletion of the item and displaying the final bill on the LCD.

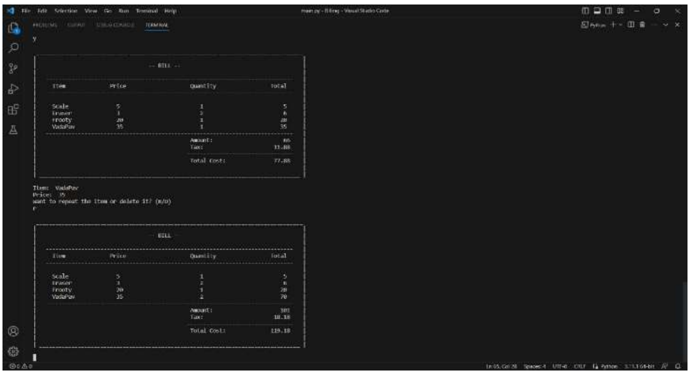

Figure 10. Generation of bill

The figure (as in Figure 10) above shows how the bill is generated on the computers terminal. This bill helps us keep a track of product that were added in the cart and how much do they cost. As a future scope, this feature can be used to send the bill directly on the users mobile phone using GSM module for communication.

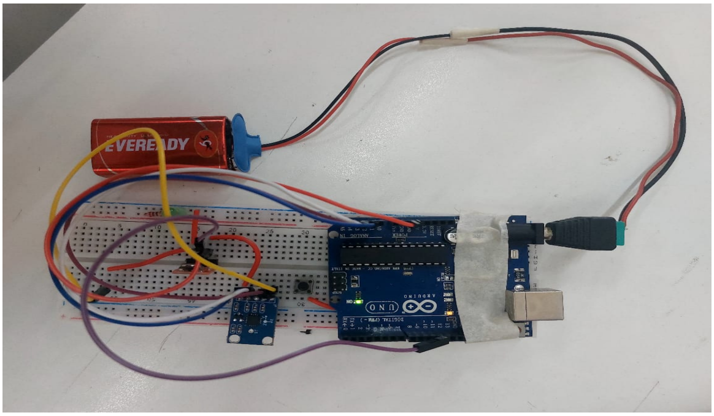

Figure 11. Control module for gesture analysis

In Figure 11, we have an RF transmitter module that is used to transmit a signal of motion to the Cart bot. The module has ADXL35 embedded in it which is used for acceleration purposes, gesture control and manoeuvre the cart according to the gesture performed with it.

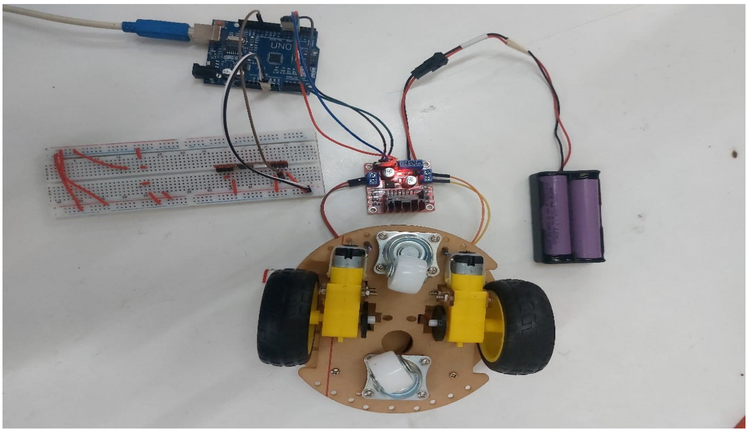

Figure 12. Smart cart consisting of RF receiver

In Figure 12, an RF receiver was used to receive signals from the transmitter module i.e. the gesture-controlled glove. Based on these signals the Cart performs the moments. The Cart bot has a billing system embedded in it, which makes it a wholesome Automated Billing Cart bot.

Considering the overall implementation of the project, the product has proven to be cost-effective, with development expenses amounting to Rs 2,500. When scaled for larger industries or malls, the cost per unit is expected to decrease proportionally, thereby enhancing its feasibility for businesses operating on a larger scale.

Implementing security measures against fraud in an automatic billing cart that operates based on hand gestures is crucial to ensure the integrity of transactions and protect both customers and businesses. We address the following issues for the product-

1 **Authentication and Session Management:** To protect the automatic billing cart from unauthorized use, robust user authentication and session management are crucial. Users should log in via mobile apps, RFID cards, or biometrics before accessing the cart. Additionally, secure session management should ensure that access is restricted after session timeout or conclusion, preventing unauthorized transactions and ensuring only verified individuals can use the cart.
2 **Real-Time Monitoring and Anomaly Detection:** Real-time monitoring and anomaly detection are essential for transaction integrity and cart operations. Maintaining detailed, secure transaction logs and using live surveillance with cameras or sensors ensure continuous oversight. Advanced anomaly detection algorithms can identify unusual patterns or behaviors, such as irregular gestures, to flag potential fraud in real-time.
3 **Secure Payment Processing and Encryption:** To prevent fraud, the billing cart should use end-to-end encryption for payment data and tokenization to replace sensitive information with unique tokens. These measures secure transactions and protect user data from breaches and unauthorized access.

The overall results achieved on various parameter of the cart bot is stated in Table 1.

Table 1. Test Results

Project	Response Time	Accuracy	Stability
Parameters	0.50 Sec	96.72%	94%

5 Conclusion

Overall, the results and discussion demonstrate the successful implementation and effectiveness of the automated billing cart system. The combination of OpenCV for barcode detection and ESP32 for displaying the bill on an LCD display offers an efficient and user-friendly solution for automated billing in retail environments. The Cart with further advancements in calibration can be precise and upto the point. The system's accuracy, real-time capabilities, speed, and efficiency contribute to streamlining the billing process and enhancing the overall shopping experience.

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