

Shopping Automation Techniques

Pushpavalli S¹, Bharath S², Aravinth Kumar P³, Krishnakanth M⁴

¹Assistant Professor, Department of Information Technology, Sri Manakula Vinayagar Engineering College of Engineering, Puducherry - 605107

²³⁴UG Students, Department of Information Technology, Sri Manakula Vinayagar Engineering College of Engineering, Puducherry - 605107

Abstract - A major task on which people are discovered investing conservative amount of energy and time nowadays is shopping. Convenient shopping experience has been a popular research topic due to the rapid growth of corporate companies and their market strategies. In the growing population and their daily needs, it is the most essential task to keep the sales high and shopping more convenient and innovative. Technological innovations in shopping overcome a lot of day to day challenges. This paper briefs about the challenges and advantages of various methods in shopping automation. The broad classification of existing methods is done. The main aim is to comprehensively study all the existing methods.

Key Words: Shopping automation, Billing, Retailing, Convenient shopping, RFID Shopping.

1. INTRODUCTION

The need for improvement or development of new technology has been coupled with an aim to reduce and make our day to day tasks less demanding, agitating and conserves time. Generally, most of the general population go through an hour or more on shopping every day.

Every people in the city goes to shop the daily needs of life such as food, clothing, electrical products etc. in the nearby shopping malls [1]. Almost all the weekends are spent on shopping at these malls. A large number of potential buyers choose to leave the shopping store on seeing a long queue or even after picking the products and not buying them eventually because they don't want to wait in that long queues.

We are witnessing Barcodes for many years and have been used by every departmental stores and supermarkets for managing purchases and keeping track of inventories. There are certain issues with the existing system of barcodes.

- Customers are not satisfied on waiting at longer queues [2]
- Requires lot of man power which is very expensive
- Orientation dependent

The advent of online shopping doesn't take away the in-person shopping completely because of the people's craze on visual shopping.

There have been various attempts which were carried out in the past to change the conservative and traditional shopping experience. There are numerous constructive frameworks for detecting the products, billing them and making payments radically. In this paper, we will discuss various technologies and methodologies to automate the troublesome offline retail shopping. The methods can be classified based on the technology and implementing methodologies. There is a major focus on reducing the lengthy queues.

As stated above, we investigated few technologies that aid in transforming conventional counter billing, following are the classification for this techniques and description of each one of them.

This paper is organized as follows. Section 2 presents various technologies on shopping automation, the comparative study of various techniques is detailed in Section 3. Finally, we discuss the research directives in section 4.

2. TECHNOLOGIES ON BILLING AND RETAILING

2.1 Radio Frequency Identification

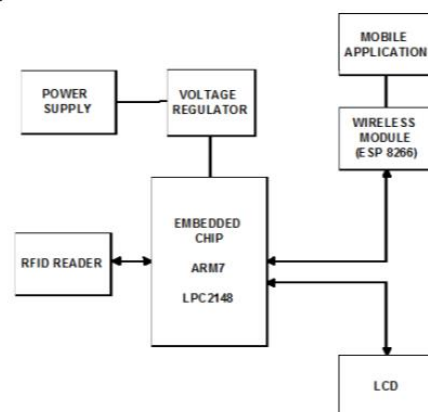


Fig -1: Automated Shopping and Billing System Using RFID [3].

System uses Radio Frequency Identification based trolley which scans every product placed in the trolley. The data about the products are shown in the display fitted for purchase confirmation. The trolley will be connected with the

customer mobile application through the Wi-Fi Module (ESP 8266). The application redirects to payment of the purchase. Information is eradicated from the microcontroller memory after the customer has finished purchasing and makes the trolley available for the next customer [3].

Trolleys are designed in such a way that it is fitted with an UHF RFID Reader. The reader initiate transmission signal, this signal will reach Circular Polarised (CP) antenna and start transmission. Trolley is scanned throughout which will give power to the RFID tag and that will induce current to power IC on the tag. The tag generates a signal with EPC code and sends the signal back to CP antenna. The received signal will provide product information that will be displayed in customer UI and helps in update inventory [4].

The developed system comprises of Billing and Inventory management unit (BIMU), Cart location detection unit (CLDU), User Interface and display unit (UIDU) and Server Communication unit (SCU). These units are integrated into a smart enclosed system. This smart shopping cart will reduce the checkout lanes to help the customers. The customers have to scan the items themselves. The total of products on shopping cart updated on the LCD screen [5].

2.2 Near Field Communication



Fig -2: Payment using Near Field Communication(NFC)

After picking of product, customer have to scan the corresponding QR code on the product using his/her mobile application. Now customer should create a wish list by adding the items. After confirming of the products in the wish list to buy, the bill will be generated using the mobile payment system using NFC technology. Customer should confirm the payment by clicking pay option from the mobile payment [6].

It introduces a smart basket cart and NFC membership card. The basket is activated by scanning the NFC membership card. Basket checks for any NFC tags of products. On reading a tag, basket keeps adding it to the purchase list. The end shopping option on the screen will generate the bill.

The data from the OLED is going to transfer to the billing counter computer through ESP8266 Wi-Fi module. The OLED allows customers to compare the total price with the budget in the pocket before billing. Purchase will be completed on paying cash at counter [7].

2.3 RFID AND ZIGBEE

This system proposes a Trolley which has a RFID reader and ZigBee Trans receiver installed on it. Every product in the shelves of the shop is fitted with a RFID tag on it. The products on placing in the trolley will send the purchase details to a Centralized Server System using the ZigBee module and the cart also displays Product Info, Expiry Date and Better Alternatives to customer. The payment of money will be an online payment procedure. It also includes a RFID reader at the exit door for anti-theft [8].

All products are tagged with RFID tags and the smart shelves in the store with RFID scanner will maintain the stocks. The tag has HMAC field which checks malicious modification on tag data and the cart has weight scanner which checks for tag tampered products. The cart will scan the products and send the data to counter using ZigBee. After billing, the status of product changed to "SOLD", this prevents theft at exit gate [9].

2.4 RFID AND RASPBERRY PI

Employing a Smart RFID cards which are attached to the products for their unique identification. The trolley will check for the RFID tags on the products and the LCD mounted on the trolley will display the data and total cost. If any item is removed, the total cost will be deducted. After complete purchasing, the customer has to press send key, this makes the raspberry pi to generate bill on the counter and SMS will be sent to user [10].

2.5 ANDROID APPLICATION

Products with barcode are scanned using the customer's android application which is designed by a specific retailing chain or company. Application will add products to purchase list and update the inventory by communicating with the biller system. The customer then proceeds with payment in the application and checkout with his product [11].

2.6 SENSORS

The shelves in the stores are configured with cameras and sensors. Sensors in the shelf rack will find whether the product is picked up by any customer. Sensors will find these by keep on monitoring the weight of the rack. Cameras will identify the customer who is picking up the product by using computer vision, and RFID tags will assist in the blind spots. Deep learning in the cameras will effectively identify the customers. Sensor fusion is used to enhance the data being collected by the system of cameras, RFIDs tags and readers throughout the store. The purchase is billed against customer's amazon pay account balance [12].

2.7 BARCODE READERS

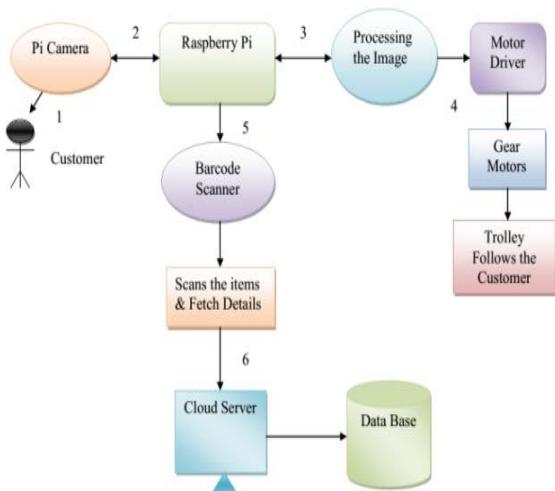


Fig -3: Automated Shopping Trolley for Super Market Billing System [14].

Each trolley is assigned a unique ID and the customer will be associated with that ID. Barcoded products are scanned using a barcode scanner in every trolley by himself. While the customer is scanning the barcode of the product, a picture of the product is taken by a camera on top of cart. The barcode and the cart ID are transmitted as two different fields by the sensor mote on the cart to the Base Station. Attendant-flag field is sent for staff assistance in case of discrepancy.

Base station will retrieve the product information from database for the barcode, update the inventory and generates the bill at the System UI. The captured image will be used if any customer skip scanning a product. Proceeding with the payment, shopping will get completed [13].

Trolleys are equipped with PI camera and it is assigned to a customer. Trolley will monitor the movements of the customer and move along with them with the help of motors. After picking the product, customer has to scan the product using barcode reader on the trolley. Raspberry pie will send the information about products being picked to the cloud. Checkout counter will get cleared by paying the bill to staff [14].

2.8 IMAGE PROCESSING

A real time application for automated billing is proposed. Database of images of all the unique products in the shop is fed to the system. System is trained to recognize the object more accurately by feeding Multiple images of same object by varying the scale and orientations.

Images are trained using Hybrid PCA-SIFT-FREAK algorithm. Camera on the checkout counter is fitted on top/ceiling having a wide noiseless coverage. Application will compare the captured image with the trained data on the database. Thus the image got recognized and billed for purchase.

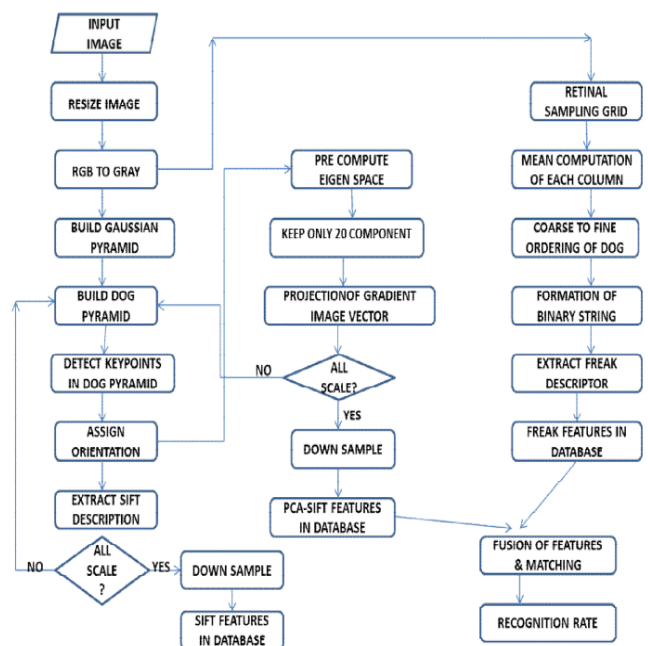


Fig -4: Hybrid PCA-SIFT-FREAK algorithm [15].

The system is also developed for simultaneous detection of multiple objects offering advantage over barcode based billing system [15].

3. SUMMARY

The methods discussed so far are listed in Table 1. The implementations of the methods are explained in brief along with the limitations.

Table -1: Classification of methods on shopping automation

METHOD	IMPLEMENTATION	LIMITATION
Radio Frequency Identification	Radiofrequency Identification based trolley can communicate with the billing system that is the Mobile Application [3].	The framework of RFID is considered to be expensive.

	Two Circular polarized antenna covers most of products on the trolley and use of Xerafy tags for easy detection [4].	Scanner may scan the products in the shelves and nearby trolleys.
	System consists of several units for each functions. They are Billing and Inventory management unit (BIMU), Cart location detection unit (CLDU), User Interface and display unit (UIDU) and Server Communication unit (SCU) [5].	1. Communication is not very secure 2. Another ZigBee module operating at the same frequency can easily interrupt the transmitted data
Near Field Communication (NFC)	Smart basket designed with NFC scanner will bill the NFC tagged products [6].	Expensive to adopt NFC system in every basket.
	Buyer can buy the items directly from his Android NFC empowered Mobile [7].	NFC payments are not secure as it can be easily hacked.
RFID and ZigBee	RFID products get billed and an anti-theft module is employed [8].	Installation cost increases by increase in number of carts.
	Smart shelves will maintain stocks and HMAC fields on tag checks for malicious RFID data modifications [9].	computational overhead at the smart cart side that reduces efficiency, and lack of security issues on ZigBee Communication.
RFID and Raspberry pie	RFID scanner fitted trolley will send the purchase details to billing system using the raspberry pie module [10].	Communication signals with the billing system may be interrupted with other signals.
Android application	Barcoded products are scanned and billed using mobile application, payment will be on the counter end [11].	No mechanism for legitimate billing as customers can easily.
Sensors	Computer vision and sensors will identify the purchase and bill it to the customer [12].	Huge installation cost.
Barcode Readers	Barcode is scanned by customer and the base station will generate bill and update inventory [13].	Similar to traditional billing at counter as it takes the same time.
	PI camera fixed trolley follows the customer and customer scans the products using barcode [14].	No changes are made in billing time.
Image processing	Billing is done by recognizing products by product images trained using Hybrid PCA-SIFT-FREAK algorithm [15].	Products get missed while product recognition. This causes loss to the shop.

4. RESEARCH DIRECTIVES

Automation on shopping provides endless scope for research ideas. The major problems, further to be considered in future are,

- Product recognition is one of the main hurdles in automating the shopping. Product identification methods are often associated with inaccuracy. Therefore, efficient method to recognise the products should be proposed to arrive at results more accurately.

- The classification of different products and brands plays a major role in identifying the product.
- Classifying products become an overhead in case of image processing methodologies.
- In case of RFID based detection, there is a huge disadvantage of placing the RFID scanner in the trolley due to their huge cost and installation issues. This can be overcome by installing the RFID scanner at the exit gate.
- In image based detection the occlusions due to orientations, light glare and other distortions causes

disturbances for product recognition. Therefore, they should be removed.

- Payment by NFC will have some trust issues. This can be overcome by introducing wallet technologies or by debiting bill amount directly from linked bank account.

5. CONCLUSIONS

Shopping in a more convenient and easy way is a wide range expectation by the consumers. The survey article is a brief study of various technological innovations on convenient shopping and related methods. The components and sensors used are analyzed such as RFID, NFC, barcode readers, etc. Various methods are comprehensively studied.

Implementation of these methods and their limitations are discussed. Future scope of this research topic is discussed as research directives. This paper broadly analyses, discusses and classifies wide range of smart shopping techniques.

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