Voice controlled shopping trolley navigation with RFID scanner and live billing using IoT

Praveen S1, Pugalenthiran V2, Jaraline Kirubavathy K3.
Department of ECE, KCG College of Technology, Chennai, Tamil Nadu, India.

Email: - jaraline.ece@kcgcollege.com

Abstract. The current process of shopping in a mall involves figuring out and navigating to required sections and either carrying a shopping basket or pushing around a trolley. Although it might not feel so but this is a time consuming and for some people, a physically demanding task. The other main disadvantage is having to wait in queues at the cashier and have the items billed in one by one. The proposed system is a Raspberry Pi based device integrated to traditional shopping trolleys. The desired section of the mall is given to it as voice input. Necessary signals are provided to a driver IC which drives the wheels of the trolley through motors towards the required section. The very moment an item is dropped into the trolley, it is scanned by an RFID reader module. The item details and total bill amount to the customer and live update is provided at the checkout through IoT.

1. Introduction
With all the technological advancements getting updated and becoming outdated by the hour, there is a need for constant innovation in every aspect of life. Shopping is a process which has never had any kind of technological advancements in quite some time.

The entire process of traditional shopping at malls is a very time consuming and a physically engaging process [4][16]. Having to figure out the layout of a mall and locate the required sections of it can not only be time consuming [13][18][20] but can also be misleading to the customer as the customer is usually made to navigate past items that are expensive, attractive and potentially not needed to reach the items that are actually needed[6][7][23]. At times the customers forget what was required by them in the first place and end up wasting too much time and money on items that are not needed[5][24].

As time passes and the trolley keeps getting filled, naturally it becomes heavier and harder to push [19]. At the end of procuring the required items, customers have to wait in usually long queues to get their items billed [3][12]. Since the cashier has to scan every single item of every single customer [1][14], it can prove to be a very demanding and an error prone task [2]. Technology is required in many instances [8] during the entire shopping process to benefit both the customer and the cashiers [25].

2. Literature survey
In shopping malls, RFID technology is also used for billing mostly during purchasing decision, and IoT is used for bill management through the ESP module. The payment details are getting to be sent to the server by which the central billing unit will affect the customer’s payment. The ESP module goes to be operating as a short-distance Wi-Fi chip for wireless communication. But there is a drawback which includes constraints like distance and interference. The server
goes to be busy if customers are high and internet connectivity should be stable for finishing the tactic. [7]

Sainath (2014) developed an automated supermarket trolley for a supermarket billing system, that uses barcode technology to scan goods. The bill is going to be forwarded to the central billing system where the customer can pay them by showing a singular id. The limitation of barcode scanning needs a line of sight for scanning and it ought to be fastened inside its boundary. [9]

Budic (2014) developed a cash register line optimization system using RFID technology. The system was developed for smart shopping using RFID. The RFID is employed for scanning products and also the info is kept within the database which will be paid online or during a central bill. It also uses an internet application to take care of entire shopping details. It requires the upkeep of an internet application server. No necessary steps are taken for the merchandise that's accidentally dropped into the trolley by the client. [10]

In Smart shopping trolley using RFID paper. They implemented a sensible way of a shopping trolley with RFID and Zigbee by which bill is generated by a scan of products within the reader and bill transmitted to central billing department by that bill could also be paid at the counter that would be a serious issue for the client. [11]

Prateek Aryan (2014) presented a smart shop cart with automatic billing and Bluetooth, which is a method for billing to be done while in a trolley and then uploaded to the user's Android device through Bluetooth. Every customer can't be expected to possess a Smartphone and Bluetooth can have connectivity issues and the range is a smaller amount. [15]

In Smart RFID-based Interactive Kiosk Cart using wireless sensor node paper, they used RFID technology for the smart automated shopping. They used a fanatical website for billing maintenance and for user interaction. Every user with a singular id accesses the webserver for the bill payment and invoice information. Internet service is mandatory during this sort of service, therefore the method could fail thanks to internet instability and server error issues may additionally occur due to high load. [17]

Vinutha (2014) built an automatic billing with server end employing RFID technology for shopping and automatic billing. This scans product by frequency identification then the bill is generated at the server finish that's then communicated to the client. This needs server maintenance and internet connectivity each for the client and shopkeeper. [21]

Smart handcart with customer-oriented service by Hsin-Han Chiang (2016), established a thought of an automatic billing system and programmed shopping trolley where they used face recognition for client authentication. It's not an easy straightforward method as face recognition of shoppers throughout shopping hours won't be easy and proper as malls are often crowded. Many errors are potential whereas using recognition for authentication. [22]

3. Methodology
The proposed system primarily aims to automate the existing shopping process as much as possible. A smart device is fitted to a traditional trolley. The device takes the customer’s required section of the store or mall as voice input. As per the input, the trolley automatically moves towards the desired section, eliminating the need to push the trolley while searching for the needed section. Whenever an item is dropped onto the trolley, it is scanned and updated in the trolley’s audio output and also at the designated billing system at the cashier. When an item is removed from the trolley, it is removed from the live bill both in the trolley and the billing computer.

The many advantages of this system like automation of trolley movement, voice input, automatic billing and updation make this a very practical and efficient way to shop.

4. Implementation
The various technologies, software and hardware used in the implementation of the prototype include Raspberry Pi, Wi-Fi module, Bluetooth module, RFID Reader and tags, driver IC, Motors with battery power supply, IOT, headset for audio output, Python to code and program the trolley.
The very first step in this approach to shopping is to give the trolley the desired section of the store as a voice input. This is done through an app on the phone as it is much more convenient than bending down to the trolley and speaking out the command. This voice command is sent to the device’s brain, Raspberry Pi through Bluetooth.

Once the command is received by the Raspberry Pi, it gives out an audio acknowledgement and then sends the instructions to the driver IC to power the motors attached to the trolley’s wheels and navigate to the desired section. The directions are pre-programmed using python to the Raspberry Pi using the layout of the store. Once the trolley reaches the destination, a prompt is given to the user to point them to the precise shelf where the required item is kept.

The entire process is based on the fact that every item in the store is RFID tagged. When the customer drops the item to the trolley, the RFID reader scans the item’s RFID tag and gives out a voice prompt informing the customer of the details of the item dropped in the trolley and the total bill amount. In case of removal of any item, the action is recorded and the item gets removed from the live bill which also provides a voice prompt for the same action. Simultaneously the same details are being updated at the billing section at designated billing lane’s billing computer online, thereby implementing IOT to make shopping better.

On completion of shopping, the customer can check out at the designated counter for the trolley after making the payment for the bill which was created in real time during the entire duration of the purchase.

There are numerous advantages to the proposed system like,

- Ease of shopping
- Convenient way to find the required items
- Automation of trolley thereby minimizing physical involvement only to drop items inside the trolley
- Live billing
- Time and energy saving approach
- Practicality
- Ease of installation and maintenance

![Block diagram](image)
Figure 2. Prototype

Figure 3. Flow chart
Python is installed in the Raspberry PI. This Main program is coded in python and this will control all modules which are connected to the Raspberry PI.

```
if (str(rf.T99) == "chocolate") or (str(rf.T98) == "chocolate")
  print("Looking")
  "* * * * " + "HELLO NIKHIL NO ME NOW" + " * *")
  time.sleep(1)
  os.system("espeak " + ""HELLO NIKHIL ME NOW" + "")
while True:
  with open("/dev/motor_control") as f:
    motor = f.read().strip()
    os.system("espeak " + ""HELLO NIKHIL ME NOW" + "")
```

**Figure 4. Main Program**

Python is installed in the Raspberry PI. This Main program is coded in python and this will control all modules which are connected to the Raspberry PI.

Raspberry PI is a series of small single board computer. It is a Quad-core 64-bit ARM Cortex A53 clocked at 1.2 GHz. It is used to get the input from RFID reader and gives the output to driver IC, Node MCU, headset and IOT.

**Figure 5. Raspberry PI**
Figure 6. Bluetooth

The Bluetooth module has a GFSK modulation and the sensitivity is ≤-84dBm at 0.1% BER. It is used to get input (which product customer wants) from the mobile phone.

Figure 7. RFID Reader

EM-18 RFID Reader is used to select the products and remove the products.

Figure 8. L293D Driver

L293D Driver is used to control the motors. It will get the input from the Raspberry PI and it gives the output to the motor.
Figure 9. DC Motor

DC Motor is used to move the trolley from one location to another. It get the output from the L293D Driver.

Figure 10. Node MCU

Node MCU is a SDIO 2.0, SPI, UART and it has a 32-pin QFN package. Integrated MAC/baseband processors. It is used for billing the products. It get the input from the Raspberry PI (which products the customer selected) and it gives the output to the billing counter.

5. Output

IoT Monitoring and Controlling System

We can bill the products automatically with this output and it is a time saving process and also the customers no need to wait in the bill counter.
6. Conclusion
The proposed system doesn’t just focus on current difficulties in shopping like the physical requirement of pushing a trolley or long queues at the billing section, but also aims to make innovative advances using technology to make the entire shopping experience a short but efficient one. The system is also very practical and even helpful for physically challenged people equally as it is useful for any other customer. In the growing age of technology, there isn’t a place in the world that lacks the need to be updated and technologically improved. By using the various technologies like IOT, Cloud and RFID, the project aims to technologically advance the process of shopping as far as possible. The result of the project is not just to help the customer save time and shop efficiently but also cover all aspects of shopping like eliminating long queues at the billing section, reducing the cashier’s work, increasing the number of customers at the mall etc. Furthermore, this alternative to traditional shopping does not prove to be harmful for the environment and does not contribute in any type of pollution. In fact, the energy source used is electric batteries, which can be recharged and reused several times. Considering the very negligible cons of the project (Need to recharge the batteries), the many advantages make this a perfect solution to the problem that is the method of traditional shopping.

References
[1] M. R. Mane, N. G. Amane, S. D. Patil, and A. L. Lakesar, “Electronic shopping using barcode scanner,” Int. Res. J. Eng. Technol., vol. 3, no. 4, pp. 1–5, 2016
[2] D. N. Sanjay and S. Pushpalatha, “All-in-one intelligent shopping trolley with automatic billing and payment system,” Int. Res. J. Eng. Technol., vol. 4, pp. 59–62, Jul. 2017.
[3] M. A. Lambay, A. Shinde, A. Tiwari, and V. Sharma, “Automated billing cart,” Int. J. Comput. Sci. Trends Technol., vol. 5, pp. 148–151, Mar./Apr. 2017.
[4] S. Jadhav, S. Kamath, S. Yadav, A. Rajput, and P. K. S. Sakure, “Smart shopping application using NFC,” Int. Res. J. Eng. Technol., vol. 5, no. 3, pp. 1521–1524,
D. Choi, C. Y. Chung, and J. Young, “Sustainable online shopping logistics for customer satisfaction and repeat purchasing behavior: Evidence from China,” Sustainability, vol. 11, no. 20, p. 5626, 2019.

Dr. P. Muthukannan, Anupriya Asthana, “Automatic Retail System Using RFID”, Volume 1, Issue 5, October 2013, International Journal of Advance Research in Computer Science and Management Studies.

D. Budić, Ž. Martinović, D. Simunić, “Cash register lines optimization system using RFID technology”

Satish Kamble, Sachin Meshram, Rahul Thokal, Roshan Gakre, “Developing a Multitasking Shopping Trolley Based on RFID Technology” , International Journal of Soft Computing and Engineering (IJSCE) ISSN: 2231-2307, Volume-3, Issue-6, January 2014

Sonali J. Mane “An Automated Shopping cart using RFID” International Journal of Engineering Science and Computing, Vol. 8 Issue No.4, April 2018

J. Thangakumar “Automated Shopping Trolley for Super Market Billing System” International Journal of Computer Applications (0975 – 8887) in 2014.

Dhavale Shraddha D, Bhokane Trupti J, Shinde Priyanka S “IOT Based Intelligent Trolley for Shopping Mall” International Journal of Engineering Development and Research, Volume 4, Issue 2, 2016

Ria Singh, Satyam Varma, “RFID and IR based Smart Shopping Cart Management System”, 2018 International Conference on Advances in Computing, Communication Control and Networking (ICACCCCN), 01 July 2019

K P Vidya, K M Swathi, D Chaitra, S H Jayalakshmi, M V Manoj Kumar, H R Sneha, Likewin Thomas, B H Puneetha “Virtual Cart: Novel Approach for Revamping Smart Shopping Experience”, 2018 IEEE Distributed Computing, VLSI, Electrical Circuits and Robotics (DISCOVER), 28 March 2019

Vinutha M L, Harshitha P Bale, Sushma R, Suchitra M “SHOPPING AND AUTOMATIC BILLING USING RFID TECHNOLOGY”, International Journal Of Electronics And Communication Engineering & Technology (IJECET), Volume 5, Issue 8, pp. 132-138, 2014

Mr.P.Chandrashekar,Ms.T.Sangeetha “Smart shopping cart with automatic billing system through RFID and ZIGBEE” ISBN No: 978-1-4799-3834-6/14, 2014 IEEE

Hsin-Han Chiang, Wan-Ting You, Shu-Hsuan Lin “Development of smart shopping carts with customer-oriented service”, IEEE International Conference on System Science and Engineering (ICSSE), 2016

Megha R. Mane1, Nilam G. Amane2, Sunita D. Patil3, Archana L. Lakesar4, “Electronic Shopping Using Barcode Scanner”, International Research Journal of Engineering and Technology (IRJET), Volume: 03 Issue: 04 | Apr-2016.

B. N. Arathi and M. Shona, “An Elegant Shopping using Smart Trolley” India Journal of Science and Technology, Vol. 10, Issue 3, Jan 2017.

Vrinda Gupta, Niharika Garg, Analytical Model for Automating Purchases using RFID-enabled Shelf and Cart, 2014

J.C. Narayana Swamy, D. Seshachalam, Saleem Ulla Shariff “Smart RFID based Interactive Kiosk cart using wireless sensor node”, IEEE International Conference on Computation System and Information Technology for Sustainable Solutions (CSITSS), 2016

Komal Ambekar, Vinayak Dhole, supriya sharma, Tushar Wadekar “Smart Shopping Trolley Using RFID” International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 4 Issue 10, 2015

V. Lobo, R. Prabhu, Polu Bal Kumar Reddy, International Journal of Innovative
Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8, Issue-11S2, September 2019

[24] Ramya P, Aravind C, Mouriya N, Pavithra S “Smart shopping for visually impaired using RFID” International Journal of Information And Computing, Volume 6, Issue 3, March 2019 ISSN NO: 0972-1347, Volume 6, Issue 3, March 2019.

[25] Lakshmi Narayanan, Dhanya Sudhakaran, Subhika Grandhe, Namra Iqbal, Jimcymol James “A Deep Learning Enabled Smart ShoppingCart”, Biosc.Biotech.Res.Comm. Special Issue Vol 13 No 13 (2020) Pp-247-251.