SMART BASKET

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ABSTRACT

Supermarkets have become an integral part of our lives, where we purchase our daily necessities. However, the checkout process at supermarkets can often be time-consuming and frustrating due to long queues and delays caused by manual scanning of products. In this context, we present a smart basket that aims to reduce chain delay in supermarkets. Our smart basket incorporates modern and cost-effective technologies such as image recognition to make it intelligent and time-saving.

In recent years, technology has been rapidly advancing, and there has been a growing need to automate processes to improve efficiency and reduce delays. With this in mind, we have developed a smart basket that utilizes image recognition technology to enable self-egress at supermarkets. The smart basket has an in-built camera that captures images of the products placed inside the basket, which are then processed using image recognition algorithms to identify the products.

The smart basket uses a combination of image recognition and billing technology to reduce the time taken at checkout counters in supermarkets. When a customer places an item in the basket, the camera installed on top of the basket captures an image of the product, which is then processed using image recognition algorithms to identify the product. Once the product is identified, the corresponding price is added to a running total, which is displayed on a screen attached to the side of the basket. At the end of the shopping trip, the customer can make payment at a self-checkout counter without having to scan each product manually, thereby reducing chain delay in the supermarket.

In conclusion, the smart basket presents a promising solution to the challenges faced by traditional checkout systems in supermarkets. The use of image recognition technology enables customers to self-egress, reducing chain delay and improving the overall shopping experience.

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INTRODUCTION

Grocery shopping is an essential task for every household. However, it can often be time-consuming and tiring. In recent years, technology has played a significant role in making grocery shopping more convenient and efficient. One such technology is the smart basket, which is capable of recognizing products placed inside it using image recognition module and generating a bill in real-time. This paper aims to discuss the current systems used in grocery shops and how this smart basket can be beneficial in the context of India.

Currently, most grocery shops use a manual billing system where the cashier manually enters the products and their prices into the billing software. This system is not only time-consuming but also prone to errors. Moreover, it requires a skilled workforce to operate, which can be a challenge in India due to the shortage of skilled labour in the retail sector.

In recent years, some grocery shops have started using barcode scanners to scan the products and generate bills automatically. However, this system has its limitations as it requires the products to have a barcode, which may not be available in all products. Moreover, the barcode scanning process can be slow and may cause delays at the checkout counter.

The smart basket is an innovative solution that has the potential to revolutionize the grocery shopping experience in India. One of the key benefits of using a smart basket is the efficiency it offers. By using image recognition technology, it can recognize products placed inside it and generate bills automatically in real-time, significantly reducing the time required for billing. This can lead to faster checkout times, reducing the waiting time for customers. Another significant advantage of the smart basket is its accuracy.

The image recognition technology used in the smart basket is highly accurate and can identify products even if they do not have a barcode. This can eliminate errors in the billing process, reducing disputes between customers and the shop owners. Moreover, the smart basket is cost-effective, as it does not require a skilled workforce to operate. This can make it easier for small grocery shops to adopt this technology and compete with larger retailers. Additionally, the smart basket can provide information about the products, such as their nutritional value and ingredients, making it easier for customers to make informed decisions. This convenience can further enhance the overall shopping experience for customers.

In conclusion, the smart basket is an innovative solution that can revolutionize the grocery shopping experience in India. It can significantly reduce the time required for billing, eliminate errors, and make grocery shopping more convenient and personalized. Moreover, it can also reduce the cost of operations for grocery shops, making it easier for small retailers to compete with larger retailers. Therefore, the smart basket has the potential to transform the grocery shopping industry in India and improve the overall shopping experience for customers.

LITERATURE REVIEW

[1] Galande Jayashree, Rutuja Gholap, Priti Yadav on "RFID based Automatic billing trolley" year -2015,publication – IJETAE:

Galande Jayshree, Rutuja Gholap, and Preeti Yada developed an RFID-based automatic billing trolley in. With this model, the system comprises of an RFID reader and goods found in malls that have RFID tags attached to them. When a customer places any item in the cart, the RFID reader will read the item's code and record the price of the item in memory. Wireless RF modules at the billing counter will communicate the whole bill data to the computer.

[2] D. Mohanapriya, R. Mohamed Anas, P. Nandhini, N.M. Deepika, "Design and Implementation of Smart Basket Cart Using Near Field Communication", Department of Electronics and Communication Engineering, Jay Shriram Group of Institutions, Tirupur, Tamil Nadu, India

The authors developed a smart basket cart using OLED, display, Arduino Uno R3, a wifi module, NFC tag, a power supply. This smart basket will use NFC to pinpoint the product rate and send the data wirelessly to the receiver. Then the data is sent to the main server and the bill is generated for all the products in the cart.

[3]. Mr.Yathisha L, Abhishek A, Harshit R, Drashal Koundinya on "Automation of shopping cart to ease queue in malls by using RFID", year-2015, publication- IRJET.

the authors "Mr. Yathisha L, Abhishek A, Harshit R, Darshan Koundinaya " proposed a model robotization of shopping wain to ease line in boardwalk by using RFID module and Zigbee module. In this system we're using RFID markers rather of bar canons, whenever a client puts a product into a trolley, it'll get checkup by RFID anthology and product price and it'll be displayed on the TV. We're using Zigbee transmitter which is used to transfer the data to the main pc.

[4]. Jadhav Rahul, Pradeep, Nandkumar, Tarali Shivkumar "RFID based Automated billing trolley", year -2015, publication – IJSRD.

the authors " Jadhav Rahul, Pradeep, Nandkumar, Tarali ShivkumarJ " proposed a model of RFID grounded automated billing trolley. In this technology, the communication is in between RFID label and anthology, each label has glamorous strip with specific law and label is read by RFID Reader module. The automated billing system grounded on the unresistant RFID provides suitable result to the homemade billing system in shopping boardwalk.

[5] L.K. Hin, "Radio-Frequency Identification for Library: Bookshelf. Department of Electronic Engineering" , City University of Hong Kong, 2007.

the authors " Udita Gangwal, Sanchita Roy, Jyotsna Bapat " proposed a system of smart shopping wain for automated billing purpose using wireless detector networks. In this paper authors describing the perpetration of a dependable, fair and cost efficient shopping card using wireless detector networks.

[6] Z.N. Chen and X. Qing. "Antennas for NFC Applications". Institute for Infocomm Research, Singapore. ISBN 978-1-4244-4885-2. 2010.

the authors "Kalyani Dawkar, Shraddha Dhomae, Samruddhi Mahabaleshwarkar " proposed a model of electronic shopping wain for effective shopping grounded on RFID in which a system correspond of smart trolley will have RFID anthology, TV display. When the person puts a product in trolley it'll overlook and the cost, name and expiry date of the product will be displayed.

[7] Ms Kalyani Mohod, Ms Shivani Devkar, Ms Vijaya Goswami, Ms Neha puri, Prof. Ashish R Zade. "Smart basket for efficient billing in Su[ermarket". Department of Electronics and Telecommunication Engineering G.H. Raisoni Institute of Engineering and Technology, Nagpur

The authors proposed a model of smart basket with OLED display and RFID reader on the shopping trolley which will read the product information through the RFID tag attached to the product and displays it on the OLED screen. With this system customer will have the information about price of every item that are scanned in, total price of the item and also brief about the product.

[8] Jadhav Neha, Joshi Geeta, Kandhare Rachana, Mane Pratiksha, Prof. Dr. M .C. Hingane " Design And Implementation Of The Smart Shopping Basket Based On Iot Technology"

The authors proposed a model named "Smart Shopping Cart System" that will save the track of items which are bought and figure the bill utilizing RFID peruser and Transmitter and Receiver. The framework will likewise give ideas to items to purchase dependent on client buy history from a brought together framework. In "Smart Shopping Cart System" each item in Mart will be appended with RFID tag, and each Trolley will have RFID Reader, LCD show and Transmitter and beneficiary connected to it.

[9] Kursheed B, Mohana I N, Kavya A, Kishan S, Medhini B Hegde, "SMART SHOPPING BASKET USING RFID", Electrical and Electronics, Engineering, Sri Venkateshwara College of Engineering, Bengaluru, India

The authors proposed a smart basket system which can be controlled using a mobile application. The basket consists of the Bluetooth module to connect with the user's smartphone through which the basket's movements are commanded over. The basket also avoids coming in contact with any obstacles that it faces by taking deviation while following its user using ultrasonic sensors. Each product the user puts inside the basket is read using RFID technology, where each data is sent to the supermarket's server for a total billing of items the user wishes to buy. The total bill amount is sent to the user installed application so that customer can use any online payment applications available to complete his payment.

[10] Talreja Sahil, Pendharkar Arjun, Madur Srushti, Mohammad Saad Nalband, Pragati Mahale, "Smart Basket : The Modern era IoT application", Information Technology, B.E AISSMS's Institute of Information Technology, Pune, Maharashtra, India

The authors proposed a system during pandemic time consider the COVID-19 situation and the crowded situation in grocery stores. They proposed a smart basket using Arduino and RFID. Using Arduino and RFID tag customer gets a final bill through the web app which gives a list of products scanned by the smart basket. The customer can remove the products which he further wishes to eliminate from his basket and delete the item from the final bill in the web app which can result in savings too. This smart basket also reduces manpower as the traditional method of buying the products involves a long time, with RFID tag the same thing is performed in a modern way.

[11] - Mohammad Nadeem, Prashant Verma, "SMART SHOPPING CART FOR CONTACTLESS SHOPPING", Department of Computer Science & Engineering, SRM Institute of Science & Technology.

The authors have proposed a model a contactless smart shopping cart which necessitates the use of integrated electronic hardware which include LCD monitor, Arduino, RFID and power supply attached to a shopping cart. The data is then sent to the main processor, where the commodity is either inserted or removed from the cart. Instead of spending time in long lines, we should use it for more productive tasks.

[12] - PROF. MONALI A. GURULE, KALYANI N. GULVE, "IOT BASED SMART CART BILLING SYSTEM", Department of Computer Engineering, Sandip Foundation, India

The authors of the paper introduced a model iot based smart cart billing system which consist of barcode scanner, microcontroller, display & trolley unit. The customer will be able to delete unwanted items from the shopping list by use of a toggle switch.

[13] Sethakarn Prongnuch, Suchada Sitjongsataporn, Patinya Sang-Aroon, "Low-cost Smart Basket Based on ARM System on Chip Architecture: Design and Implementation"

The authors of the paper proposed system of low-cost smart basket which is based on an ARM system on chip architecture using Raspberry Pi single board computer. The authors applied kansei engineering and form follows function theory to develop the product design

[14] S.K. Shankar, Balasubramani S, S Akbar Basha, Sd Ariz Ahamed, N Suneel Kumar Reddy, Smart Trolley for Smart Shopping with an Advance Billing System using IoT

The paper titled "Smart Trolley for Smart Shopping with an Advance Billing System using IoT" presents a solution for enhancing the shopping experience. The authors propose the use of a smart trolley equipped with IoT technology and an advanced billing system. The smart trolley is designed to keep track of the items placed in it and calculate the total bill automatically. The authors suggest that this solution will improve the shopping experience by reducing checkout times and eliminating the need for manual billing. The integration of IoT technology in the smart trolley will also provide valuable data to retailers, helping them improve their operations and make better business decisions. The authors conclude that the use of smart trolleys with an advanced billing system is a step towards the future of smart shopping.

[15] Sakorn Mekruksavanich, "Design and Implementation of the Smart Shopping Basket Based on IoT Technology"

The paper "Design and Implementation of the Smart Shopping Basket Based on IoT Technology" by Sakorn Mekruksavanich focuses on the design and implementation of a smart shopping basket using Internet of Things (IoT) technology. The author presents a smart basket that can keep track of the items placed in it and calculate the total cost automatically. The basket is equipped with weight sensors, RFID technology, and a microcontroller that allows it to communicate with a central database. The author suggests that this technology will improve the shopping experience by reducing checkout times and increasing efficiency. The author also highlights the potential benefits of using smart baskets in retail stores, including the ability to gather data and improve operations. The paper provides a comprehensive overview of the design and implementation of the smart shopping basket and demonstrates its potential as a practical solution for enhancing the shopping experience.

[16] Samuel Fosso Wambaa,b, Abhijith Anandb , Lemuria Carterc, "RFID Applications, Issues, Methods and Theory: A Review of the AIS Basket of TOP journals".

https://www.sciencedirect.com/science/article/pii/S2212017313002016?ref=pdf_download&fr=RR-2&rr=798eb6132e5fb2a5

This paper provides a review of the current research and advancements in RFID technology, covering its applications, challenges, methods, and theories. The authors reviewed articles from the "AIS Basket of TOP journals" to provide an overview of the field. The paper concludes by highlighting future research directions for improvement.

[17] Fatah Chetouane, An Overview on RFID Technology Instruction and Application, IFAC-PapersOnLine, Volume 48, Issue 3, 2015, Pages 382-387, ISSN 2405-8963,

The paper "An Overview on RFID Technology Instruction and Application" provides a comprehensive overview of RFID technology and its applications. It covers the basics of RFID technology, its components, and the various types of RFID systems. The paper also discusses the applications of RFID in various fields such as supply chain management, inventory control, and asset tracking. The author concludes by highlighting the potential of RFID technology for future development.

[18] Kamran AHSAN, Hanifa SHAH, Paul KINGSTON, "RFID Applications: An Introductory and Exploratory Study"

The paper "RFID Applications: An Introductory and Exploratory Study" provides an introduction to RFID technology and its applications. The authors present a study on RFID applications and explore the potential benefits and limitations of the technology. The paper covers the use of RFID in various fields such as retail, healthcare, and supply chain management. The authors conclude by highlighting the need for further research and development of RFID technology.

[19] DAVINDER PARKASH, TWINKLE KUNDU, PREET KAUR, " THE RFID TECHNOLOGY AND ITS APPLICATIONS: A REVIEW".

The paper "THE RFID TECHNOLOGY AND ITS APPLICATIONS: A REVIEW" provides a comprehensive overview of RFID technology and its applications. The authors present a review of RFID technology, including its components, types of systems, and potential benefits. The paper also covers the applications of RFID in various fields such as supply chain management, healthcare, and retail. The authors conclude by highlighting the potential for future growth and development of RFID technology.

[20] ACHRAF HAIBI, KENZA OUFASKA, KHALID EL YASSINI, MOHAMMED BOULMALF AND MOHSINE BOUYA, "Systematic Mapping Study on RFID Technology".

The paper "Systematic Mapping Study on RFID Technology" presents a systematic mapping study on RFID technology. The authors provide an overview of the current research and advancements in RFID technology, including its applications and challenges. The paper covers the use of RFID in various fields such as supply chain management, healthcare, and retail. The authors conclude by highlighting the potential for future growth and development of RFID technology and the need for further research.

[21] Ag. Asri Ag. Ibrahim; Kashif Nisar; Yeoh Keng Hzou; Ian Welch, "Review and Analyzing RFID Technology Tags and Applications".

The paper "Review and Analyzing RFID Technology Tags and Applications" provides a review of RFID technology and its applications. The authors analyze the different types of RFID tags and their applications in various fields such as supply chain management, healthcare, and retail. The paper highlights the benefits of RFID technology and the potential for future growth and development. The authors conclude by calling for further research and development of RFID technology.

[22] Kwangho Jung, Sabinne Lee, " A systematic review of RFID applications and diffusion: key areas and public policy issues"

The paper "A systematic review of RFID applications and diffusion: key areas and public policy issues" provides a systematic review of RFID technology and its applications. The authors discuss the key areas and public policy issues surrounding the diffusion of RFID technology. They cover the use of RFID in various fields such as supply chain management, healthcare, and retail. The authors conclude by highlighting the potential benefits of RFID technology and the need for further research and development in the field.

[23] Neethi S, Pooja K Shanbhag, Prathibha K, Risaalat Jorjes, Dr. H S Guruprasad, "A STUDY ON RFID BASED APPLICATIONS".

The paper "A Study on RFID Based Applications" presents a study on RFID technology and its applications. The authors provide an overview of RFID technology and its various applications in fields such as supply chain management, healthcare, and retail. The paper highlights the benefits of RFID technology and the potential for future growth and development. The authors conclude by calling for further research and development of RFID technology.

[24] Hegadi, Ravindra. (2010). Image Processing: Research Opportunities and Challenges.

The paper "Image Processing: Research Opportunities and Challenges" by Ravindra Hegadi provides a comprehensive overview of the field of image processing. The author discusses the various research opportunities and challenges in image processing and highlights the importance of image processing in various fields such as computer vision, medical imaging, and remote sensing. The paper provides insights into the future developments and trends in image processing and the potential impact on various industries.

[25] Nolen, Craig M., et al. "Large-scale automated identification and quality control of exfoliated and CVD graphene via image processing technique." ***ECS Transactions*** **33.13 (2010): 201.**

The paper "Large-scale automated identification and quality control of exfoliated and CVD graphene via image processing technique" presents a study on the use of image processing techniques for large-scale automated identification and quality control of exfoliated and chemical vapor deposition (CVD) graphene. The authors discuss the use of image processing techniques to analyze the characteristics of graphene and its potential applications in various fields. The paper highlights the importance of image processing techniques for the efficient and accurate identification and quality control of graphene.

[26] Lee, Sangwook. "Automated defect recognition method by using digital image processing." ***Proceedings of the 46th Annual International Conference by Associated Schools of Construction (ASC)*****. 2010.**

The paper "Automated defect recognition method by using digital image processing" presents a study on the use of digital image processing for automated defect recognition. The author discusses the use of digital image processing techniques to analyze the characteristics of defects and improve the efficiency of the defect recognition process. The paper highlights the potential benefits of digital image processing for construction applications, including improved accuracy and cost savings. The author concludes by calling for further research and development of digital image processing techniques for construction applications.

[27] Kirchner, Matthias, and Jessica Fridrich. "On detection of median filtering in digital images." ***Media forensics and security II*****. Vol. 7541. SPIE, 2010.**

The paper "On detection of median filtering in digital images" by Matthias Kirchner and Jessica Fridrich presents a study on the detection of median filtering in digital images. The authors discuss the impact of median filtering on digital images and the methods for detecting its use.

The paper highlights the importance of detecting median filtering for image analysis, forensics, and security applications. The authors conclude by presenting a new method for detecting median filtering and its potential for improving the accuracy of image analysis and security.

[28] Rocha, Anderson, et al. "Vision of the unseen: Current trends and challenges in digital image and video forensics." ***ACM Computing Surveys (CSUR)*** **43.4 (2011): 1-42.**

The paper "Vision of the unseen: Current trends and challenges in digital image and video forensics" by Anderson Rocha et al. provides an overview of current trends and challenges in digital image and video forensics. The authors discuss the state of the art in digital image and video forensics, including recent developments and emerging trends, and identify key challenges and limitations. The paper highlights the importance of digital image and video forensics for a variety of applications, including law enforcement, intelligence, and legal proceedings. The authors conclude by calling for further research and development in this field.

[29] Ekwaro-Osire, S., et al. "Performance of a bi-unit damper using digital image processing." ***Vibro-Impact Dynamics of Ocean Systems and Related Problems*** **(2009): 79-90.**

The paper "Performance of a bi-unit damper using digital image processing" by S. Ekwaro-Osire et al. investigates the performance of a bi-unit damper using digital image processing. The authors examine the behavior of the damper under different loading conditions and use digital image processing to analyze the resulting vibration patterns. The paper presents results from experiments and digital image processing analysis, and highlights the potential of using digital image processing in the study of the performance of dampers. The authors conclude by discussing the implications of their results for the design and optimization of dampers.

[30] Mittal, Sparsh, Saket Gupta, and Sudeb Dasgupta. "FPGA: An efficient and promising platform for real-time image processing applications." ***National Conference On Research and Development In Hardware Systems (CSI-RDHS)*****. 2008.**

The paper "FPGA: An efficient and promising platform for real-time image processing applications" by Sparsh Mittal, Saket Gupta, and Sudeb Dasgupta discusses the use of Field-Programmable Gate Arrays (FPGAs) for real-time image processing applications. The authors argue that FPGAs offer several advantages over traditional processing platforms, including increased processing speed, reduced power consumption, and greater design flexibility. The paper presents results from experiments that demonstrate the feasibility of using FPGAs for real-time image processing, and highlights the potential for further research in this area. The authors conclude by emphasizing the importance of FPGAs for real-time image processing applications, and their potential for advancing the field.

[31] Jan, J. "Signal and Image Processing for Interdisciplinary Biomedical Technology Tuition." ***Proc. int. conf. ICEE*****. 2009.**

The paper "Signal and Image Processing for Interdisciplinary Biomedical Technology Tuition" by J. Jan presents a tutorial on signal and image processing techniques for interdisciplinary biomedical technology. The paper provides an overview of the key concepts and techniques in signal and image processing, with a focus on their application in the field of biomedical technology. The paper covers topics such as image representation, image enhancement, image compression, image segmentation, and image analysis. The author emphasizes the importance of interdisciplinary collaboration in developing new technologies for biomedical applications. The paper is intended to serve as a useful resource for students and researchers in the fields of biomedical technology and signal and image processing.

[32] Gupta, Abhilekh, et al. "Image processing methods for the restoration of digitized paintings." ***Science & Technology Asia*** **(2008): 66-72.**

The paper by Gupta et al. focuses on image processing methods for restoring digitized paintings. The authors discuss various techniques such as color correction, denoising, and inpainting, and analyze their effectiveness in preserving the original quality and details of the artwork. The paper concludes that image processing is an important tool for the preservation of cultural heritage.

[33] Luo, Congbo, Yunhui Hao, and Zihe Tong. "Research on Digital Image Processing Technology and Its Application." ***2018 8th International Conference on Management, Education and Information (MEICI 2018)*****. Atlantis Press, 2018.**

The paper "Research on Digital Image Processing Technology and Its Application" by Luo, Hao and Tong presents a study on the state of the art digital image processing technology and its various applications. The authors analyze the latest advancements and discuss the potential future trends in the field.

[34] Zhang, Lina, Lijuan Zhang, and Liduo Zhang. "Application research of digital media image processing technology based on wavelet transform." ***EURASIP Journal on Image and Video Processing*** **2018 (2018): 1-10.**

The paper focuses on the application research of digital media image processing technology based on wavelet transform. The authors, Lina Zhang, Lijuan Zhang, and Liduo Zhang, present their findings on the utilization of wavelet transform in processing images and its benefits for digital media applications.

[35] Saha, Sangeet, Satyabrata Maity, and Suman Sau. "A brief experience on journey through hardware developments for image processing and its applications on Cryptography." ***arXiv preprint arXiv:1212.6303*** **(2012).**

The paper provides a brief overview of the journey of hardware developments in image processing and its applications in cryptography. It highlights the use of image processing technology in the field of cryptography to enhance security and improve the processing time.

[36] He, Defu, and Si Xiong. "Image Processing Design and Algorithm Research Based on Cloud Computing." ***Journal of Sensors*** **2021 (2021): 1-10.**

The paper "Image Processing Design and Algorithm Research Based on Cloud Computing" by He and Xiong (2021) focuses on the design and implementation of image processing algorithms using cloud computing technology. It aims to analyze the feasibility and advantages of cloud computing in image processing and explores its potential for improving the efficiency and scalability of image processing applications.

[37] Zelelew, H. M., A. T. Papagiannakis, and E. Masad. "Application of digital image processing techniques for asphalt concrete mixture images." ***The 12th International Conference of International Association for Computer Methods and Advances in Geomechanics (IACMAG)*****. 2008.**

The paper discusses the application of digital image processing techniques for analyzing asphalt concrete mixture images. The authors present the results of a study on the use of image processing to analyze the mixture images, and describe the benefits and limitations of this approach. The paper was presented at the 12th International Conference of International Association for Computer Methods and Advances in Geomechanics.

[38] Kumar, Vinay, and Manas Nanda. "Image Processing in Frequency Domain using Matlab®: A Study for Beginners." (2008).

The paper by Kumar and Nanda provides a comprehensive study on image processing in the frequency domain using MATLAB, aimed at beginners in the field. The authors focus on the basic concepts and techniques used in frequency-based image processing and provide practical examples to illustrate their applications.

[39] Smart Shopping cart *G Shanmugavadivel , Dr. B Gomathy - January 2019*

The Internet of Things is poised to revolutionize the way we shop. By attaching a low-cost RFID tag to each item, a shopping cart equipped with RFID devices can automatically sense and generate a bill for the items in the cart, eliminating the need for customers to wait in long checkout lines. The system can also be connected to smart shelves equipped with RFID sensors to monitor inventory and communicate with a central server. An additional RFID reader is placed at the store's entrance to track the items entering and exiting the store. This system not only enhances the shopping experience for customers but also makes maintenance and future upgrades easy and cost-effective. The aim of this effort is to identify the requirements for a robust shopping system, test the proposed model, and develop a secure communication protocol to make the system practical.

[40] Automatic billing system for shopping cart based on RFID tag *Kirubasankar K, M Ezhilmaran, Kokila H, Hemalatha S - January 2023*

The number of people purchasing groceries in supermarkets is on the rise. At the billing counter, customers often have to wait for a few minutes to get their bill and complete the payment process. The current system relies on barcode scanning to process the purchase. The proposed system aims to save customers time at the checkout by allowing them to purchase their desired products in a relaxed manner. The system makes use of RFID technology, which does not require a line of sight to scan the product and can track multiple items at once. The RFID reader attached to the shopping cart and the RFID tags on each product, within range, send signals to the reader, which wirelessly updates the shopping list on the server and the cart screen. The customer can see the updated bill each time they add or remove items from the cart. Payments can be made through cash or online payment methods.

[41] Smart Supermarket billing system using python *Mrudul Padole, Apurva Gupta, Ayush Kumar, Vitthal Gadekar, Prof S R Patil - April 2021*

The proposed shopping system uses Internet of Things (IoT) technology with RFID tags and devices to create an efficient and user-friendly shopping experience. The RFID tags on items and the RFID reader on the shopping cart allows for easy billing without the need for customers to wait in long lines. Smart shelves equipped with RFID sensors monitor inventory and communicate with a central server. Another RFID reader at the store entrance tracks the items entering and exiting. This system is designed to be cost-effective, easy to maintain, and upgradeable in the future. The goal is to build a model that tests the system's functionality and establish secure communication to make it practical for use.

[42] Smart Cart For Automatic Billing With Integrated Rfid System *Shaik Farhan Shahnoor, Ravi Kumar, Manish Rathore, Shivashish Saha – January 2021*

A new automated smart shopping system is proposed to address issues with traditional billing in supermarkets. This system uses RFID technology by embedding inexpensive RFID tags in products. When products are placed in a smart cart, the cart reads the tags and generates a bill, eliminating the need for customers to wait in line at the checkout. The system also helps maintain social distancing and validate purchased items at checkout.

[43] Smart Shopping trolley based on RFID *Bhagyashree, Kavya, Vijaylaxmi, Sushma, Prof. Shravan Kumar – June 2022*

This project aims to improve the shopping experience by reducing the time spent by customers at the billing counter. It proposes to implement an automatic billing system using RFID technology, where customers can scan the products in the trolley and receive the final bill amount. Payment can be made through a pre-recharged customer card provided by the shop. The information will be sent to the central computer of the shopping mall.

[44] Deep learning for Retail product recognition: challenges and techniques *Yuchen Wei, Son Tran, ShuxiangXu, Byeong Kang, Matthew Springer – July 2020*

The process of identifying products and waiting in line at checkout in retail stores is a common experience. The development of automatic product recognition has important implications for both economic and social progress, as it is more efficient and reliable than manual operations. Image-based product recognition is a challenging task in computer vision, but has great potential applications, including automatic checkout, stock tracking, compliance with store displays, and assistance for the visually impaired. In recent years, deep learning has seen great advancements in image classification and object detection. This paper aims to provide a comprehensive overview of recent research on the use of deep learning in retail product recognition. The review covers the key challenges in deep learning for this task and discusses potential techniques that can be used. The available public datasets for deep learning are also discussed, as well as the current progress and future perspectives of the field.

[45] Smart Shopping system for billing Automation *Vatsalya Singhi , Kayalvizhi Jayavel – January 2017*

The current trend in the information age is to digitize data and create efficient and user-friendly systems to simplify people's lives. The development of a smart shopping cart that can handle instant billing is a step towards a more automated and convenient shopping experience. Shopping in large grocery stores, which can be time-consuming and tedious, can be improved by automating the billing process. The smart cart consists of a portable computing device, such as a Raspberry Pi, and an automatic product identification technology, such as RFID. The main objectives of this intelligent cart are to provide instant billing without long lines and to track expenses in real-time. The goal of this project is to reduce the time spent on shopping for everyday items and to make the process less tedious, giving consumers more time to focus on other important tasks.

[46] Automatic Billing system by using artificial intelligence *Prof. Rajkumar Patil, Alim Bahadur, Abhinandan kandekar, Shubham Koli, Sridhar Bosge – April 2021*

In recent years, automated billing systems in supermarkets have been introduced and have had a significant impact on traditional shopping methods. During the current pandemic situation, contact-free shopping is of utmost importance and unmanned billing has a crucial role to play. The aim of this paper is to explore the automation of the supermarket billing process. Conventional methods such as barcode scanning and RFID are used in the billing process, but they have certain limitations. A new approach is proposed in this work to overcome these limitations. Artificial intelligence-based object detection can be utilized in billing automation as it is faster, more accurate, and more cost-effective than traditional methods.

[47] A literature Review on improving error accuracy and range based RFID for smart shopping *Paxal Shah, Jasmine Jha, Nirav Khetra, Manmitish Zala – January 2015*

This paper provides information about the implementation of IoT (Internet of Things) technologies such as sensors, protocols, and application problems. It focuses on the latest developments in RFID, smart sensors, communication technologies, and protocols to enable applications without human interference. The paper surveys current scenarios in product identification and provides a comprehensive summary of available technologies and research. The pros and cons of each method and issues in research are discussed. The relationship between IoT and smart product identification is explained, as well as RFID range and accuracy problems related to product identification.

[48] IOT Based Smart shopping system *Ayuti Ashok Algur, Rituja Nandakumar Gavade, Sayali Sudam Kundale, Ashwini Mohan Kurkute, Yogita V Sawant – May 2020*

This study suggests a solution for improving the shopping experience in supermarkets and general stores using a "just walk out" technology powered by Raspberry Pi. The traditional shopping process in these establishments often includes waiting in long billing lines, but the proposed technology aims to eliminate this inconvenience. The system can be applied to shopping centers like Dmart, Big Bazaar, Walmart, and supermarkets, with the goal of making shopping easier and more enjoyable for customers.

[49] Implementation of smart shopping cart using RFID *Nilesh Unde, Shankar Shinde, Abhishek Thombre, Satish Suryavanshi, Harshada Mhaske – November 2015*

This paper proposes an automatic billing system for supermarkets using RFID and Bluetooth communication modules. Each product will have an RFID tag and shopping carts will have a Product Identification Device with a microcontroller, LCD, RFID reader, EEPROM, and Bluetooth module. The system reads the product information via the RFID reader and sends it to the central billing system through the Bluetooth module, which calculates the total amount to be paid. The aim of the project is to reduce queues and crowds in shopping malls and supermarkets.

[50] SHOPIFY the smart shopping cart *Alfida PP, Aromal Suresh, Bagio Babu, Mariya Eldho, Dr. Siddharth Shelly – June 2019*

The project "SHOPIFY" is designed to make shopping easier by creating a smart shopping cart that can generate a bill automatically. The cart has an RFID reader and LCD screen that displays the price of the products added to the cart. The customer can remove products and the price will be adjusted accordingly. At the end of shopping, the customer can press a button to get the total bill. The bill can also be sent to the customer's registered mobile phone through GSM technology with a link for payment. The cart can move automatically using an obstacle detection system and line follower. This system is aimed to reduce man power and improve the shopping experience for customers by reducing shopping time.

[51] Smart shopping cart using machine vision along with machine learning *Rakshit Shetty, Darshana Pawar, Rishika Poojari, Ritvik Patel, Dr. Jyoti Mali – October 2021*

This research focuses on using machine vision, a crucial and growing technology in the current computing world, to enhance the Internet of Things (IoT) by exchanging information. The potential applications of machine vision are vast, spanning from healthcare to transportation and more, including smart shopping. As people of all ages are becoming increasingly attracted to electronic devices, this research aims to improve the shopping experience by saving customers time through a digital billing system for shopping carts. By incorporating object recognition along with machine vision, the aim is to maximize the shopping experience in supermarkets.

[52] Smart shopping cart for automated billing purpose using wireless sensor networks *Udita Gangawal, Sanhita Roy, Jyotsna Bapat*

This paper presents the implementation of a reliable and cost-effective Smart Shopping Cart using Wireless Sensor Networks for use in supermarkets. The system aims to automate the billing process and enhance the shopping experience for customers, reducing wait time in lines. It also detects cases of deception by dishonest customers, making the system fair and appealing to both buyers and sellers. The system design and experimental results are described, showing that the approach is feasible for real-world deployment with the use of repeaters in appropriate locations within supermarkets.

PROPOSED METHODOLOGY

We have tried out different algorithms to find the most efficient algorithm that will be the best fit for our model, we have analysed how each algorithm works and got some good results from each algorithm.

The first proposed methodology for a smart basket uses image recognition and SIFT algorithm which aims to improve inventory management in grocery stores and supermarkets. By using a camera or sensor to capture images of products placed in the basket, the algorithm can extract features and match them with known products in a database, utilizing techniques such as KNN flann matcher, dimensionality filtering, and colour filtering to improve accuracy. The proposed methodology has the potential to reduce human error in inventory management and increase efficiency in retail environments. Here is the detailed steps that is involved behind the model:

1. **Image capture:** A camera or a sensor in the smart basket captures an image of the products that are placed inside it.
2. **Image processing:** The captured image is pre-processed to remove noise and enhance the contrast.
3. **Feature extraction:** SIFT (Scale-Invariant Feature Transform) algorithm is used to extract the features from the pre-processed image. The steps involved in the SIFT algorithm are as follows:

a. **Scale-space extrema detection:** The scale-space representation of the image is created using the Difference of Gaussian (DoG) algorithm. Local extrema are detected in this scale-space representation.

b. **Key point localization:** The key points are localized in the scale-space extrema by fitting a quadratic function to the nearby extrema.

c. **Orientation assignment:** An orientation is assigned to each key point by creating a histogram of gradient orientations in the local neighbourhood of the key point.

d. **Key point descriptor:** A descriptor is created for each key point by considering the gradient magnitudes and orientations in the local neighbourhood of the key point.

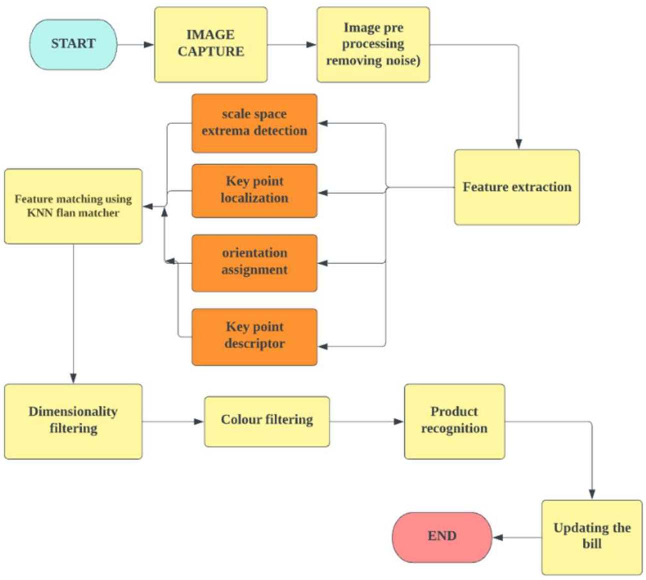
4. **Feature matching**: The extracted features are matched with the features of the known products in the database using KNN (K-Nearest Neighbours) flann (Fast Library for Approximate Nearest Neighbors) matcher. This matcher is a fast approximate algorithm that can handle large datasets efficiently.

5. **Dimensionality filtering:** To improve the accuracy of the feature matching, dimensionality filtering is performed. This involves reducing the dimensionality of the feature descriptors using Principal Component Analysis (PCA) before matching.

6. **Colour filtering:** Some grocery products may have similar shape and texture features, but different colours. Therefore, a colour filtering technique is used to differentiate between different products. This involves extracting the colour information from the image and using it as an additional feature in the matching process.

7. **Product recognition:** The extracted features and colour information are compared with the features of the known products in the database. The product that has the closest match is identified and its name is displayed on the smart basket.

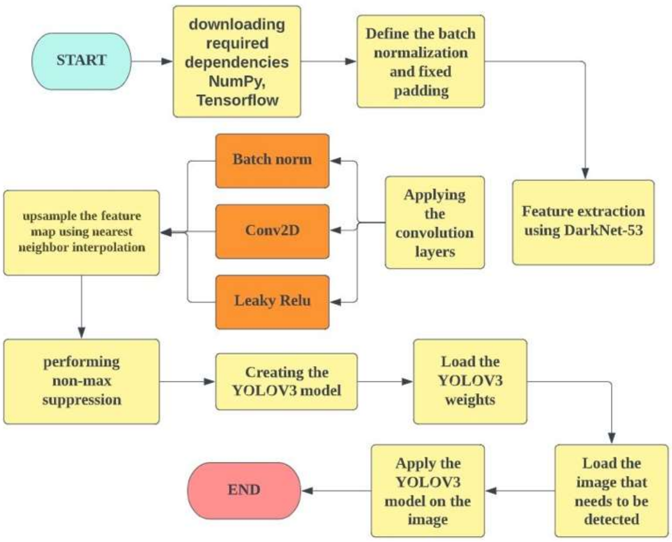
8. **Updating the bill:** The bill is updated to reflect the addition of the identified product.



architecture diagram for SIFT algorithm

The second algorithm that we had implemented was a modified version of the yoloV3 algorithm, YOLOv3 (You Only Look Once version 3) is a real-time object detection algorithm used for computer vision tasks, particularly in the area of autonomous systems such as self-driving cars and drones. It was introduced in 2018 as an improvement to the previous version, YOLOv2, by incorporating a number of changes to the underlying architecture and training process. YOLOv3 uses a single neural network to simultaneously perform object detection and classification on a given image, allowing it to run in real-time on resource-constrained devices such as small IoT devices or mobile devices.

The first step in the proposed system is to train the YOLOV3 model on a dataset of images. This involves using an annotated dataset of images to train the model to recognize objects of interest. The YOLOV3 model is trained using a deep neural network, which allows it to learn from large datasets and generalize to new images. Once the YOLOV3 model is trained, it can be used for object detection in real-time. The proposed system will use a camera to capture images of the environment and apply the YOLOV3 model to detect and track objects in the images. The YOLOV3 algorithm processes the entire image at once, predicting the class and bounding box coordinates of all objects in the image in a single forward pass.



architecture diagram for yoloV3 algorithm

The third algorithm we implemented is TFOD API which is used for object detection. The TensorFlow object detection API is a platform for building deep learning networks that can accurately identify and locate objects in images or videos. The API provides a framework for creating such networks, and it also includes a set of pre-trained models, referred to as the Model Zoo. These models are already trained on large datasets such as COCO, KITTI, and Open Images, and can be used for inference tasks when working with categories that are present in these datasets.

IMPLEMENTATION RESULTS AND DISCUSSION

The experimental results and discussion section of the proposed system for a smart basket provides a critical evaluation of the effectiveness and accuracy of the algorithm. We first look at the results obtained by the first algorithm (SIFT).

We first load the scene image from the dataset,

```
#Load Scene
scene_img = cv2.imread('/content/Product-Recognition-on-Store-Shelves/scenes/e1.png', cv2.COLOR_BGR2RGB)

#Plot Scene
plt.figure(figsize=(20, 10))
plt.imshow(cv2.cvtColor(scene_img, cv2.COLOR_BGR2RGB));
```

We now load the model images from the dataset,

```
In [74]: #Load Model
model_img = cv2.imread('/content/Product-Recognition-on-Store-Shelves/models/0.jpg', cv2.COLOR_BGR2RGB)

#Plot Model
plt.figure()
plt.imshow(cv2.cvtColor(model_img, cv2.COLOR_BGR2RGB));
```

Checking SIFT descriptor for feature extraction,

```
In [82]: print("Number of model descriptors: ", len(des_model))
print("Dimensionality of a SIFT descriptor: ", des_model[0].shape)
print("Type of the descriptor: ", des_model[0].dtype)

Number of model descriptors:  8044
Dimensionality of a SIFT descriptor:  (128,)
Type of the descriptor:  float32
```

```
In [83]: def Matching(Model_Descriptors, Scene_Descriptors, Treshold = 0.45, k=2):
    FLANN_INDEX_KDTREE = 1

        # Defining parameters for algorithm
    index_params = dict(algorithm = FLANN_INDEX_KDTREE, trees = 5)

        # Defining search params.
        # checks=50 specifies the number of times the trees in the index should be recursively traversed.
        # Higher values gives better precision, but also takes more time
    search_params = dict(checks = 50)

        # Initializing matcher
    flann = cv2.FlannBasedMatcher(index_params, search_params)
        # Matching and finding the 2 closest elements for each query descriptor.
    matches = flann.knnMatch(Model_Descriptors, Scene_Descriptors, k)
        #defining an array containing all the matches that results to be considered "good" matches applying a certain treshold
    good = []
    for m,n in matches:
        if m.distance < Treshold * n.distance: #  if m.distance/n.distance < Threshold:
            good.append(m)

    return good
```

Checking if we found enough matches and drawing the matches on the image,

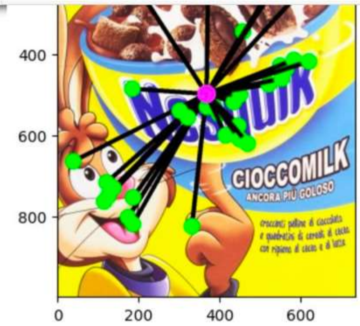
```
In [85]: # Checking if we found enough matching
MIN_MATCH_COUNT = 30
print(len(good))
if len(good)>MIN_MATCH_COUNT:

    # building the corrspondences arrays of good matches
    src_pts = np.float32([ kp_model[m.queryIdx].pt for m in good ]).reshape(-1,1,2)
    dst_pts = np.float32([ kp_scene[m.trainIdx].pt for m in good ]).reshape(-1,1,2)

    # Using RANSAC to estimate a robust homography.
    # It returns the homography M and a mask for the discarded points
    M, mask = cv2.findHomography(src_pts, dst_pts, cv2.RANSAC, 5.0)

    # Mask of discarded point used in visualization
    matchesMask = mask.ravel().tolist()

    # Corners of the query image
    h,w = model_img.shape[:2]
    pts = np.float32([ [0,0],[0,h-1],[w-1,h-1],[w-1,0] ]).reshape(-1,1,2) # myc: these are the 4 corners of the query image

    # Projecting the corners into the train image
    dst = cv2.perspectiveTransform(pts,M) # myc: you project the corners by using the homography. M is the homography

    # Drawing the bounding box
    scene_img = cv2.polylines(scene_img, [np.int32(dst)],True, (0, 255, 0), 3, cv2.LINE_AA)

else:
    print( "Not enough matches are found - {}/{}".format(len(good), MIN_MATCH_COUNT) )
    matchesMask = None

156
```

```
In [86]: # Drawing the matches
draw_params = dict(matchColor = (0,255,0), # draw matches in green color
                   singlePointColor = None, # not draw keypoints only matching lines
                   matchesMask = matchesMask, # draw only inliers
                   flags = 2) # not draw keypoints only lines
img3 = cv2.drawMatches(model_img, kp_model, scene_img, kp_scene, good, None, **draw_params)
plt.imshow(cv2.cvtColor(img3, cv2.COLOR_BGR2RGB))
plt.show()
```

Drawing bounded boxes using robust homography, for single product detection,

```
In [100]: for j in scenes_to_test:
    plt.imshow(cv2.cvtColor(final_scene_images_with_bb[j], cv2.COLOR_BGR2RGB))
    plt.show()
    print_result(e_results, j)
```

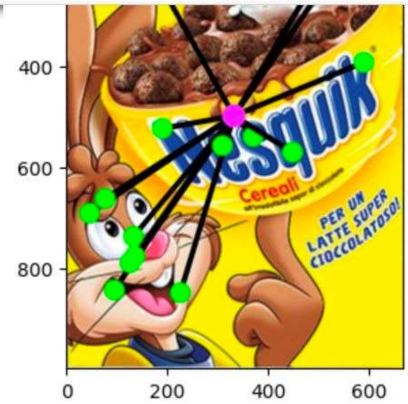
For multiple product detection we are defining this function to find model centre of different images and store it in a dictionary model_image_features



```
Number of Key point found :  39
```

```
Number of Key point found :  12
```

```
Number of Key point found :  0
```

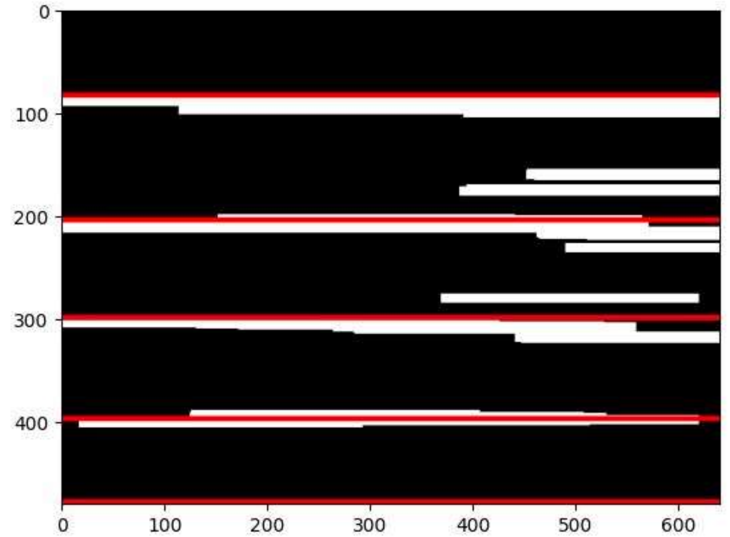


```
Number of Key point found :  16
```

```
In [112]: for j in scenes_to_test:
              plt.imshow(cv2.cvtColor(m_final_scene_images_with_bb[j], cv2.COLOR_BGR2RGB))
              plt.show()
              print_result(m_results, j)
```

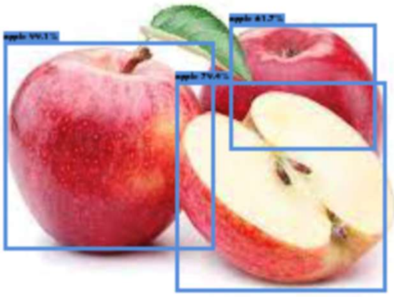
```
Product 0 - 0 instance/s found:
Product 1 - 0 instance/s found:
Product 11 - 0 instance/s found:
Product 19 - 0 instance/s found:
Product 24 - 2 instance/s found:
Product 25 - 1 instance/s found:
```

For products that are in the shelves,

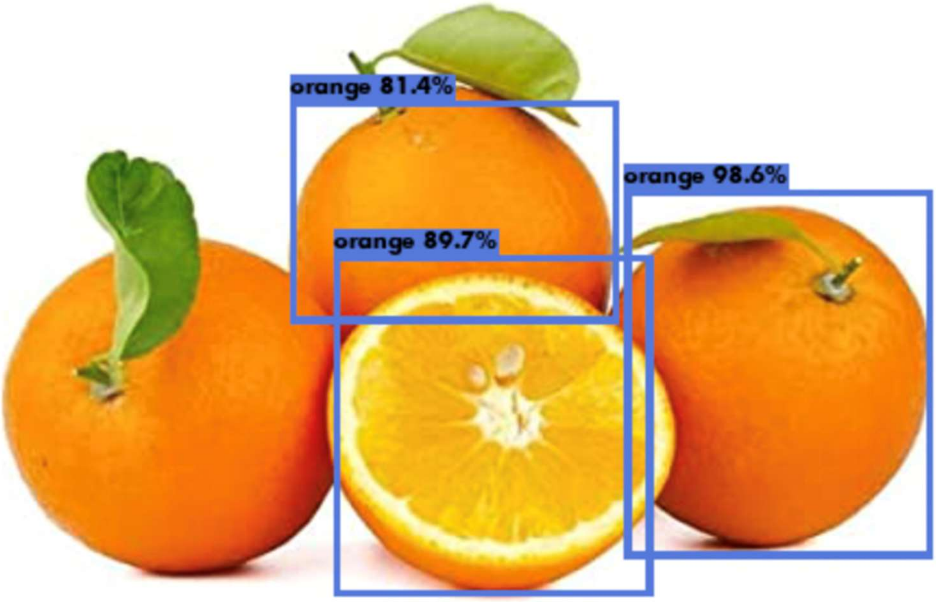


Here are the results obtained by the second algorithm, which the yoloV3 algorithm.

We give the dataset different product images like oranges, apples, toothbrush and scissors.

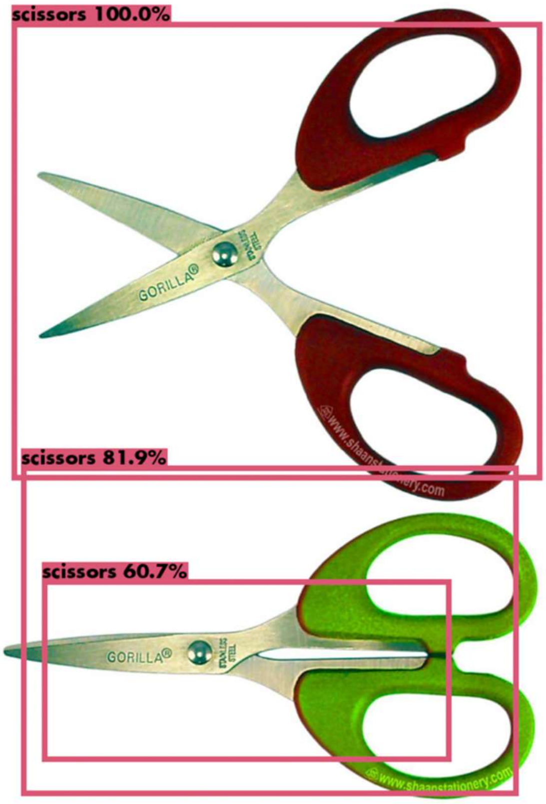


```
61.65405511856079
apple 61.7%
```




```
81.35052919387817
orange 81.4%
```


scissors 83.2%
GORILLA
Euro Quality
No.1
Brand
genuine
GS-004/36
5 Years warranty
Extra
Ideal for
Office,
School,
Home,
etc.
SCISSORS
NEW
Www.ShaanStationery.Com


scissors 100.0%
GORILLA®
scissors 81.9%
scissors 60.7%
GORILLA®
www.shaanstationery.com


toothbrush 82.4%
WHITENING
edel
white
WHITENING
STAIN ERASER BRUSH
SWISS
TECHNOLOGY
+35%
WHITER TEETH
edel
white

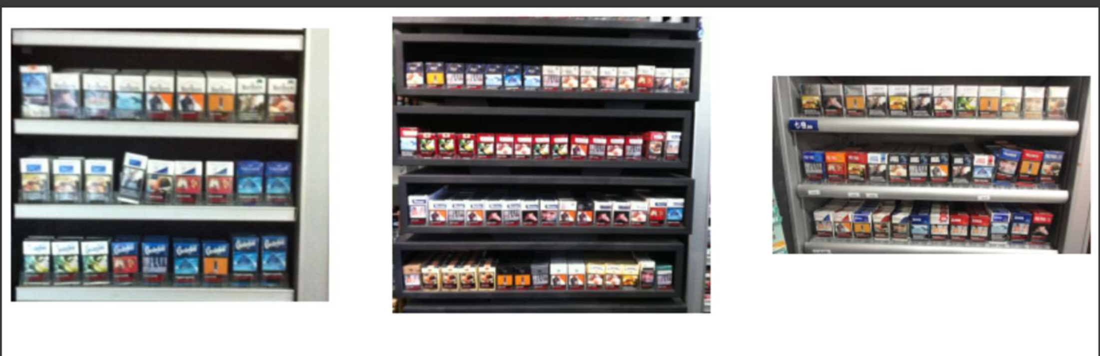
```
total time taken:  12.035783529281616
generated bill:
 ['', 'apple 99.1%', 'apple 79.4%', 'apple 61.7%', 'orange 98.6%',

'orange 89.7%', 'orange 81.4%', 'scissors 100.0%', 'scissors 83.2%', 'scissors 81.9%',

 ', 'scissors 83.2%', 'scissors 81.9%', 'scissors 60.7%', 'toothbrush 82.4%']
```

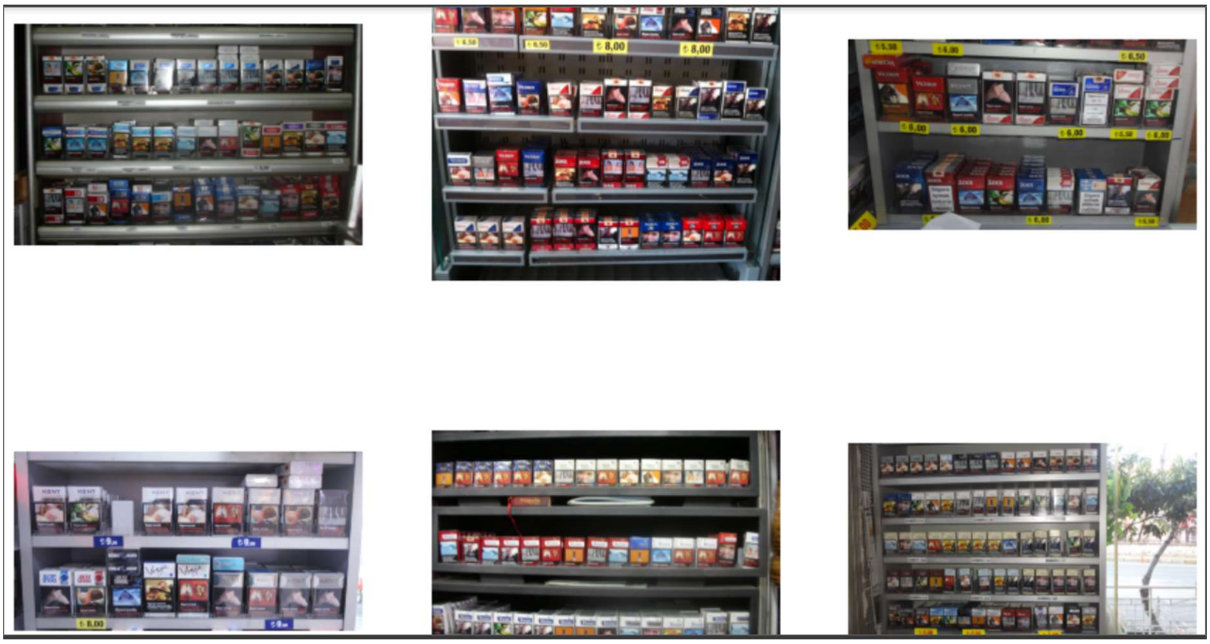
from the above pictures we can see that the model was able to classify oranges with a confidence level between 89 to 98, and apples with a confidence level of 70, scissors with confidence levels between 60 to 100 and the toothbrush with a confidence of around 82. We can also see that the bill is generated at the end with a list of all the products that has been purchased.

Implementation for TFOD algorithm is as follows:

Plotting shelf images

```
train_images = list(paths.list_images("ShelfImages/train"))
plt.figure(figsize=(15, 15))
for i, image  in enumerate(train_images[:9]):
    image = plt.imread(image)
    ax = plt.subplot(3, 3, i + 1)
    plt.imshow(image)
    plt.axis("off")
```





Annotations for different images in dataset:

```
cols = ["image_name", "x_i", "y_i", "w_i", "h_i", "b_i"]
master_df = pd.read_csv("https://raw.githubusercontent.com/gulvarol/grocerydataset/master/annotations.csv",
                        names=cols)
master_df.head()
```

	image_name	x_i	y_i	w_i	h_i	b_i
0	C1_P01_N1_S2_1.JPG	1008	1552	1260	1928	0
1	C1_P01_N1_S2_1.JPG	1028	928	1280	1304	0
2	C1_P01_N1_S2_1.JPG	24	872	268	1264	0
3	C1_P01_N1_S2_1.JPG	280	1568	532	1944	0
4	C1_P01_N1_S2_1.JPG	292	872	544	1248	0

Setting up TFOD API models

```
[ ]  #Setup TFOD API
     #%tensorflow_version 2.11.0

     import tensorflow as tf
     print(tf.__version__)

     !git clone https://github.com/tensorflow/models.git

     % cd models/research
     !pip install --upgrade pip
     # Compile protos.
     !protoc object_detection/protos/*.proto --python_out=.
     # Install TensorFlow Object Detection API.
     !cp object_detection/packages/tf1/setup.py .
     !python -m pip install --use-feature=2020-resolver .

     2.12.0
     fatal: destination path 'models' already exists and is not an empty directory.
     UsageError: Line magic function `%` not found.
```

Mapping images to their ids

```
#Generate .pbtxt
#We need to generate a .pbtxt file that defines a mapping between our classes and integers.
#In our case, the classes are already integers. But we still need this file for the TFOD API to operate.
classes = new_train_df["class"].unique()
label_encodings = {}
for cls in classes:
    label_encodings[str(cls)] = int(cls)

f = open("/content/label_map.pbtxt", "w")

for (k, v) in label_encodings.items():
    item = ("item {\n"
            "\tid: " + str(v) + "\n"
            "\tname: '" + k + "'\n"
            "}\n")
    f.write(item)

f.close()

!cat /content/label_map.pbtxt
```

```
item {
        id: 1
        name: '1'
}
item {
        id: 2
        name: '2'
}
item {
        id: 5
        name: '5'
}
item {
        id: 8
        name: '8'
}
item {
        id: 4
        name: '4'
}
item {
        id: 7
        name: '7'
}
item {
```

```
}
item {
        id: 11
        name: '11'
}
item {
        id: 3
        name: '3'
}
item {
        id: 6
        name: '6'
}
item {
        id: 9
        name: '9'
}
item {
        id: 10
        name: '10'
}
```

EVALUATION PROCEDURE

In this research paper, we conducted an evaluation procedure for a product detection algorithm used in a smart basket for detecting products and generating bills. The algorithms used for the evaluation were SIFT, yoloV3, and TFOD, and we found that SIFT provided the best results among the used algorithms.

Robustness to Scale and Rotation: SIFT is designed to be invariant to changes in scale and rotation, which allows it to detect objects of different sizes and orientations in an image. On the other hand, YOLOv3 relies on anchor boxes and predefined scales for object detection, which may not perform as well in detecting objects at extreme scales or orientations.

Feature-Level Localization: SIFT provides localized keypoints and feature descriptors that encode the appearance of objects in a compact manner, allowing for precise feature-level localization. This can be particularly useful for applications that require accurate object localization, such as image stitching or augmented reality. YOLOv3, on the other hand, provides bounding boxes around detected objects, which may not always precisely align with the object boundaries.

Distinctiveness and Matching: SIFT features are designed to be distinctive, which reduces the chances of false positives and false negatives in object matching. YOLOv3 relies on convolutional neural networks (CNNs) for feature extraction, which may not always provide as distinctive features as SIFT, especially in scenarios with cluttered backgrounds or low-resolution images.

Robustness to Lighting Conditions and Image Noise: SIFT features are designed to be robust to changes in lighting conditions and image noise, which makes it suitable for object detection in challenging environments. YOLOv3, on the other hand, may be sensitive to lighting conditions and image noise, as CNNs can be affected by variations in illumination and noise levels.

Computational Efficiency: SIFT uses a local feature-based approach and provides efficient feature extraction and matching mechanisms, which can make it computationally efficient, especially for applications that require real-time processing. YOLOv3, being a CNN-based approach, may require more computational resources and processing time, making it less suitable for certain resource-constrained scenarios.

CONCLUSION

In conclusion, the smart basket is a revolutionary invention that simplifies the checkout process for customers and retailers. By using image recognition modules to detect items as they are placed in the basket, the technology eliminates the need for customers to scan each item individually or wait in line to have their items checked out. The generated bill can be paid quickly and easily, allowing for a seamless shopping experience. Overall, the smart basket has the potential to save time and increase efficiency for both customers and retailers, making it a valuable addition to the retail industry.

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