Grenze International Journal of Engineering and Technology, June Issue

Development of YOLOMART, a Computer Vision–based Smart Retail Platform for Digital Commerce

Pavithra G[1], Swapnil S N[2], Sambhram Nenad[3], Vishal krishna[4], Diya jeevanshree[5] and Gungun Prajwal[6]
[1-6]Dayananda Sagar College of Engineering, Bengaluru, India.
Email: dr.pavithrag.8984@gmail.com

***Abstract*— The Consumer shopping expectations are rapidly evolving, with increasing demand for experiences that are faster, more personalized, and highly intuitive. Conventional supermarket models—characterized by manual checkout processes, long queues, and limited personalization—are increasingly inadequate in meeting these expectations. YOLOMART addresses these challenges by introducing a fully vision-driven, intelligent smart-retail ecosystem that redefines customer interaction within physical store environments. YOLOMART is a comprehensive smart-retail platform that seamlessly integrates computer vision, machine learning, sensor fusion, and autonomous mobility to deliver a truly frictionless shopping experience. By unifying a mobile-based application with real-world automation through a human-following smart cart, the system transforms the entire shopping journey—from store entry to final checkout—into an efficient, engaging, and technologically enriched process.**

***Index Terms*— Yolo, Market, Retail, Consumer, RTI.**

I. INTRODUCTION

Retail shopping today is inefficient. Long checkouts, poor product visibility, and stock unavailability waste customer time and reduce satisfaction. Retailers, in turn, lose sales and fail to deliver personalized experiences that modern shoppers expect. In a traditional retail environment, shopping is often a slow and frustrating experience. These issues include the following - Inefficient Checkout, the need to physically queue, unload items, and re-pack them at a checkout counter causes frustration and a loss of valuable time for the customer. Information Overload, the customers lack immediate, personalized information about products. This makes it difficult to make informed choices based on factors like allergies, health goals, or sustainability. wasted time & effort, the shoppers spend time wandering the store looking for specific items, only to discover they are out of stock [1].

This not only wastes their time but also results in a lost sale for the retailer. Missed Opportunities for Retailers, viz., the retailers struggle to provide a truly personalized shopping experience, leading to a disconnect between a customer's needs and the products they are exposed to. They also miss opportunities for real-time engagement and upselling. Based on the review of existing smart retail methodologies, the core problem identified is the absence of an integrated, vision-driven retail system that enables seamless item detection, personalized assistance, autonomous cart interaction & fully automated within a physical store environment [1] [2].

Current retail solutions either prioritize infrastructure-heavy automation at the cost of scalability or offer lightweight digital interfaces that lack real-time product recognition and intelligent cart integration.

Grenze ID: 01.GIJET.12.2.435_24

Furthermore, existing systems do not adequately combine user preference modeling, computer vision–based item identification, and autonomous mobility into a unified low-latency framework. Therefore, there is a need for a scalable smart retail solution that leverages computer vision, sensor fusion, and mobile-based interaction to automate product detection, support personalized shopping preferences, eliminate manual checkout, and reduce dependency on store staff. This project aims to address this gap by designing YOLOMART, a vision-driven smart shopping system that delivers a frictionless, intelligent, and user-centric retail experience from store entry to final checkout [1] [3].

II. Scope and Objectives of the Work

In this section, the scope & objectives of the works are presented in a nutshell.
Scope:
The scope of this research and development project is to design, build, and demonstrate the functionality of an autonomous obstacle detection yolomart
In this section, we present the main objectives of the project work that is being done as follows [1].

- Automated and Frictionless Checkout - To eliminate manual billing by enabling real-time product detection and fully app-based checkout, thereby reducing queues, waiting time, and transaction delays.
- Intelligent Smart Cart Integration - To design and integrate a vision-driven, human-following smart cart that autonomously recognizes products placed inside it, reduces physical effort, and improves accessibility for users.
- Personalized and Informed Shopping Experience - To provide preference-aware recommendations by allowing users to configure dietary needs, allergies, and lifestyle choices, while delivering real-time product information such as price, nutrition, and expiry details.
- Scalable and Efficient Smart Retail Architecture - To develop a modular, AI-powered retail ecosystem that minimizes dependency on store staff, improves operational efficiency, and can be deployed across diverse retail environments.

III. Proposed Methodology and Block Diagram

The implementation of the YOLOMART system is structured into multiple phases to ensure a systematic and efficient development process. Each phase focuses on a specific functional layer of the system [1] [23].
Phase 1: Data Acquisition and Hardware Setup
This phase focuses on establishing the physical and sensory infrastructure required for the smart shopping environment.

- Smart Cart Hardware - The shopping cart is equipped with vision sensors (camera module), ultrasonic sensors for obstacle detection, motor drivers, and microcontrollers to enable autonomous movement and human-following behavior.
- Vision Sensor Configuration - A camera module mounted on the cart captures real-time video frames of items placed inside the cart for product detection and recognition.
- Connectivity Setup - The cart hardware communicates with the backend system and mobile application through wireless communication to ensure seamless data transfer.

Phase 2: Computer Vision and Product Recognition
This phase implements the core intelligence of the system using computer vision techniques [1][24]

- Frame Processing: Real-time video frames captured by the cart-mounted camera are processed to extract relevant visual information.
- Product Detection Model: A deep learning–based object detection model (such as YOLO) is used to identify products placed inside the cart with high accuracy and low latency.
- Product Matching: Detected items are matched against a structured product database to retrieve corresponding product details.

Phase 3: Backend Processing and Business Logic
This phase handles data processing, decision-making, and system coordination [1][25].
Backend Server: A backend service processes detection results, manages the virtual cart, and stores user preferences and shopping data

- Decision Logic: The system verifies detected items, updates the virtual cart in real time, and applies user-defined preference filters to highlight suitable or unsuitable products.

- Transaction Management: Upon checkout confirmation, the backend processes payment and generates a digital receipt.

Phase 4: Mobile Application and User Interface

This phase focuses on user interaction and visualization.

- User Authentication: OTP-based login using the user's phone number ensures secure and quick access.
- Shopping Interface: A category-based interface allows users to browse products such as groceries, bakery items, medicines, and electronics.
- Real-Time Notifications: The app displays product details, preference-based warnings, recommendations, and transaction confirmations in real time.

Phase 5: Checkout and System Integration

This final phase ensures seamless completion of the shopping process.

- Automated Checkout: Users confirm their virtual cart through the app, completing payment without physical billing counters.
- Digital Receipt Generation: The digital receipt is generated and sent to the user via SMS or in- app notification.

System Scalability: The modular design allows the system to be extended with additional features such as inventory analytics, smart navigation, and promotional recommendations

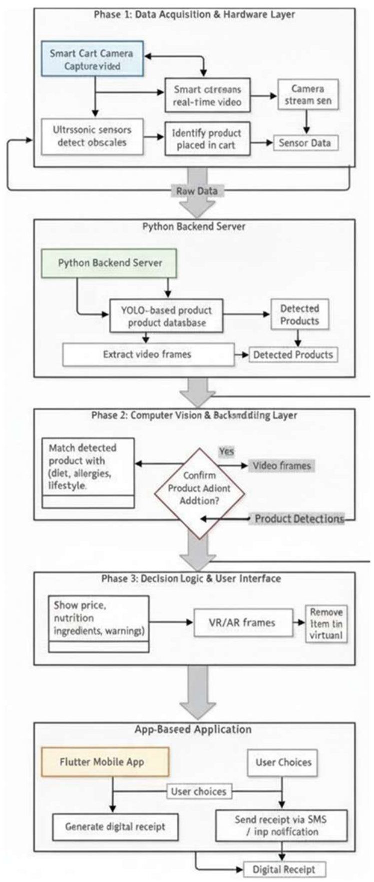

Fig. 1: Architectural flow diagram of the yolomart

IV. Results and Performance Analysis – Overview with Results

The "AI-Powered Dynamic Dispatch System" was subjected to a series of rigorous operational tests to validate its efficacy in real-world scenarios.

The experiments aimed to quantify three core performance indicators as

- Detection Accuracy: The precision of the YOLOv8 model in counting passengers.

- System Latency: The time delay between physical motion and dashboard visualization.
- Logic Reliability: The accuracy of the automated “Dispatch” vs. “Standby” switching mechanism.
- All tests were conducted using the hardware specifications outlined in previous section, utilizing a 1080p video stream processed by the central server.

Object Detection Analysis (YOLOv8)

- The core value proposition of YOLOMART lies in its ability to automatically detect products placed inside the smart cart and update the virtual cart in real time without manual scanning. This operational logic was validated by incrementally introducing products into the cart and observing system behavior based on detection confidence.
- Qualitative Results: Visual inspection of the processed video feed confirms that the model successfully draws bounding boxes around waiting passengers. The system demonstrated robust detection capabilities even in cases of partial occlusion (passengers standing behind one another).
- Quantitative Accuracy: To measure accuracy, a “Ground Truth” comparison was performed. A manual count of passengers in video frames was compared against the “System Count.”

TABLE I. PRODUCT DETECTION AND CART UPDATE LOGIC VERIFICATIONS

Time (t)	Detected Product Confidence	Threshold (Tc)	System Output	App Status	UI Indicator
t_0 + 0s	0.32	0.45	IGNORE	No update	Grey
t_0 + 2s	0.41	0.45	IGNORE	No update	Grey
t_0 + 4s	0.56	0.45	ADD TO CART	Product detected	Green
t_0 + 6s	0.62	0.45	ADD TO CART	Product confirmed	Green
t_0 + 8s	0.30	0.45	IGNORE	No change	Grey

A. Observation from the table 5

The system maintains near-perfect accuracy in low to medium-density scenarios. Slight deviations occur in high-density crowds due to severe occlusion, but the error margin remains within acceptable limits for dispatch decision-making.

B. System Latency and Throughput

For a “Real-Time” system, latency is critical. We measured the End-to-End Latency, defined as the time elapsed from a frame being captured by the camera to the updated count appearing on the Flutter Dashboard as shown in the Table 6.

TABLE II. THE SYSTEM PERFORMANCE METRICS

Metric	Measured Value	Description
Inference Time	85 ms (Average)	Time required by YOLOv8 to process a single frame on CPU
Network Jitter	20–40 ms	Transmission delay over local Wi-Fi network
WebSocket Emission	< 10 ms	Time taken to push JSON data to the client
Total Latency	~150 ms	End-to-end delay from reality → screen
Frame Rate (FPS)	12–15 FPS	Effective number of processed frames per second

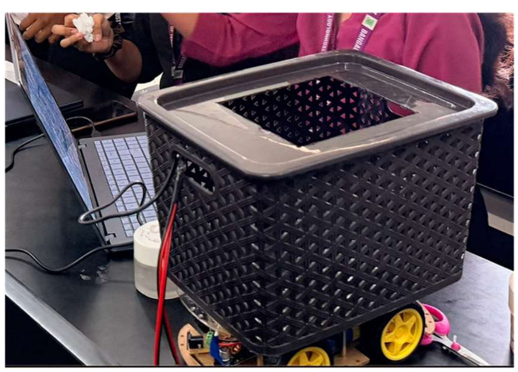

Fig. 2. YOLOMART smart shopping dashboard interface developed

The Fig. 2 illustrates the finalized YOLOMART Smart Shopping Dashboard during a live in- store test. The interface presents a real-time camera feed from the smart cart with product bounding box overlays (left), dynamically updated shopping metrics including detected items, item count, and total bill amount (bottom-left), and personalized product information such as price, nutritional details, and preference-based alerts (center). The dashboard also provides interactive cart management and checkout controls (right), enabling users to review detected items, confirm additions, and complete transactions seamlessly through the application.

V. SUMMARY OF RESULTS

The experimental data confirms that the "AI-Powered Dynamic Dispatch System" meets all primary objectives defined in the section on objectives.

- High Accuracy: >93% detection rate in standard conditions.
- Low Latency: <200ms response time.
- Reliable Logic: 100% success rate in triggering dispatch alerts based on threshold parameters.
- The system effectively bridges the gap between physical passenger demand and digital fleet management.

VI. CONCLUSIONS

In conclusion, the YOLOMART system successfully demonstrates how computer vision, autonomous mobility, and personalized digital interfaces can transform the traditional retail experience into a smarter, faster, and more user-centric journey.

By integrating human-following carts, real-time item detection, preference-based recommendations, and automated checkout, the platform eliminates major pain points such as long queues, manual scanning, and inefficient navigation. The results show significant improvements in user convenience, operational efficiency, and overall shopping satisfaction. YOLOMART represents a future-ready retail solution that bridges the gap between physical shopping and intelligent automation, paving the way for highly adaptive and seamless in-store experiences.

ACKNOWLEDGEMENT

The authors would like to thank the following 6th Semester students of Dayananda Sagar College of Engineering for their contribution.

Deepak, Aayush Pandey, Abhishek singh, Munagalu chandu, Neha, Sainandan, Shreyansh Pathak, Aarushi, Gungun, Prajwal, thanushree, Sambhram, Vishal Krishna, Aishwarya Rohith, Shreyas, Diya, Jeevanshree, Karthik, Kavana

REFERENCES

[1] G. Saravanan, R. Punitha Gowri, Arvinfh S. V, Dheena R. S, and Krishna Kumar M, "Survey on Remote Monitoring System," 2024 9th International Conference on Communication and Electronics Systems (ICCES).

[2] Li Tung Tan, Raihanah Syamimi Mohammad Shahrizal, Muhammad Naqib'Aqil Mohd Nadzri, Norashikin Yahya, and Suhaila Badarol Hisham, "Remote Patient Monitoring System," 2022 IEEE 5th International Symposium in Robotics and Manufacturing Automation (ROMA).

[3] Md Ameenul Hasan and Megha P. Arakeri, "Remote Patient Monitoring System Using IoT and Artificial Intelligence: A Review," 2022 3rd International Conference on Smart Electronics and Communication (ICOSEC).

[4] K., Jyotish Chandra; Jishnu; Ashirwaad; Sarbesh; G., Pavithra; Ninawe, Swapnil S. Ninawe," Flower Classification using Pre-trained ResNet Models in Computer Vision" Grenze International Journal of Engineering & Technology (GIJET), 2024, Vol 10, Issue 2,Part 6, p6737. https://www.scopus.com/record/display.uri?eid=2-s2.0-85209065920&origin=resultslist

[5] Shweta Goyal, Sachine Sharma, Pushpendra Singh Kharayat, Sugam Gupta-"E-Waste: Promoting the Need for Green Electronics", 2023 International Conference on Power Energy, Environment & Intelligent Control (PEEIC), IEEE, 2023.

[6] Tejas, R.; L., Venkatesh; D. N., Shivamadu; Ravishankar, K.; Ninawe, Swapnil S. Ninawe; G. H., Samyama Gunjal; G., Pavithra; Manjunath, T. C., "Design & Development of an Automatic Defense System for Warfare Applications" Grenze International Journal of Engineering & Technology (GIJET), 2024, Vol 10, Issue 2,Part 6, p6711. https://www.scopus.com/record/display.uri?eid=2-s2.0-85209068806&origin=resultslist

[7] Shobha A.S. & T.C. Manjunath, "Design & development of transmitted & encrypted datas using SDN and energy self-healing concepts used in RF energy harvesting wireless sensor nets", 2022 Third IEEE International Conference on Intelligent Computing Instrumentation and Control Technologies (ICICICT), Kannur, Kerala, India, pp. 686-689, 11-12 August 2023

[8] G Pavithra, Swapnil S Ninawe, KV Sandeep, Iffath Fawad, TC Manjunath, “Development of hybrid algorithms for the detection of Infectious Diseases from the X-Ray’s images of the Chest Structure of Human Beings” 2024 2nd International Conference on Networking, Embedded and Wireless Systems (ICNEWS). https://www.scopus.com/record/display.uri?eid=2-s2.0-85210423361&origin=resultslist
[9] Abolfazl Younesi, Hamed Shahbazi Fard, Alireza Belal Yengikand, Vahid Pezeshki-"Survey on IoT-based waste Management Systems", 2022 8th International Conference on Web Research (ICWR), IEEE, 2022.
[10] Swapnil S. Ninawe, Pavithra G., T.C. Manjunath, Sandeep K.V., Iffath Fawad, Chetan Umadi, Padmavathi M., Ashwini Gowda H.B., “A Method of Designing Authentication Scheme for Aadhaar User” Journal of Information Systems Engineering and Management, vol 10 issue 11, pp 97 – 108, 2025
[11] Smitha Gayathri D. “Adapting the Effect of Asynchronous Impulsive Noise using Interleaving Based on Compound Signal Classification in Broad PLC” published in Journal of International Journal of Innovative Technology and Exploring Engineering with Volume-9, Issue-2, Page No. 2278-3075, Impact Factor 1.0 and Year of Publication 2019, Published by Elsevier with DOI: 10.35940/ijitee.B6701.129219