VISVESVARAYA TECHNOLOGICAL UNIVERSITY

Jnana Sangama, Belagavi, Karnataka – 590018.

Phase-I, Review-1I Major Project Report on

AI-Powered Smart Kiosk for Product Information Retrieval and Recommendation”

Submitted in partial fulfilment of the requirements for the conferment of the major project of

BACHELOR OF ENGINEERING

in

INFORMATION SCIENCE AND ENGINEERING

by

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CERTIFICATE

This is to certify that the project entitled “AI-Powered Smart Kiosk for Product Information Retrieval and Recommendation” is a bonafide work carried out by Rayhaan A R(1BY22IS131),Gaurav Murali(1BY22IS057), Shrikha Vivek(1BY22EC099) and Kavya Krishnan(1BY22EC047)in partial fulfilment of Major Project - Phase-1 (BCS606) of **"Bachelor of Engineering"** in **"Information Science and Engineering"** of the **Visvesvaraya Technological University, Belagavi**, during the year 2024-25. It is certified that all corrections/suggestions indicated by internal assessment have been incorporated in the report. The project report has been approved as it satisfies the academic requirements.

Signature of the Guide

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Signature of the Associate HOD/HoD

ABSTRACT

The proliferation of processed foods and the increasing consumer awareness about health and nutrition have created a significant gap between product information availability and consumer understanding. Traditional product labels often present nutritional information in complex formats that are difficult for average consumers to interpret, leading to uninformed purchasing decisions that may negatively impact their health and environmental consciousness. This project addresses this challenge by developing an AI-powered smart kiosk system that provides real-time product information retrieval and intelligent health recommendations through barcode scanning technology.

The primary objective of this system is to create an accessible, user-friendly interface that transforms complex nutritional data into comprehensible health insights while offering personalized alternatives for healthier living. The kiosk utilizes a Raspberry Pi-based architecture integrated with a display monitor, camera sensor, and advanced computer vision capabilities powered by OpenCV and pyzbar libraries for accurate barcode detection and scanning. The system leverages the comprehensive OpenFoodFacts database to retrieve detailed nutritional information and employs Google's Gemini AI to generate contextual health analysis and recommend healthier product alternatives.

A key innovation of this system is its intelligent caching mechanism that ensures consistent performance even during network connectivity issues, storing frequently accessed product information locally for seamless user experience. The Flask web framework facilitates smooth data processing and presentation, while the integration of environmental impact scoring provides users with sustainability insights alongside nutritional information. This comprehensive approach empowers consumers to make informed decisions that benefit both their personal health and environmental well-being, ultimately contributing to more conscious consumption patterns in retail environments.

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DECLARATION

We, hereby declare that the project titled AI-Powered Smart Kiosk for Product Information Retrieval and Recommendation is a record of original Major Project phase-I (BCS606) work under the guidance of **Dr. Chandrashekar K T**, **Assistant Professor,** Dept. of Information science and Engineering.

We also declare that this project report has not been submitted for the award of any degree, diploma, associateship, fellowship or other title anywhere else.

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INTRODUCTION

The modern retail landscape has witnessed a dramatic transformation in how consumers interact with products and make purchasing decisions. With the rise of health consciousness and environmental awareness, consumers are increasingly seeking detailed information about the products they purchase, particularly regarding nutritional content, health implications, and environmental impact. However, despite the abundance of information printed on product packaging, studies consistently show that the majority of consumers struggle to interpret complex nutritional labels, ingredient lists, and health claims effectively.

The traditional approach to product information dissemination relies heavily on static labels that present data in standardized formats mandated by regulatory bodies. While these labels serve their regulatory purpose, they often fail to communicate meaningful insights to the average consumer. Research conducted by the Food and Drug Administration reveals that over 70% of consumers find nutritional labels confusing, and fewer than 30% can accurately interpret serving sizes and daily value percentages. This information gap becomes even more pronounced when consumers attempt to compare similar products or seek healthier alternatives within the same category.

The emergence of artificial intelligence and computer vision technologies has opened new possibilities for bridging this information gap. AI-powered systems can process vast amounts of nutritional data, cross-reference health guidelines, and present personalized recommendations in user-friendly formats. Computer vision technology, particularly barcode scanning and image recognition, has matured to the point where it can reliably identify products in real-time retail environments. The combination of these technologies presents an unprecedented opportunity to revolutionize how consumers access and understand product information. Previous research in this domain has primarily focused on mobile applications that require consumers to use their personal devices for product scanning and information retrieval.

While these solutions have shown promise, they suffer from several limitations including inconsistent user adoption, dependency on personal device capabilities, and the need for individual app downloads and updates. Furthermore, mobile-based solutions often lack the computational power required for complex AI processing, leading to slower response times and limited functionality. The concept of smart kiosks in retail environments is not entirely new. Early implementations focused primarily on wayfinding, price checking, and basic product location services. However, these systems lacked the sophisticated AI capabilities and comprehensive databases necessary to provide meaningful health and nutritional insights. Recent advances in edge computing, powered by platforms like Raspberry Pi, have made it feasible to deploy powerful AI capabilities directly at the point of interaction, eliminating many of the limitations associated with cloud-dependent systems.

The OpenFoodFacts initiative has emerged as a crucial enabler for comprehensive product information systems. This collaborative database contains detailed information about millions of food products worldwide, including ingredients, nutritional facts, allergen information, and environmental impact scores. The availability of this open-source database has significantly reduced the barrier to entry for developing comprehensive product information systems.

Environmental consciousness has become an increasingly important factor in consumer decision-making. Studies indicate that over 60% of consumers are willing to pay premium prices for products with lower environmental impact, but they lack accessible tools to evaluate and compare the environmental footprint of different products. This growing demand for sustainability information represents an additional dimension that modern product information systems must address. Furthermore, the rapid pace of product innovation means that consumers frequently encounter new products, ingredients, or formulations with which they have no prior experience. The learning curve associated with understanding new product categories or novel ingredients creates additional complexity in the decision-making process

Time constraints in typical shopping environments exacerbate these challenges. Consumers operating under time pressure cannot realistically examine and compare detailed nutritional information for multiple products. This limitation is particularly pronounced in busy retail environments where lengthy product analysis becomes impractical. The result is that many consumers abandon their intention to make informed choices and revert to habitual purchasing patterns regardless of their health goals.Accessibility represents another critical dimension of this problem. Consumers with visual impairments, reading difficulties, or limited literacy may find traditional product labels particularly challenging to navigate. The small font sizes, technical terminology, and dense information presentation create additional barriers for these populations. Similarly, consumers who speak languages other than those used on product packaging face significant challenges in understanding product information.

The absence of personalized guidance compounds these challenges. Generic nutritional labels cannot account for individual dietary restrictions, health conditions, allergies, or personal wellness goals. A product that may be appropriate for one consumer might be entirely unsuitable for another based on their specific health profile or dietary requirements. Current labeling systems provide no mechanism for delivering personalized recommendations or warnings.

The primary objective is to develop a robust barcode scanning system capable of accurately identifying products in real-time retail environments. This system must achieve a minimum accuracy rate of 95% for barcode detection and product identification across various lighting conditions and scanning angles. The implementation of intelligent health analysis and recommendation features represents a core objective of this project. The system must leverage artificial intelligence, specifically Google's Gemini AI, to analyze product information and generate contextual health insights tailored to general wellness guidelines. This includes the ability to identify potentially problematic ingredients, highlight nutritional strengths and weaknesses, and suggest specific healthier alternatives from the same product category.

PROBLEM STATEMENT

Consumers often lack immediate, clear, and accessible information about the nutritional content, allergens, and environmental impact of packaged food products. Traditional labels can be confusing, and existing mobile apps are not always practical in public or shared settings. This creates a gap in enabling informed, health-conscious, and sustainable food choices at the point of decision.

OBJECTIVES

1. **Develop a Stationary Nutrition Kiosk Platform**: Design and build a durable, fixed-position kiosk system intended for continuous use in public spaces. The platform will integrate reliable barcode scanning and display components within a robust and secure enclosure, ensuring long-term usability and minimal maintenance.
2. **Implement an Accurate Product Identification Module**: Incorporate industrial-grade barcode scanning and computer vision techniques to consistently recognize packaged food products. The system will include error handling for varied lighting conditions, damaged or partially visible barcodes, and multiple packaging types.
3. **Implement a Comprehensive Nutritional Analysis Module**: Retrieve and display detailed nutritional data, ingredients, and allergen information by integrating with open-source food databases such as Open Food Facts. The module will format data for clarity and enable local caching to enhance performance and resilience in low-connectivity environments.
4. **Integrate AI-Powered Healthy Alternatives Recommendation**: Use generative AI models (e.g., Gemini) to suggest healthier or more sustainable alternatives based on the nutritional profile of the scanned product.
5. **Maintain Accessible Offline Functionality with Local Backup**: Ensure the kiosk remains operational during internet outages through local storage of frequently accessed data and automatic synchronization when connectivity is restored.

LITERATURE REVIEW

Paper 1: *Starke, Alain D, Jutta Dierkes, Gülen Arslan Lied, Gloria a B Kasangu, and Christoph Trattner "Supporting Healthier Food Choices Through AI-tailored Advice: A Research Agenda." PEC Innovation 6 (January 10, 2025): 100372*

Starke et al. (2025) present a comprehensive research agenda that addresses the intersection of psychology-aware artificial intelligence and clinical validation in promoting healthier food choices. Their work establishes a theoretical framework that extends beyond simple nutritional information provision to encompass long-term behavioral modification through gradual dietary interventions. The authors advocate for a systematic approach that integrates transtheoretical models of behavior change with AI-driven personalization, recognizing that effective dietary modification requires understanding and respecting individual psychological acceptance thresholds.

The significance of this research lies in its recognition that technological solutions for health improvement must be grounded in established behavioral psychology principles. The authors propose that AI systems should not merely provide information but should actively engage users in a process of gradual change that aligns with their psychological readiness and capacity for modification. This approach represents a departure from traditional information-centric models toward more sophisticated intervention strategies that consider the complex interplay between knowledge, motivation, and behavioral implementation.The study identifies personalized advice delivery as a critical component of effective AI health systems, emphasizing that recommendations must be tailored not only to nutritional needs but also to individual psychological profiles and change readiness. This personalization extends beyond simple demographic or preference matching to include assessment of user motivation, previous behavioral patterns, and psychological barriers to change. The integration of clinical trial methodologies into AI system validation represents another significant contribution, establishing a framework for evidence-based evaluation of digital health interventions.

However, the research reveals a critical gap in longitudinal validation of AI-driven dietary changes on real-world populations. While the theoretical framework is well-established, the authors acknowledge that minimal empirical evidence exists regarding the long-term effectiveness of such systems in promoting sustained behavioral change. This limitation is particularly significant given that the ultimate goal of health-focused AI systems is not just immediate information provision but lasting improvement in user health outcomes. The absence of comprehensive longitudinal studies means that the actual impact of these systems on population health remains largely theoretical.

Paper 2: *Han, Michelle, and Junyao Chen. "NutrifyAI: An AI-Powered System for Real-Time Food Detection, Nutritional Analysis, and Personalized Meal Recommendations." New York University, August 12, 2024*

Han and Chen (2024) developed NutrifyAI, an integrated system that demonstrates the practical application of AI-powered food recognition technology combined with personalized nutritional analysis and recommendation generation. Their work represents a significant advancement in real-time food detection systems, utilizing sophisticated AI models integrated with comprehensive nutritional databases to provide immediate feedback on food items. The system's architecture incorporates multiple data sources and processing pipelines to deliver rapid recognition capabilities that enable immediate nutritional analysis and alternative suggestions.

The significance of this research lies in its demonstration of the feasibility of real-time AI-powered nutritional analysis systems. The authors successfully integrated computer vision technology with nutritional databases to create a system capable of rapid food identification and immediate feedback provision. This integration addresses a critical gap in existing health information systems, which typically require manual input or extensive user interaction to provide nutritional analysis. The real-time capability of NutrifyAI represents a substantial improvement in user experience and practical applicability.The system's personalization capabilities extend beyond generic nutritional information to accommodate user-specific dietary requirements, allergies, and health goals. This personalization framework demonstrates how AI systems can move beyond one-size-fits-all approaches to provide tailored recommendations that account for individual differences in dietary needs and restrictions. The integration of allergen detection and dietary goal tracking represents a practical application of personalized health technology that addresses real-world consumer needs.

The rapid recognition capabilities of NutrifyAI enable immediate feedback provision, which is crucial for practical deployment in retail environments where time constraints significantly impact user interaction patterns. The system's ability to provide instant nutritional values, allergen warnings, and healthy alternatives addresses the temporal limitations that often prevent consumers from making informed food choices in typical shopping scenarios.

However, the research reveals significant limitations in the current state of food recognition technology. The authors acknowledge that existing models exhibit substantial difficulties in accurately distinguishing visually similar food items, which represents a critical limitation for practical deployment. This limitation is particularly problematic in retail environments where product variations, packaging differences, and lighting conditions can significantly impact recognition accuracy. The inability to reliably distinguish between similar products undermines the system's utility and could lead to incorrect nutritional information or inappropriate recommendations.

Paper 3: *Chen, Ying, and Catherine Prentice. "Integrating artificial intelligence and customer experience." Australasian Marketing Journal (2024): 14413582241252904.*

Chen and Prentice (2024) provide a comprehensive conceptual framework for integrating artificial intelligence tools with customer experience enhancement across various retail touchpoints. Their research develops a theoretical model that encompasses chatbots, kiosks, and IoT devices as integrated components of a seamless customer journey enhancement system. The framework emphasizes the creation of multisensory, emotionally engaging experiences that leverage AI capabilities for personalization, real-time assistance, and improved decision-making support.

The significance of this work lies in its holistic approach to AI integration in retail environments. Rather than focusing on individual technologies or applications, the authors present a comprehensive framework that considers the entire customer journey and the role of AI in enhancing each touchpoint. This systems-level perspective is crucial for understanding how individual AI applications, such as smart kiosks, fit within the broader retail ecosystem and contribute to overall customer experience improvement. The framework's emphasis on personalization represents a critical advancement in understanding how AI can enhance retail experiences. The authors demonstrate how AI systems can leverage customer data, behavioral patterns, and real-time interactions to provide highly personalized experiences that adapt to individual preferences and needs. This personalization capability extends beyond simple product recommendations to encompass entire interaction paradigms that adjust to user communication styles, information processing preferences, and decision-making patterns.The integration of real-time assistance capabilities represents another significant contribution of this research.

However, the research reveals a substantial gap in real-world validation across hybrid service models that combine digital and physical retail elements. While the theoretical framework is comprehensive, the authors acknowledge limited empirical evidence regarding the effectiveness of these integrated approaches in actual retail environments. This validation gap is particularly significant for self-service kiosks and similar hybrid technologies that represent a critical interface between digital AI capabilities and physical retail spaces.

The need for robust human-AI interaction designs that prevent confusion or frustration during service usage represents another critical gap identified in this research. The authors note that poorly designed human-AI interactions can lead to user frustration, system abandonment, and negative customer experiences. The challenge of creating intuitive, error-resistant interaction paradigms for diverse user populations in time-constrained retail environments remains largely unaddressed in current research.

Paper 4: *Wisastra, Albertus Lian, Amaganza Engwy Ardianyah, Berren Arisandy Hermanto, and Devyano Luhukay. "The Influence of Self-Service Kiosks on Customer Experience in Retail Stores." In 2024 International Electronics Symposium (IES), pp. 365-370. IEEE, 2024*

Wisastra et al. (2024) conducted a comprehensive analysis of how self-service kiosks impact customer experience in retail environments, utilizing the DeLone & McLean model to evaluate the relationships between system quality, information quality, service quality, and customer satisfaction.

The significance of this research lies in its empirical validation of the factors that drive successful kiosk implementation in retail environments. The authors demonstrate that usability, responsiveness, and information accuracy are critical determinants of kiosk acceptance and repeat usage. This empirical evidence provides essential guidance for designing effective kiosk systems and prioritizing development efforts to maximize user satisfaction and system adoption.The research establishes that well-designed kiosks can significantly enhance customer satisfaction and perceived service value, providing empirical support for the business case for kiosk implementation.

However, the study reveals significant limitations in the scope of kiosk applications examined. The research focuses primarily on transactional functions such as price checking, product location, and basic information retrieval, without addressing more sophisticated applications such as health impact analysis, personalization, or comprehensive decision support. This limitation represents a significant gap in understanding how advanced kiosk capabilities might impact customer experience and satisfaction.The research also lacks consideration of content depth and sophistication in kiosk applications. While the study establishes that information accuracy is important, it does not address how complex information such as nutritional analysis, health recommendations, or environmental impact scores might be effectively presented and utilized by customers. This gap is particularly relevant for advanced kiosk applications that aim to provide comprehensive decision support rather than basic informational services.

Paper 5*:* *Jeon, Ji-Ye, Shin-Woo Kang, Hyuk-Jae Lee, and Jin-Sung Kim. "A retail object classification method using multiple cameras for vision-based unmanned kiosks." IEEE Sensors Journal 22, no. 22 (2022): 22200-22209*

Jeon et al. (2022) developed an innovative approach to retail object classification using multiple cameras and view-aware feature aggregation to enhance recognition accuracy in unmanned kiosk environments. Their research addresses fundamental challenges in computer vision applications for retail settings, particularly the problem of high interclass similarity among retail products that can confound single-camera recognition systems.

The significance of this work lies in its innovative approach to addressing recognition accuracy challenges through multi-perspective data collection and analysis. The authors demonstrate that aggregating visual information from multiple camera angles can significantly improve product identification accuracy compared to single-camera systems. This improvement is particularly important in retail environments where products may have similar appearances, varying orientations, or partial occlusion that can challenge recognition systems.The research contributes a novel "view-aware" feature extraction methodology that intelligently combines information from multiple camera perspectives to create more robust product representations. This approach represents a significant advancement in computer vision techniques for retail applications, providing a framework for improving recognition accuracy without requiring expensive hardware upgrades or complex sensor integration.

The system's cost-effectiveness represents another significant contribution. By avoiding the need for weight sensors or other expensive hardware components, the multi-camera approach provides an economical solution for enhanced product recognition that can be practically deployed in retail environments. This cost consideration is crucial for widespread adoption of advanced recognition systems in price-sensitive retail applications.

However, the research reveals important limitations in its scope and integration capabilities. The current design focuses primarily on physical appearance-based classification without integration of nutritional, health, or environmental data that would be necessary for comprehensive product information systems. This limitation means that while the system can accurately identify products, it cannot provide the enhanced information and recommendations that consumers increasingly demand. The lack of integration with comprehensive product databases represents a significant gap that limits the practical utility of the recognition system. While accurate product identification is a necessary first step, the ultimate value of such systems lies in their ability to provide meaningful information and recommendations based on product identification. The absence of this integration capability limits the system's applicability for advanced retail information applications.

Paper 6: *Akram, Tooba, Huma Hasan Rizvi, Syed Adeel Ali, Shahzada Muhammad Hamza, and Aqib Ifthikhar. "OCR and barcode based halal and health analyzer." In 2020 International Conference on Information Science and Communication Technology (ICISCT), pp. 1-5. IEEE, 2020.*

Akram et al. (2020) developed a comprehensive mobile application that combines optical character recognition (OCR) and barcode scanning technologies to address the specific needs of consumers requiring religious dietary compliance alongside health and allergen information. Their system represents an innovative approach to addressing the intersection of religious dietary requirements, health considerations, and food safety concerns through automated ingredient analysis and classification.

The significance of this research lies in its recognition that consumer food information needs extend beyond basic nutritional data to encompass religious, cultural, and ethical considerations. The authors address a critical gap in existing food information systems by developing technology specifically designed to identify Halal and Haram food status, which serves a substantial global population with specific dietary requirements. This approach demonstrates the importance of developing inclusive food information systems that accommodate diverse consumer needs and cultural contexts.The integration of fast barcode scanning with multilingual OCR capabilities represents a significant technical achievement that addresses practical usability challenges in diverse global markets. The multilingual OCR functionality enables the system to process ingredient lists and product information across different languages and scripts, which is essential for serving international markets and immigrant communities who may encounter products with packaging in unfamiliar languages. This capability significantly expands the practical applicability of automated food analysis systems beyond English-speaking markets.

The system's automated allergen detection and calorie tracking based on personal profiles demonstrates sophisticated personalization capabilities that go beyond generic food information provision. By maintaining individual user profiles that include allergen sensitivities and dietary preferences, the system can provide personalized warnings and recommendations that are tailored to specific health needs and restrictions. This personalization approach represents an important advancement in making food information systems more relevant and actionable for individual users.The combination of religious dietary compliance checking with health and allergen analysis represents an innovative integration that addresses multiple consumer concerns within a single system.

However, the research reveals significant limitations in database coverage and system scalability. The authors acknowledge that their system suffers from limited product database coverage, requiring manual additions for many products not included in existing databases. This limitation represents a critical barrier to practical deployment, as the system's utility is directly dependent on its ability to recognize and analyze the products that consumers actually encounter in retail environments. The need for manual database expansion significantly limits the system's scalability and increases maintenance requirements.The lack of integration between allergy and nutrition tracking with broader environmental scoring and healthier alternative suggestions represents another significant gap in the system's capabilities. While the system effectively addresses religious compliance and basic health concerns, it does not provide the comprehensive decision support that would enable users to make holistic choices considering health, environmental impact, and alternative product options. This limitation means that users must rely on multiple systems or sources to obtain comprehensive product information and recommendations.

PROPOSED METHODOLOGY

1. Approach

- **Modular System Architecture:**
  The kiosk is designed using a modular approach, where each functional block (scanner, embedded system, API, AI model, local cache, UI, etc.) operates as an independent yet interconnected module. This ensures scalability, ease of debugging, and modular upgrades.
- **Edge Computing:**
  The system processes data locally using a Raspberry Pi to ensure real-time responsiveness, reduce latency, and provide offline capabilities during internet outages.
- **AI-Assisted Decision Support:**
  By integrating AI-based recommendation models (via Gemini API), the kiosk offers users healthier food alternatives based on the nutritional profile of scanned items.
- **User-Centric Design:**
  Focus is placed on clarity and ease of use. Nutritional data is simplified for the general public, and AI suggestions are contextualized for better comprehension and decision-making.

2. Tools and Technologies

HARDWARE

- Raspberry Pi 4 Model B**:** Acts as the embedded computing platform.
- USB Camera Module or Pi Camera**:** Used for barcode/QR code scanning via computer vision.
- LCD Display (HDMI connected): Provides visual feedback and UI to the user.
- Power Supply Unit & Casing**:** Ensures stable power and durable enclosure for deployment in public spaces.

SOFTWARE

- Operating System**:** Raspbian OS (Debian-based Linux for Raspberry Pi)

- <u>Programming Languages</u>**:** Python (primary), Bash scripting
- <u>Web Framework</u>**:** Flask (for API communication and backend routing)
- <u>Computer Vision Libraries</u>**:** OpenCV (image processing), Pyzbar (barcode detection)
- <u>AI API</u>**:** Gemini API (for suggesting healthy alternatives)
- <u>Food Database API</u>**:** Open Food Facts API (for product and nutrition information)
- <u>Local Database</u>**:** SQLite or TinyDB (for caching frequently scannedproducts)

BLOCK DIAGRAM

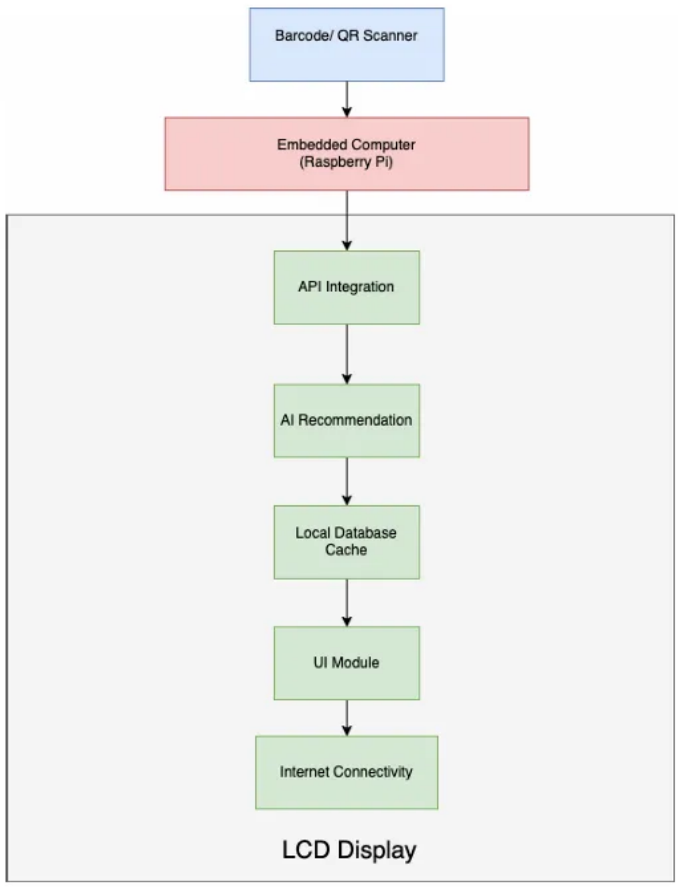

Fig 1: Process Block Diagram

3.PROCESS:

Step 1: Product Scanning

- The kiosk uses a camera to scan the barcode or QR code on a food item.
- Pyzbar + OpenCV detects and decodes the barcode in real-time.

Step 2: Embedded Processing

- The decoded barcode is sent to the embedded computer (Raspberry Pi) for further processing.
- Flask handles the routing between the frontend and backend of the system.

Step 3: API Integration

- The Raspberry Pi sends the barcode to the Open Food Facts API to retrieve product metadata, nutritional values, ingredients, and allergen information.

Step 4: AI-Based Recommendation

- Once the product data is retrieved, it is passed to the Gemini API, which analyzes it and returns healthier or more environmentally-friendly alternatives.
- The recommendations are ranked and simplified for display.

Step 5: Caching and Offline Backup

- If the internet is slow or the product was previously scanned, the local SQLite database is queried first.
- A caching mechanism checks for duplicate entries and stores new results to optimize speed and reduce API calls.

Step 6: User Interface Rendering

- The clean and user-friendly UI presents the product's nutritional profile, health warnings, allergen alerts, and AI-powered alternatives.
- The environment score is also shown if available.

Step 7: Continuous Operation and Sync

- Periodic syncing is done in the background to upload cloud data to the local data cache when the internet is available.
- The system runs in a continuous loop, ready for the next scan

4. DATA COLLECTION

- Primary Data Source: Nutritional information, ingredient lists, and product metadata are pulled from Open Food Facts API using barcode identifiers.
- Secondary Data Processing: AI-based healthy alternative recommendations are generated using Gemini API trained on large-scale health, nutrition, and food science datasets.

- Local Caching Strategy: When product data is retrieved for the first time, it's stored locally for reuse. A caching logic based on Least Recently Used (LRU) ensures storage efficiency.
- User Interaction Data : If extended in the future, gesture tracking or interaction logging can be added to improve UI design and recommendation algorithms.

EXPECTED OUTCOMES

Expected Results / Deliverables:

1. **Functional Smart Kiosk Prototype:**
   A working Raspberry Pi-based kiosk capable of scanning barcodes or QR codes on packaged food products and delivering nutritional insights in real time.
2. **Integrated Nutrition Retrieval System:**
   Seamless retrieval of product data (ingredients, calories, allergens, environmental scores, etc.) using Open Food Facts API.
3. **User-Friendly Nutritional Display Interface:**
   A clean and intuitive UI that presents complex nutritional data in an understandable format for everyday users.
4. **Local Caching Mechanism:**
   An offline-first approach using SQLite or TinyDB for caching product data and ensuring continued functionality during internet downtime.
5. **Error-Handled Barcode Scanning System:**
   A camera-based system using OpenCV and Pyzbar that robustly handles poor lighting, partial barcodes, and various packaging materials.
6. **Environmental Impact Awareness Feature:**
   Display of eco-scores or sustainability indicators, encouraging consumers to make more environmentally responsible choices.
7. **Scalable Flask-Based Backend:**
   Lightweight yet extensible backend architecture using Flask, supporting API communication, AI integration, and caching.

How These Outcomes Address the Problem and Meet the Objectives

1. **Addresses Consumer Information Gap:**
   By displaying clear and trustworthy nutritional details, the kiosk empowers users to make informed food choices, solving the problem of limited on-the-spot product awareness.
2. **Promotes Healthier Eating Habits:**
   AI-powered suggestions encourage healthier alternatives, contributing to dietary awareness and behaviour change.
3. **Facilitates Offline Accessibility:**
   The local caching feature ensures uninterrupted operation even in low-connectivity zones like rural areas or crowded public spaces.
4. **Improves Public Health Literacy:**
   Simplified visuals and categorized health warnings (e.g., sugar content, saturated fat) make nutrition education accessible to non-experts.
5. **Supports Scalable Deployment:**
   The use of Raspberry Pi and open-source software makes the solution cost-effective and easy to replicate in schools, hospitals, grocery stores, and community centers.
6. **Enhances Technological Integration:**
   The fusion of AI, computer vision, API communication, and embedded systems demonstrates a practical use of interdisciplinary technologies.
7. **Ensures System Robustness:**
   Local error handling, modular design, and internet failover mechanisms ensure the kiosk is reliable and suitable for long-term deployment.
8. **Delivers Real-Time Interaction:**
   Rapid barcode recognition and immediate data display ensure a smooth user experience, crucial for real-world usability.

```
rayhaan@Rayhaans-MacBook-Air majproj % python3 main.py
 * Serving Flask app 'main'
 * Debug mode: on
WARNING: This is a development server. Do not use it in a production deployment. Use a production WSGI server instead.
 * Running on all addresses (0.0.0.0)
 * Running on http://127.0.0.1:5001
 * Running on http://192.168.68.109:5001
Press CTRL+C to quit
 * Restarting with stat
 * Debugger is active!
 * Debugger PIN: 781-043-668
127.0.0.1 - - [29/May/2025 19:27:19] "GET / HTTP/1.1" 200 -
```

Fig 2:Main.py output terminal

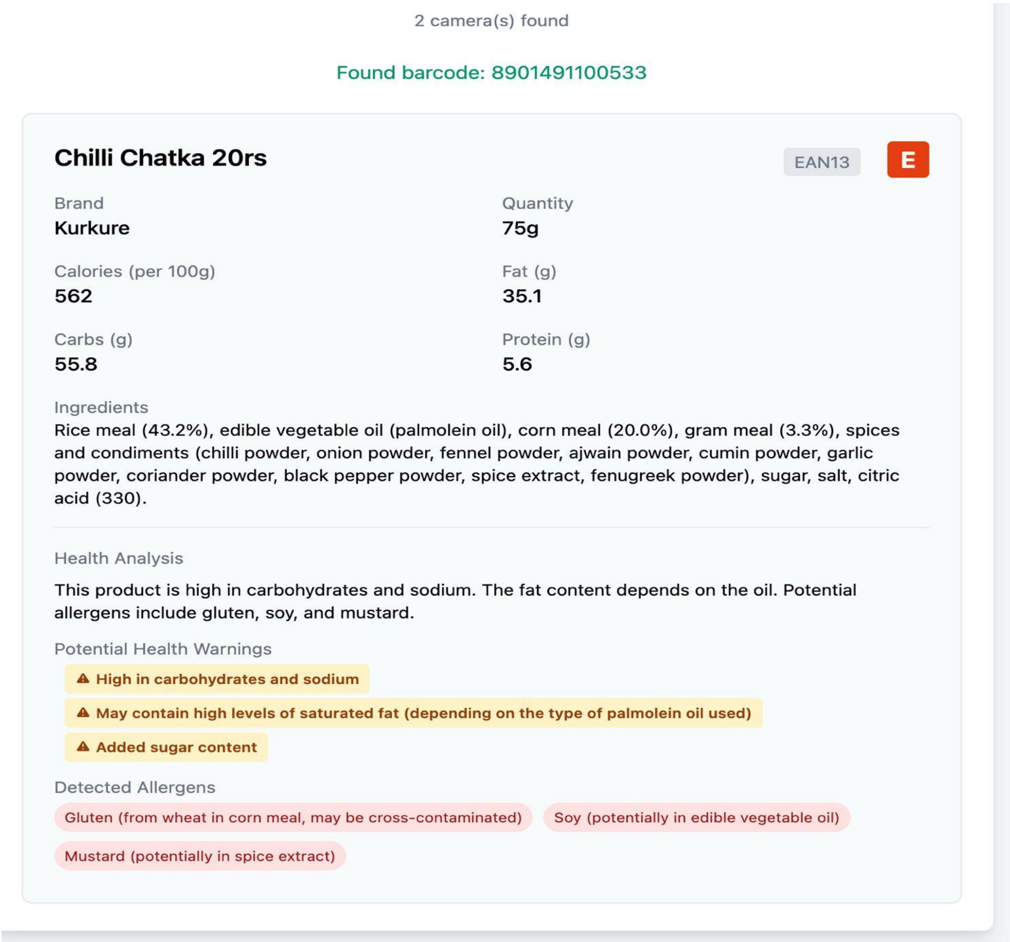

Fig 3: Scanned example product with nutrition retrieval

SDG ALIGNMENTS

1. **SDG 3 :-Good Health and Well-Being**
   The kiosk promotes informed food choices by displaying nutritional content and recommending healthier alternatives, contributing to reduced risks of lifestyle diseases such as obesity, diabetes, and heart conditions.
2. **SDG 12 :- Responsible Consumption and Production**
   By providing environmental scores and ingredient transparency, the system encourages sustainable food consumption habits and increased awareness of food sourcing and packaging.
3. **SDG 9 – Industry, Innovation, and Infrastructure**
   The project demonstrates innovative use of embedded systems, AI, and open data for public benefit, contributing to sustainable, intelligent infrastructure in public and commercial spaces

ETHICS

1**.Transparency and Explainability**
The kiosk presents nutrition data in a clear, interpretable format, allowing users to understand how product assessments and recommendations are made—promoting trust and informed decision-making.

2.Equity and Accessibility
Designed for deployment in diverse settings (e.g., schools, public health centers), the kiosk democratizes access to food knowledge, especially for those who may not have digital literacy or internet access.

3.Privacy and Data Security
As the kiosk does not collect or store personal user data, it ensures ethical handling of information and maintains user anonymity, aligning with principles of privacy by design.

PROJECT MANAGEMENT

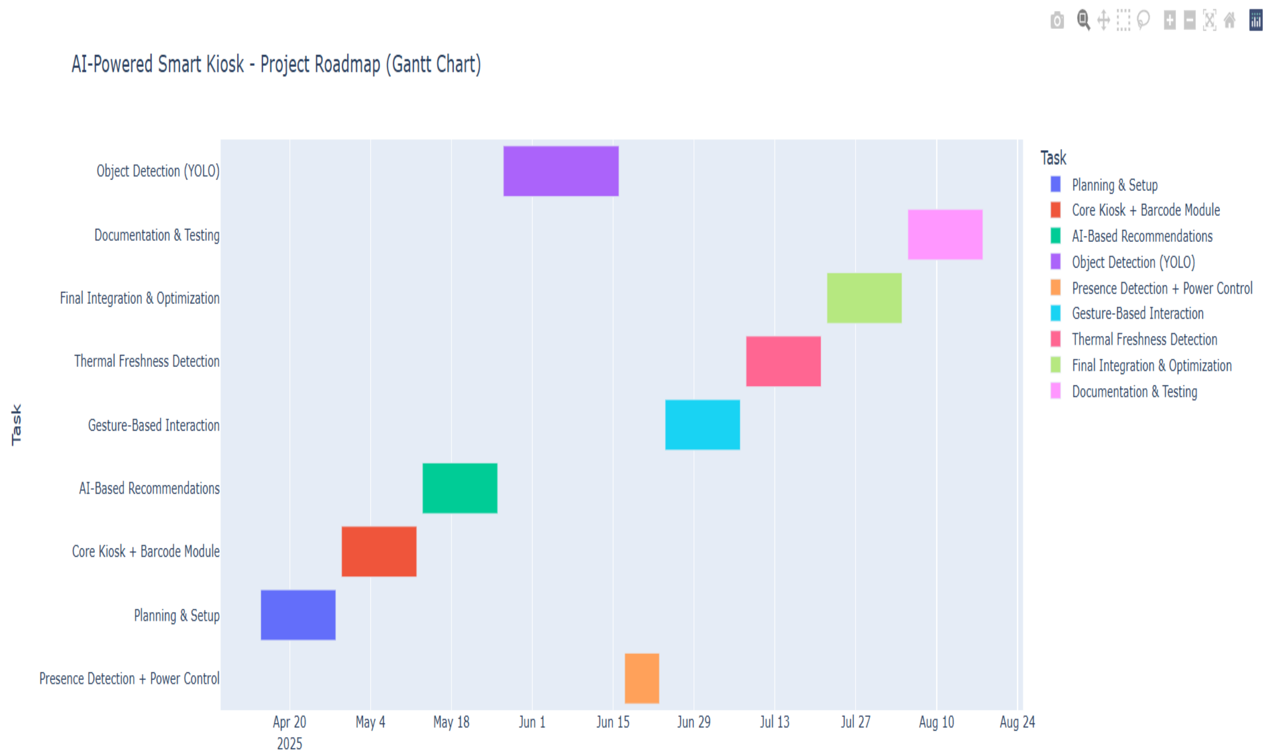

Fig 4: Gantt Chart

PHASES AND RESOURCE ALLOCATION:

1. Research and Planning Phase

This initial stage involved identifying user needs, reviewing existing food databases (like Open Food Facts), evaluating APIs, and exploring hardware compatibility with Raspberry Pi.

- **Time Allocated:** 1–2 weeks
- **Resources:** Research papers, developer forums, API documentation, Raspberry Pi specs

2. Development Phase

Core system components such as barcode scanning (using OpenCV and Pyzbar), API integration, AI-based recommendation using Gemini, local caching, and UI design were implemented.

- **Time Allocated:** 3–4 weeks
- **Resources:** Raspberry Pi, camera module, barcode/QR samples, Flask, Python libraries, local storage (e.g., SQLite), display monitor

3. Testing and Optimization Phase

Functional testing under various lighting conditions, offline scenarios, and product variations was performed. The UI was refined based on responsiveness and clarity of nutritional output.

- **Time Allocated:** 1–2 weeks
- **Resources:** Variety of food items, test datasets, debugging tools, simulated slow internet conditions

4. Deployment and Documentation Phase

Final deployment in a public-style setup was done with documentation of usage instructions, system limitations, and performance metrics. This also included report writing and presentation preparation.

- **Time Allocated:** 1–1.5 weeks
- **Resources:** Printed documentation, kiosk housing, evaluation checklist, user guides

APPLICATIONS

This project has a wide range of applications:-

- **Retail Stores and Supermarkets**
  To help customers make informed purchasing decisions by scanning packaged foods and viewing nutritional and sustainability information on the spot.
- **Educational Institutions**
  For educating students about healthy eating habits and nutrition in school and college cafeterias.
- **Hospitals and Health Clinics**
  To assist patients with dietary restrictions in evaluating food products before consumption, supporting dieticians and nutritionists.
- **Public Spaces (e.g., Malls, Railway Stations)**
  Can be deployed in high-traffic areas to raise awareness about food choices, sustainability, and health in an accessible manner.
- **Government and NGO Wellness Campaigns**
  Useful in community outreach programs to promote public health, responsible consumption, and food literacy.
- **Smart Cities and Urban Innovation Hubs**
  As part of smart infrastructure promoting citizen well-being, sustainability, and digital access to information.

CONCLUSION

The AI-powered smart kiosk project presents a novel solution to bridge the gap between consumers and accessible, understandable nutritional information. By integrating barcode scanning, real-time data retrieval from Open Food Facts, and AI-driven healthier recommendations, the system empowers users to make smarter food choices.

The project also addresses broader social and environmental goals by promoting health, responsible consumption, and technological innovation. With offline support and low-cost deployment using Raspberry Pi, the kiosk ensures accessibility in a variety of settings, from supermarkets to schools.

In conclusion, this project is not only technically feasible but also socially impactful. Our team is committed to completing the remaining stages of development and ensuring that the kiosk meets both user needs and real-world operational standards. We believe this innovation holds the potential for large-scale adoption and meaningful contributions to public health and sustainable living.

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