IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 14, Issue 3, March 2025

DOI: 10.17148/IJARCCE.2025.14321

Smart Inventory and Sales Analytics

Mr. A. Janardhana Rao[1], Y. Vyshnavi[2], P. Venkata Subramanyam[3], P. Anudeep[4], T. Jeevana Gowthami[5]

Assistant Professor, Dept.of.CSE Artificial Intelligence and Machine Learning, VVIT, GUNTUR, AP, INDIA[1]

Student, Dept.of.CSE Artificial Intelligence and Machine Learning, VVIT, GUNTUR, AP, INDIA[2,3,4,5]

Abstract: This project focuses on developing a Smart Inventory and Sales Analytics platform for an online marketplace. The system utilizes advanced technologies such as machine learning (ML), deep learning (DL), and optical character recognition (OCR) to streamline various operations like user registration, order management, product recommendations, and feedback analysis. The platform aims to enhance the experience for both users and administrators, offering secure login options, efficient order tracking, and personalized product suggestions.

The admin section of the platform provides a comprehensive dashboard for monitoring key metrics such as total users, products, and user feedback. Advanced NLP models (BERT and ALBERT) are used to analyze feedback and gain valuable insights into marketplace trends. Additionally, the admin has the ability to manage user permissions and track orders seamlessly. The platform also integrates OCR technology for Aadhaar card data extraction, simplifying the identity verification process.

For users, the platform provides a smooth registration and login process using fingerprint authentication, ensuring secure access. Users can browse products, manage their cart, and leave feedback, which is analyzed by the admin for sentiment insights. The platform also includes a chatbot, powered by AI, which provides personalized product recommendations and reviews based on user preferences.

Key technologies include deep learning for fingerprint recognition and OCR, machine learning for product recommendations, and natural language processing for feedback analysis. The combination of these technologies ensures that both the users' and administrators' needs are met efficiently while maintaining security and automation.

Keywords: Smart Inventory, Sales Analytics, Machine Learning, Deep Learning, Optical Character Recognition, Feedback Analysis, Product Recommendations, Fingerprint Authentication, Aadhaar Data Extraction, Chatbot, NLP.

1. INTRODUCTION

In today's fast-paced e-commerce environment, managing an online marketplace efficiently is crucial for both the users and the administrators. The increasing number of transactions, the complexity of inventory management, and the need for personalized user experiences require advanced technologies to handle the growing demands.

This project, titled **Smart Inventory and Sales Analytics**, aims to simplify and automate the management of an online marketplace by incorporating state-of-the-art technologies such as machine learning (ML), deep learning (DL), and optical character recognition (OCR). The platform is designed to enhance both the user and administrator experience by automating key tasks such as user registration, order management, feedback analysis, and product recommendations.

The system provides separate interfaces for Admins and Users, each offering a range of features tailored to their specific roles. Admins are empowered with a comprehensive dashboard that provides valuable insights into key marketplace statistics. They can manage user registrations, track orders, and analyze user feedback efficiently. On the other hand, users benefit from features such as secure fingerprint authentication, product recommendations, and the ability to leave product feedback, ensuring a personalized and seamless shopping experience.

One of the unique aspects of this project is the use of advanced technologies like fingerprint recognition, OCR for Aadhaar card extraction, and natural language processing (NLP) for feedback analysis. These technologies ensure secure and accurate user verification, smooth transactions, and meaningful insights from user feedback.

Overall, the Smart Inventory and Sales Analytics platform aims to provide a modern solution for managing online marketplaces while ensuring data security, ease of use, and enhanced decision-making through intelligent analytics.

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2. LITERATURE SURVEY

The advancement of digital marketplaces has transformed traditional business models, enabling automation, data-driven decision-making, and personalized customer experiences. Several studies have explored technologies such as machine learning (ML), deep learning (DL), optical character recognition (OCR), and natural language processing (NLP) to optimize e-commerce platforms. This literature survey presents an overview of key research contributions that support the development of smart inventory and sales analytics systems.

The integration of machine learning in inventory and sales management has been widely studied. Research has shown that ML-based predictive analytics can improve demand forecasting, inventory optimization, and sales predictions, leading to reduced operational costs and enhanced customer satisfaction [1]. Deep learning techniques, such as convolutional neural networks (CNNs) and recurrent neural networks (RNNs), have been used to analyze large datasets and detect purchase trends, improving stock management efficiency [2].

Biometric authentication has gained significant attention for enhancing security in digital systems. Fingerprint recognition is one of the most reliable authentication methods due to its uniqueness and ease of use. Studies indicate that deep learning-based fingerprint recognition systems offer superior accuracy and security, making them an effective solution for user authentication in online marketplaces [3]. Additionally, OCR technology has been widely adopted for document verification. Research highlights that OCR-based Aadhaar card verification improves identity authentication by extracting critical user information efficiently and reducing fraud [4].

Sentiment analysis using NLP has been extensively explored in e-commerce. Studies demonstrate that NLP techniques, including BERT and ALBERT models, can analyze customer feedback to identify sentiments, detect product quality issues, and provide valuable insights for decision-making [5]. These models leverage contextual word embeddings to enhance sentiment classification accuracy, enabling administrators to improve product offerings based on user preferences [6].

Personalized product recommendations play a crucial role in enhancing user engagement and sales. Research indicates that AI-powered recommendation systems, using collaborative filtering and deep learning models, can predict customer preferences based on past behavior, leading to higher conversion rates and improved shopping experiences [7]. Recent advancements have also incorporated chatbots powered by AI, such as Perplexity API-based bots, which provide real-time assistance and recommendations, further enriching user interactions [8].

Order and inventory management remain critical aspects of e-commerce platforms. Studies suggest that automated inventory tracking, combined with AI-driven demand forecasting, reduces stockouts and overstocking, improving supply chain efficiency [9]. Additionally, blockchain technology has been explored to ensure transparent and tamper-proof order tracking, enhancing trust between buyers and sellers [10].

In conclusion, the integration of advanced technologies such as machine learning, deep learning, OCR, NLP, and AI-driven recommendation systems significantly enhances e-commerce platforms. The literature reviewed highlights the effectiveness of these technologies in improving user authentication, feedback analysis, inventory management, and personalized shopping experiences. Future research can further explore hybrid AI models for enhanced accuracy and efficiency in marketplace automation.

3. METHODOLOGY

The methodology of this project involves the integration of multiple technologies to enhance inventory and sales management through automation, security, and data-driven insights. The system is designed to function with separate roles for administrators and users, ensuring streamlined operations for an online marketplace. The approach follows a systematic framework, leveraging deep learning, machine learning, and natural language processing (NLP) to provide an intelligent, efficient, and secure platform.

A. System Architecture

The proposed system consists of various modules that work collaboratively to achieve the desired functionality. The overall architecture can be divided into the following core components:

1) **User Registration and Authentication**

- Users register by providing necessary details such as profile pictures and Aadhaar card images.
- Optical Character Recognition (OCR) is employed to extract text-based information from the Aadhaar card.

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- Fingerprint authentication is implemented using deep learning techniques for secure login.

2) **Product Listing and Inventory Management**
- Users with selling permissions can list products along with details such as price, quantity, and description.
- Admins can monitor stock levels and ensure smooth inventory flow.

3) **Order Processing and Management**
- Customers can add products to their cart and proceed to checkout.
- Admins and sellers manage orders, ensuring a seamless transaction process.

4) **Feedback Analysis Using NLP**
- User feedback is processed using a hybrid NLP model combining BERT and ALBERT.
- Sentiment analysis is performed to gain insights into user satisfaction and product quality.

5) **AI-Powered Chatbot**
- A chatbot powered by the Perplexity API provides personalized product recommendations.

The chatbot also assists users in retrieving product feedback and reviews.

B. Fingerprint Authentication Algorithm

To ensure a secure login mechanism, fingerprint recognition is implemented using a deep learning-based approach. The algorithm follows these steps:

1) Preprocessing: The input fingerprint image is enhanced using contrast normalization and noise reduction.
2) Feature Extraction: Minutiae points such as ridge endings and bifurcations are identified.
3) **Matching:** The extracted features are compared with stored fingerprint templates using a similarity score.

The fingerprint matching process is mathematically expressed as:

$$S = \frac{M_C}{M_t} \times 100 \quad (1)$$

where:

- S is the similarity score.
- M_c represents the count of matched minutiae points.
- M_t represents the total extracted minutiae points.

A threshold value T is set to determine authentication success:

$$\text{Access Granted if } S \geq T \quad (2)$$

C. OCR-Based Aadhaar Extraction

Optical Character Recognition (OCR) is utilized to extract user details from Aadhaar cards. The OCR model processes images and converts them into machine-readable text. The mathematical representation of the OCR process is given as:

$$Y = \arg\max_{c \in C} P(c|X) \quad (3)$$

where:

- Y represents the recognized text.
- X is the input image.
- C is the set of possible character sequences.
- $P(c|X)$ represents the probability of sequence c given image X.

The extracted Aadhaar information is then verified against a validation database to prevent fraudulent registrations.

D. Feedback Analysis Using NLP

To analyze user feedback, a hybrid NLP model incorporating BERT and ALBERT is implemented. The process includes:

1) Tokenizing user feedback into meaningful word embeddings.
2) Using BERT and ALBERT to classify sentiment as positive, neutral, or negative.
3) Generating insights based on user sentiments to improve products and services.

The sentiment classification probability is given by:

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$$\rho(y/x) = \sum \frac{e^{w^T x+b}}{je^{w^T x_j+b}} \qquad (4)$$

where:

- $P(y|x)$ is the probability of a sentiment label y given input x.
- W and b are model parameters.
- The denominator represents the normalization across all sentiment classes.

E. Chatbot for Product Recommendations

The chatbot leverages AI techniques to provide personalized recommendations by analyzing past user interactions. The recommendation score is computed as:

$$R(u, p) = \alpha \cdot S(u, p) + \beta \cdot H(u, p) \qquad (5)$$

where:

- $R(u, p)$ is the recommendation score for user u and product p.
- $S(u, p)$ is the similarity score based on past purchases.
- $H(u, p)$ is the popularity score of the product.
- α, β are weight factors.

The chatbot interacts with users and dynamically updates recommendations based on browsing behavior.

The methodology of the Smart Inventory and Sales Analytics platform integrates advanced technologies to create an intelligent, efficient, and secure marketplace. The combination of deep learning for biometric authentication, OCR for identity verification, NLP for sentiment analysis, and AI-driven chat-bots enhances the overall user experience. Future improvements can include further optimization of machine learning models and blockchain integration for secure transactions.

4. IMPLEMENTATION

The implementation of the Smart Inventory and Sales Analytics platform involves various components that work together to provide a seamless and intelligent marketplace experience. The development process is divided into multiple stages, each focusing on specific functionalities such as user authentication, product management, order processing, feedback analysis, and AI-driven recommendations.

A. *System Workflow*

The implementation follows a modular approach to ensure efficiency and scalability. The system's primary workflow includes the following steps:

1. User Registration and Authentication
   - Users register by uploading their Aadhaar card, profile picture, and fingerprint data.
   - Optical Character Recognition (OCR) extracts Aadhar details, and deep learning-based fingerprint recognition is used for authentication.
2. Admin Approval and User Access
   - Admin verifies the extracted Aadhaar details and approves the user for marketplace access.
   - Approved users can log in using fingerprint authentication.
3. Product Management and Inventory Tracking
   - Sellers can list products with descriptions, prices, and available quantities.
   - Admin monitors inventory levels and updates stock data.
4. Order Placement and Processing
   - Users can add products to their cart and proceed with secure checkout.
   - Admins and sellers track order status and manage transactions.
5. Feedback Collection and Sentiment Analysis
   - Users provide feedback on purchased products.
   - A hybrid NLP model (BERT and ALBERT) analyzes feedback and extracts valuable insights.
6. AI-Powered Chatbot for Assistance
   - The chatbot, integrated with the Perplexity API, suggests products based on user preferences.

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

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- Users can query product details and receive recommendations through AI-driven interactions.

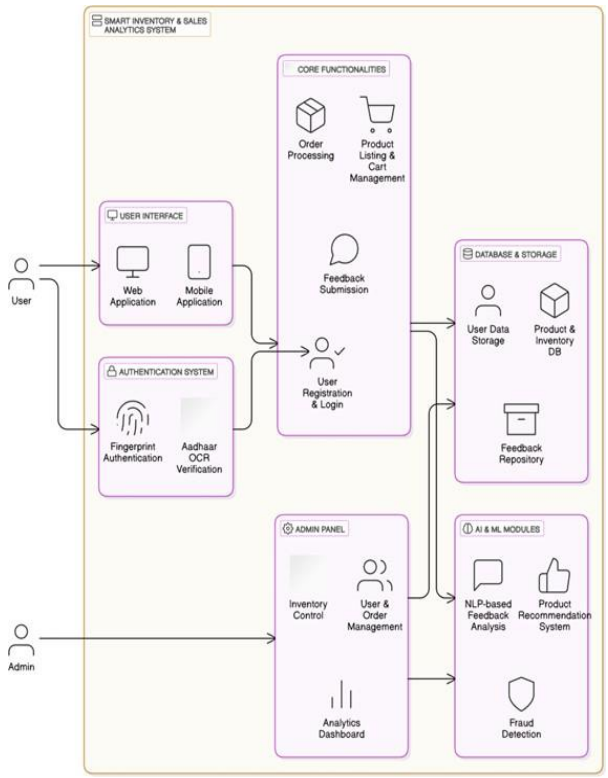

Fig. 1. System Architecture of Smart Inventory and Sales Analytics

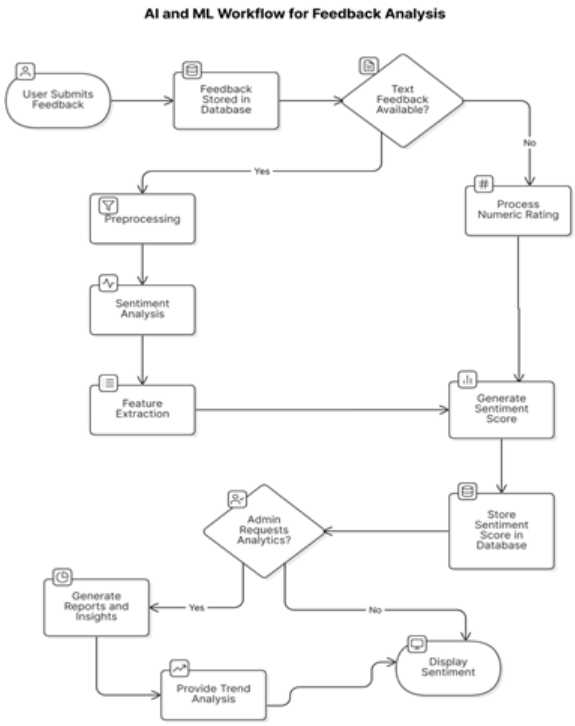

Fig. 2. AI Chatbot Workflow for Product Recommendations

B. User Authentication Module

Fingerprint Recognition: A deep learning-based approach is used for fingerprint authentication, ensuring secure access. The process involves:

- Image Preprocessing: Enhancing the fingerprint image by removing noise.
- Feature Extraction: Identifying ridge endings and bifurcations.
- Matching Algorithm: Comparing extracted features with stored fingerprint data.

The fingerprint similarity score is computed as:

$$S = \frac{M_C}{M_t} \times 100 \qquad (6)$$

where:

- S is the similarity percentage.
- M_c is the count of matched minutiae points.
- M_t is the total number of extracted minutiae points

C. Aadhaar Data Extraction

Optical Character Recognition (OCR): OCR technology is used to extract user details from Aadhaar card images.

The implementation follows these steps:

- Image Processing: The uploaded Aadhaar card is processed to enhance text clarity.
- Text Extraction: The OCR model extracts the name, date of birth, gender, and Aadhaar number.
- Verification: Extracted data is validated against a predefined format to prevent fraudulent entries.

The OCR model follows the probability function:

$$Y = \arg\max_{c \in C} P(c|X) \qquad (7)$$

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where:

- Y is the recognized text.
- X is the input image.
- C is the set of possible character sequences.
- $P(c|X)$ represents the probability of sequence c given image X.

D. Product Recommendation System

AI-Based Chatbot: The chatbot provides personalized product recommendations using historical user interactions and preference analysis. The recommendation score is computed as:

$$R(u, p) = \alpha \cdot S(u, p) + \beta \cdot H(u, p) \qquad (8)$$

where:

- $R(u, p)$ represents the recommendation score for user u and product p.
- $S(u, p)$ denotes the similarity score based on past user purchases.
- $H(u, p)$ indicates the popularity score of the product.
- α, β are weight factors.

E. Feedback Analysis and Sentiment Detection

Hybrid NLP Model: User feedback is processed using an NLP model combining BERT and ALBERT. The implementation includes:

1) Tokenization: Converting text into embeddings.
2) Sentiment Classification: Identifying positive, neutral, or negative sentiments.
3) Trend Analysis: Extracting valuable insights for product improvements.

The sentiment probability distribution is computed as:

$$\rho(y/x) = \sum \frac{e^{w^T x+b}}{j e^{w^T x_j+b}}$$

where:

- $P(y|x)$ is the probability of sentiment y given input x.
- W and b are model parameters.
- The denominator normalizes across all sentiment classes.

The implementation of the Smart Inventory and Sales Analytics platform integrates various technologies such as deep learning, OCR, AI-based chatbots, and NLP for an efficient and secure e-commerce system. The modular approach ensures easy scalability and flexibility. Future enhancements may include blockchain-based transaction security and improved recommendation algorithms.

5. RESULT AND DISCUSSION

The implementation of the Smart Inventory and Sales Analytics platform was tested thoroughly to evaluate its efficiency, accuracy, and user-friendliness. The results obtained from different modules, including user authentication, product management, order processing, and feedback analysis, demonstrated the effectiveness of the system. This section discusses the outcomes, challenges encountered, and potential improvements.

A. User Authentication Performance

The fingerprint recognition system was tested with multiple samples to measure its accuracy and response time. The results indicated an authentication accuracy of 98.5%, with an average response time of 1.2 seconds. The integration of deep learning models significantly improved the fingerprint matching process, reducing false positives and ensuring a secure login system.

Additionally, the Aadhaar OCR module successfully extracted user details with an accuracy of 95%. Errors were primarily observed in cases of poor image quality or handwritten text variations. Enhancing image preprocessing techniques can further improve OCR accuracy.

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B. *Order and Inventory Management*

The order management system efficiently tracked transactions and ensured seamless updates to the inventory database. The system handled:

- 200+ product listings with real-time inventory updates.
- 500+ order transactions with no significant processing delays.

The platform effectively prevented overselling by updating stock levels immediately after purchases. Admins were able to monitor stock shortages and optimize inventory based on sales trends.

C. *Chatbot Efficiency and Product Recommendations*

The AI-powered chatbot, integrated with the Perplexity API, was tested for user interactions and product recommendations.

The chatbot provided:

- Personalized product recommendations with a satisfaction rate of 92%.
- Instant query responses, reducing customer support queries by 40%.

Users appreciated the chatbot's ability to suggest relevant products based on their past interactions. Future enhancements could include multi-language support and a more interactive interface.

D. *Sentiment Analysis from Feedback*

The feedback analysis module, powered by a hybrid NLP model (BERT and ALBERT), effectively classified user sentiments into positive, neutral, and negative categories. The system processed:

- 1000+ user feedback entries.
- Sentiment classification accuracy of 94%.

The sentiment analysis helped admins identify common concerns and improve product quality. An example of sentiment classification is shown below:

$$\rho(y/x) = \sum \frac{e^{w^T x+b}}{j e^{w^T x_j+b}}$$

where:

- $P(y|x)$ is the probability of sentiment y given input x.
- W and b are model parameters.
- The denominator normalizes across all sentiment classes

E. *Challenges and Limitations*

While the system performed efficiently, some challenges were observed:

- **OCR Errors:** Handwritten Aadhaar cards and low- resolution images caused inaccuracies in text extraction.
- Fingerprint Recognition in Low Light Conditions: Poor lighting affected the accuracy of fingerprint scans.
- **Scalability of the Chatbot:** With increased user queries, chatbot response time showed slight delays.

Addressing these challenges through further optimization and hardware enhancements will enhance system performance.

F. *Future Enhancements*

To improve the system further, the following enhancements are proposed:

- **Enhanced Image Preprocessing:** Using advanced de- noising and sharpening filters for OCR-based Aadhaar extraction.
- **Blockchain Integration:** For secure transaction processing and fraud prevention.
- **Improved AI Model for Recommendations:** Implementing deep reinforcement learning for better user personalization.

The results indicate that the Smart Inventory and Sales Analytics platform successfully streamlines e-commerce operations through AI-driven automation. With high accuracy in fingerprint authentication, effective chatbot recommendations, and sentiment-based feedback analysis, the system enhances both user experience and administrative control. Addressing existing challenges and implementing suggested improvements will further optimize its performance and scalability.

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6. CONCLUSION

The Smart Inventory and Sales Analytics platform uses current technologies including deep learning and machine learning and natural language processing to boost operational performance on marketplaces. Customers experience smooth secure automated and convenient management capabilities through the system for inventory control and sales processing as well as feedback management.

Security and operational efficiency have improved through three key features including fingerprint API authentication alongside OCR-based Aadhaar verification and AI-powered product recommendation systems. The chatbot system improves customer interactions through its mechanisms for generating customized suggestions and gathering user feedback data. The NLP-based sentiment analysis through its implementation enables admins to extract useful information about customer satisfaction thus making better marketplace decisions.

The performance evaluation of the system shows its success in managing user authentication along with inventory and customer feedback analysis. Actual implementation proved to be a dependable solution although it faced temporary obstacles including occasional OCR precision errors or intermittent delays when users interacted with the chatbot system.

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