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# Intelligent Web-Based Inventory Automation Platform using OCR & NLP Techniques

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***Abstract-*** ***The rapid growth of unstructured business data, such as invoices and receipts, has created significant challenges in efficient inventory management. This paper presents an intelligent web-based inventory automation platform that leverages Optical Character Recognition (OCR) and Natural Language Processing (NLP) techniques to streamline stock management processes. The system enables users to input data through text commands or upload documents, including PDFs, images, and spreadsheets, which are processed using OCR for text extraction. The extracted information is further refined using a Large Language Model (LLM)-based mapping approach to align unstructured data with structured inventory records stored in a Supabase database. The proposed system integrates a React-based frontend for user interaction with a FastAPI backend that performs document parsing, context-aware data processing, and intelligent mapping using Groq LLM. This approach provides a scalable and intelligent solution for automating inventory updates, making it suitable for modern enterprise applications dealing with high volumes of semi-structured and unstructured data.***

***Index Terms-*** ***Inventory Automation, Optical Character Recognition (OCR), Natural Language Processing (NLP), Large Language Models (LLM), Groq LLM, Document Processing, AI-based Inventory Management.***

## I. INTRODUCTION

In recent years, businesses have experienced a rapid increase in the volume of unstructured data generated through invoices, receipts, and transactional documents. Traditional inventory management systems rely heavily on manual data entry or rigid structured formats, making them inefficient, error-prone, and time-consuming. With the advancement of Artificial Intelligence (AI), particularly in Optical Character Recognition (OCR) and Natural Language Processing (NLP), there is a growing opportunity to automate and enhance inventory-related operations.

This work presents an intelligent inventory automation platform that integrates OCR and NLP techniques with Large Language Models (LLMs) to process and interpret unstructured data. The system enables users to upload documents or provide natural language inputs, which are automatically analyzed ,retrieved and converted into structured inventory updates. By leveraging a web-based architecture with a React frontend and a FastAPI backend, the platform ensures seamless user interaction andefficient backend processing backend, the platform ensures seamless user interaction and efficient backend processing. Furthermore, the integration of an AI-powered assistant allows users to interact with the system using conversational queries, enabling intuitive access to inventory insights and historical data. Real-time efficient backend processing. Furthermore, the integration of an AI-powered assistant allows users to interact with the system using conversational queries, enabling intuitive access to inventory insights and historical data. Real-time synchronization and database integration ensure that all updates are consistently reflected across the platform. This approach significantly reduces manual effort, improves accuracy, and enhances decision-making capabilities in inventory management systems.

## II. LITERATURE REVIEW

Recent advancements in Artificial Intelligence have significantly influenced the development of intelligent inventory management systems. The literature highlights the increasing adoption of OCR

and NLP techniques to automate data extraction from unstructured documents such as invoices and receipts. While individual components such as OCR or database systems are well explored, comprehensive AI-driven platforms that unify these technologies into a single automated workflow remain limited.Numerous studies have explored the use of OCR techniques for extracting textual information from invoices and business documents. Technologies such as Tesseract and PaddleOCR have been widely used to convert scanned images and PDFs into machine-readable text. These approaches demonstrate significant improvements in reducing manual data entry and processing time.

Natural Language Processing has been extensively applied to extract meaningful entities and relationships from unstructured text. Research in this domain includes named entity recognition, semantic parsing, and text classification to identify product names, quantities, and other relevant attributes. However, traditional NLP approaches lack contextual understanding, which restricts their ability to accurately map extracted information to structured databases.Recent studies have proposed AI-based inventory systems that integrate machine learning algorithms for demand forecasting and stock optimization. These systems enhance decision-making and operational efficiency by analyzing historical data. However, they often rely on structured inputs and do not address the automation of data ingestion from unstructured sources.Recent advancements in Large Language Models (LLMs) have significantly improved the ability to process and interpret unstructured text data. Models such as transformer-based architectures have demonstrated strong capabilities in understanding context, extracting relevant information, and generating structured outputs from complex inputs. The integration of LLMs with real-time systems remains a challenge due to latency and scalability concerns, indicating the need for efficient and optimized AI pipelines.

## III. PROBLEM STATEMENT

In modern business environments, inventory management plays a critical role in ensuring operational efficiency and informed decision-making. However, a significant portion of inventory-related data is still generated in unstructured or semi-structured formats, such as invoices, receipts, purchase orders, and vendor documents. Processing this data typically involves manual entry into inventory systems, which is not only time-consuming but also highly prone to human errors, inconsistencies, and delays. These inefficiencies can lead to inaccurate stock records, poor demand forecasting, and ultimately financial losses.

Existing inventory management systems are primarily designed to handle structured data and lack the capability to effectively process unstructured inputs. While some systems provide basic digitization features, they often fail to accurately extract and interpret complex information from diverse document formats. Moreover, these systems do not leverage advanced AI techniques to intelligently map extracted data to existing inventory records, resulting in additional manual intervention and reduced productivity. Furthermore, most systems do not support real-time updates and monitoring, leading to delays in reflecting stock changes and reducing the responsiveness of business operations.Additionally, handling bulk document uploads and maintaining consistency across large datasets remains a challenge. Therefore, there is a critical need for a comprehensive and intelligent system that can automate the extraction of data from unstructured documents, accurately interpret and map this information to structured inventory databases, and provide real-time updates with natural language interaction support.

## IV. OBJECTIVE

The primary objective of this study is to design and develop an intelligent inventory automation platform capable of efficiently processing unstructured and semi-structured data using advanced Artificial Intelligence techniques. The system aims to leverage Optical Character Recognition (OCR) to accurately extract textual information from various document formats such as invoices, receipts, and spreadsheets, thereby eliminating the dependency on manual data

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entry. Furthermore, Natural Language Processing (NLP) and Large Language Models (LLMs) are employed to interpret the extracted data and transform it into structured formats that can be seamlessly integrated into inventory databases.

Another key objective is to minimize manual data entry and associated errors by automating the process of inventory updates for both purchase and sales transactions. The study also aims to incorporate a validation mechanism that allows users to verify and confirm extracted data before final submission, ensuring data accuracy and reliability. The system also focuses on enabling intuitive user interaction through a web-based interface and a chat-based assistant, allowing users to perform inventory queries and operations using natural language. Real-time data synchronization is another key objective, ensuring that all inventory updates are instantly reflected across the platform to support timely decision-making and operational efficiency. Overall, the objective is to create a scalable, efficient, and intelligent inventory automation solution that enhances accuracy, reduces operational overhead, and supports modern enterprise requirements through AI-driven technologies.

## V. SYSTEM ANALYSIS

System analysis is a crucial phase in the development of the proposed intelligent inventory automation platform, as it defines the functional and non-functional requirements of the system and evaluates existing limitations. The proposed system is designed to address the challenges associated with manual inventory management and the processing of unstructured data by integrating advanced OCR and NLP techniques within a scalable web-based architecture.

### A. Existing System

The existing inventory management systems primarily rely on manual data entry or partially digitized processes. In these systems, data from invoices, receipts, and other transactional documents must be manually interpreted and entered into the database. This approach is time-consuming and highly prone to human errors, leading to inaccuracies in stock levels and inconsistencies in records. Although some systems incorporate basic OCR for text extraction, they often lack the capability to intelligently interpret and structure the extracted data. Furthermore, these systems are limited to structured inputs and predefined formats, making them unsuitable for handling diverse and unstructured document types.

### B. Proposed System

The proposed system introduces an intelligent inventory automation platform that leverages OCR, NLP, and LLM-based techniques to address the limitations of existing systems. The platform is designed as a web-based application that allows users to input data through text commands or upload unstructured documents such as invoices, receipts, and spreadsheets. A key feature is the integration of a verification mechanism that allows users to review and confirm the processed data before it is committed to the database. The system also includes a chat-based assistant that enables users to interact with the platform using natural language queries.

### C. System Architecture

The overall architecture of the system consists of three major components: the frontend, the backend, and the database. The frontend is a React-based interface providing functionalities such as dashboard visualization, product monitoring, document upload, and a chat-based assistant. The backend is a FastAPI-based server responsible for handling document processing through OCR, NLP interpretation, and Groq LLM-based intelligent mapping. The database is implemented using Supabase, maintaining inventory records including stock levels and update history. Context pruning techniques are applied within the backend to filter relevant information, thereby improving processing efficiency and reducing computational overhead.

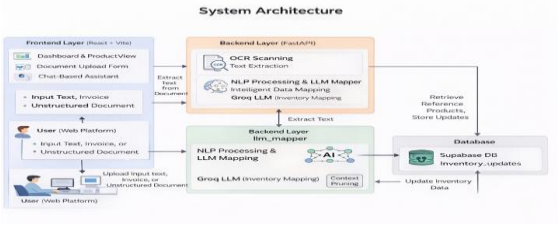


Fig. 1. System Architecture Diagram

### D. Data Flow Diagram

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The Data Flow Diagram (DFD) illustrates the systematic movement of data within the proposed system. The process begins with the user providing input as text commands or uploaded documents. These inputs are forwarded to the document processing stage where OCR converts image-based or scanned documents into machine-readable text. The processed data then moves to the data transformation stage where NLP and LLM interpret and structure the information. Finally, the system generates output presented as updated inventory details, confirmations, or dashboard visualizations. The system is designed to handle both structured and unstructured inputs, enabling flexible interaction through a unified interface. The input data is then forwarded to the document processing stage.In this phase, Optical Character Recognition (OCR) techniques are applied to convert image-based or scanned documents into machine-readable text..Following text extraction, the processed data moves to the data transformation stage, which forms the core intelligence of the system

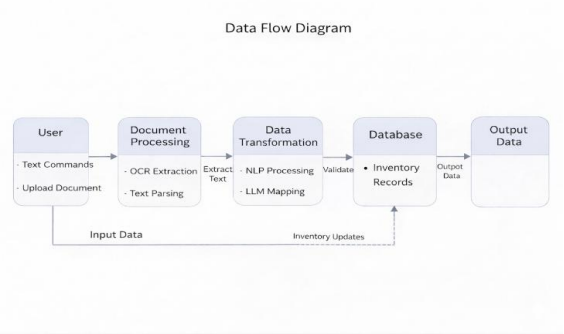


Fig. 2. Data Flow Diagram

## VI. METHODOLOGY

The proposed intelligent inventory automation system follows a structured and modular methodology to transform unstructured user inputs into accurate and validated inventory updates. The methodology is designed to ensure efficiency, scalability, and reliability by integrating document processing, natural language understanding, and intelligent mapping techniques within a unified workflow.

### A. User Input Module

The User Input Module serves as the entry point of the system, allowing users to interact through a web-based interface. Users can provide input in the form of natural language text commands, upload invoices, or submit unstructured documents. This module ensures flexibility by supporting multiple input formats and acts as the primary interface for initiating inventory updates.

### B. Document Processing Module

The Document Processing Module is responsible for handling uploaded files and extracting relevant textual data. It utilizes OCR techniques to convert scanned documents and images into machine-readable text. Additionally, basic preprocessing such as text cleaning and formatting is performed to prepare the data for further analysis.

### C. NLP Processing Module

The NLP Processing Module analyzes the extracted or input text to understand its semantic meaning. It identifies key entities such as product names, quantities, and actions. This module plays a crucial role in interpreting user intent and structuring the raw input into meaningful information.

### D. LLM Mapping Module

The LLM Mapping Module leverages Groq-based Large Language Models to transform the processed textual data into structured inventory records. It performs intelligent mapping between extracted entities and the database schema. Context pruning is applied within this module to eliminate irrelevant information, ensuring accurate and efficient data transformation.

### E. Chat Assistant Module

The AI Assistant Module serves as an intelligent interaction layer that enables users to communicate with the system using natural language queries. This module enhances usability by allowing users to retrieve inventory-related information, track updates, and gain insights without requiring technical knowledge of the underlying system.

## VII. RESULTS AND DISCUSSION

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The implementation of the proposed system demonstrates effective automation of inventory management through intelligent processing of user inputs and documents. The system successfully integrates multiple components to deliver accurate, real-time inventory updates and interactive user experiences. The following subsections describe the key output screens from the deployed application.

A. Dashboard

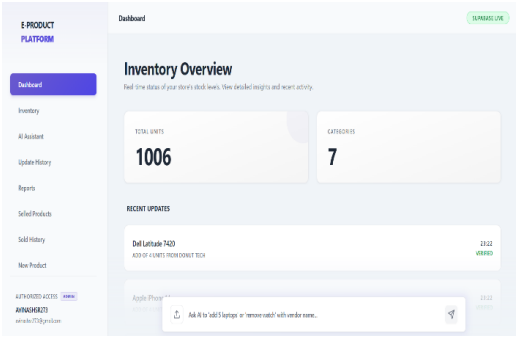


Fig. 3. System Dashboard

The dashboard output presents a structured view of products and categories, enabling users to monitor inventory status efficiently. It provides a clear overview of available stock, improving visibility and management across different product categories.

B. Reports


Fig. 4. Reports Screen

The reports module displays inventory transaction data in a tabular format, showing purchase and sales records along with their corresponding quantities and timestamps. This enables administrators to track inventory movements and generate operational insights.

C. Update History

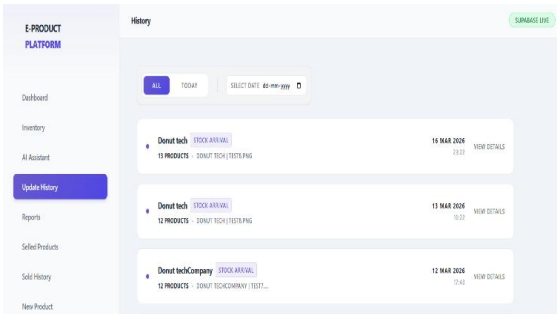


Fig. 5. Update History Screen

The update history module maintains a detailed log of all inventory changes performed by the system. Each entry captures the product, transaction type, quantity, source document, and processing timestamp, providing a complete audit trail of automated inventory operations.

## VIII. CONCLUSION

The proposed intelligent inventory automation platform demonstrates an effective integration of OCR and NLP techniques to address the challenges associated with traditional inventory management systems. By enabling the processing of unstructured documents such as invoices and receipts, the system significantly reduces manual effort and minimizes human errors. The incorporation of a Large Language Model further enhances the system's ability to interpret, structure, and map data accurately to existing inventory records.

The developed web-based platform provides a user-friendly interface for managing inventory operations, including real-time monitoring, automated stock updates, and interactive querying through a chat-based assistant. The use of a centralized Supabase database ensures data consistency and supports efficient storage and retrieval of inventory information. The database design incorporates structured relational tables covering products, transactions, document logs, and chat history, ensuring comprehensive data management. Overall, the project successfully achieves its objective of developing an automated, intelligent, and scalable inventory management platform.

## IX. LIMITATIONS

The proposed intelligent inventory automation platform, while effective in demonstrating the integration of OCR and NLP techniques for automated inventory management, is subject to certain limitations that should be acknowledged. The accuracy of the OCR module is highly dependent on the quality of input documents, and scanned invoices or receipts with poor resolution, uneven lighting, or handwritten content may result in incomplete or incorrect text extraction, which directly impacts the reliability of subsequent processing stages.

The system currently relies on the Groq-based Large Language Model API for intelligent data mapping, which introduces dependency on external service availability and internet connectivity. In scenarios involving high-volume document processing or network instability, API latency may increase response times and affect the real-time performance of the platform. Furthermore, the overall accuracy of data mapping is inherently constrained by the capabilities of the underlying language model.

The verification mechanism, while enhancing data accuracy, introduces a manual validation step that may reduce overall automation efficiency in high-throughput enterprise workflows. Finally, the system has been evaluated on moderate data volumes and has not been tested under large-scale enterprise conditions involving simultaneous bulk uploads, indicating that further infrastructure optimization would be necessary before deployment in high-demand production environments.

## X. FUTURE ENHANCEMENTS

The proposed system can be further enhanced by incorporating advanced techniques and additional functionalities to improve its performance and usability. Future improvements may include the integration of more sophisticated computer vision algorithms to enhance OCR accuracy, especially for low-quality or complex documents. The system can also be extended to support multilingual document processing, enabling wider applicability across different regions and industries.

Developing a mobile-based application would improve accessibility and allow users to manage inventory operations on the go. Integration with enterprise systems such as ERP and accounting platforms can enable seamless data exchange and end-to-end automation of business processes. The AI assistant can be enhanced with predictive analytics capabilities to support demand forecasting, stock optimization, and intelligent decision-making. The system can also be enhanced by incorporating role-based access control, allowing different levels of system access to be assigned to administrators, warehouse managers, and standard users. This would improve the security and governance of the platform in multi-user enterprise environments. Alongside this, advanced analytics dashboards with customizable reporting features, business insights will support strategic decision-making. Implementing anomaly detection mechanisms can help identify unusual inventory patterns and potential errors. Deployment on scalable cloud infrastructure and the inclusion of role-based access control with advanced analytics dashboards can further improve system performance, security, and user experience.

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