

AI-Powered Inventory and Quality Monitoring System

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1. Introduction

Efficient inventory management is a critical challenge, especially for businesses dealing with large volumes of perishable goods, such as retail, food, and pharmaceutical industries. Stock mismanagement, deterioration of products, and expiration date oversight can lead to significant financial losses and a decline in customer trust.

This project aims to develop a system that automates stock tracking and quality control by leveraging computer vision and machine learning. Through stock tracking and image recognition, we will monitor defective or nearly expired products, assess product quality, track the level of deterioration, and eliminate the need for manual processes. Additionally, by integrating historical sales data, we will implement forecasting algorithms to optimize inventory levels and reduce wastage.

Our approach seeks to offer businesses a modern, AI-driven solution that enhances accuracy in stock management, minimizes product spoilage through tracking level of deterioration via image recognition, and streamlines the decision-making process for reordering inventory.

2. Problem Statement

Manual stock tracking and quality monitoring can be inefficient, leading to errors, product waste, and stock mismanagement. These inefficiencies can negatively impact business operations, especially in industries dealing with foods. Furthermore, expiration date management and defect detection are often overlooked or inaccurately assessed, resulting in potential financial losses and reduced customer trust.

3. Objectives

The main objectives of this project are:

- To automate the stock tracking process.
- To develop a system that can measure product deterioration and defects from images, enabling accurate quality monitoring.
- To track and monitor product expiration dates.
- To utilize historical sales data to optimize forecasting and improve inventory decision-making.

4. Scope

This project will focus on the following core areas:

- **Stock Tracking:** Real-time monitoring of product availability and stock levels using image recognition.
- **Product Quality Control:** Analyzing product images to detect signs of wear, defects.
- **Deterioration Level Tracking:** Analyzing the level of deterioration using an image recognition machine learning model.
- **Expiration Date Monitoring:** Using computer vision to recognize expiration dates on product packaging and flagging items nearing expiration.
- **Inventory Forecasting:** Leveraging historical sales data and machine learning algorithms to forecast future stock needs and optimize reordering processes.

5. Methodology

To achieve the project goals, the following steps will be undertaken:

1. **Dataset:** We will gather a dataset of product images in various conditions, including normal, deteriorated, and defective items. The dataset will include images of packaging with visible expiration dates.
2. **Machine Learning Models:**
 - **Image Recognition:** We will use convolutional neural networks (CNNs) for visual analysis of product images to detect defects, deterioration level and identify expiration dates. Transfer learning may be applied to pre-trained models like ResNet or MobileNet to enhance both speed and accuracy.
 - **Sales Data Analysis:** Time-series forecasting will be in the format of CNN for future prediction.
3. **System Design:** The system will be divided into the following modules:
 - **Stock Tracking Module:** Tracks the products to update stock levels automatically.
 - **Quality Monitoring Module:** Evaluates product conditions based on visual analysis, checking for defects.
 - **Deterioration Level Tracking:** Analyzing the level of deterioration using an image recognition machine learning model.
 - **Forecasting Module:** Analyzes sales data to predict future stock requirements.
4. **Implementation:** The system will be developed using Python and PyTorch for machine learning models, and a suitable web framework for the user interface. The database will store both stock information and historical sales data for future analysis.

6. Expected Outcomes

The final system is expected to deliver the following outcomes:

- A fully functional stock tracking system.
- An accurate image recognition-based product quality monitoring tool capable of detecting deterioration and defects of food.
- An expiration date tracking feature to flag products nearing expiration.
- An optimized inventory forecasting system to reduce over-stocking or under-stocking issues.

7. Tools and Technologies

- **Programming Languages:** Python, Java
- **Frameworks:** PyTorch, React, SpringBoot
- **Libraries:** OpenCV, Scikit-learn, Pandas
- **Machine Learning Models:** CNNs, Time-Series Forecasting
- **Database:** PostgreSQL - NoSQL

8. Summary

Our project proposes an innovative solution to automate stock management and quality control through image recognition and machine learning. This system will streamline inventory tracking, improve product quality monitoring, and provide accurate forecasting capabilities. It holds significant potential for various industries, particularly those managing perishable goods. Through this project, we aim to demonstrate the practical application of AI in solving real-world business challenges.