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AI Based Real-time Vegetable/Fruits Quality and Price Prediction for Bajarsamiti

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Abstract: *Agricultural markets such as Bajarsamiti play a vital role in determining the quality assessment and pricing of perishable commodities like fruits and vegetables. However, traditional methods of quality grading and price determination rely heavily on manual inspection, which is time-consuming, subjective, and prone to inconsistencies. This paper presents an AI-based real-time vegetable and fruit quality assessment and price prediction system that leverages computer vision and machine learning techniques to automate these processes. The proposed system captures real-time images of agricultural produce and applies image preprocessing, feature extraction, and segmentation techniques to analyze visual attributes such as color, texture, and shape. Deep learning models, including Convolutional Neural Networks (CNN), are used to classify produce into quality grades, while regression and Long Short-Term Memory (LSTM) models are employed to predict market prices dynamically based on quality, historical trends, and demand patterns. The system provides real-time outputs through a dashboard, enabling transparent and data-driven decision-making for farmers, traders, and Bajarsamiti officials. Experimental results demonstrate that the proposed approach improves accuracy, reduces human error, ensures fair pricing, and enhances operational efficiency in agricultural markets. This work contributes to the digital transformation of the agriculture sector by promoting intelligent, automated, and scalable market systems.*

Keywords: Artificial Intelligence, Machine Learning, Computer Vision, Fruit and Vegetable Quality Assessment, Price Prediction, CNN, LSTM, Image Processing, Smart Agriculture, Bajarsamiti

I. INTRODUCTION

1.1 Overview

Agriculture remains the backbone of the Indian economy, providing livelihood to a large segment of the population and ensuring food security for the nation. Fruits and vegetables constitute a major share of agricultural produce traded daily in wholesale markets such as Bajarsamiti. These commodities are highly perishable in nature, and their quality directly influences market value, consumer satisfaction, and overall supply chain efficiency. Ensuring accurate quality assessment and fair price determination is therefore essential for maintaining transparency and sustainability in agricultural trade.

Traditionally, the quality grading and pricing of fruits and vegetables in Bajarsamiti are carried out through manual inspection by traders and commission agents. This conventional approach is largely subjective and depends on individual experience and visual judgment. As a result, it often leads to inconsistencies in grading, price manipulation, and disputes between farmers and traders. Moreover, manual evaluation becomes inefficient when handling large volumes of produce, especially during peak harvesting seasons, leading to delays and increased post-harvest losses.

With the rapid advancement of Artificial Intelligence (AI) and Machine Learning (ML), intelligent solutions are now being adopted across various sectors to automate complex decision-making processes. In agriculture, AI-based systems have shown significant potential in improving productivity, quality assessment, and market forecasting. By utilizing

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computer vision and data-driven models, AI can analyze agricultural produce objectively and consistently, thereby eliminating human bias and enhancing reliability in quality evaluation.

Image processing plays a crucial role in automated quality assessment of fruits and vegetables. Visual characteristics such as color, texture, size, and shape provide important indicators of freshness, ripeness, and defects. Advanced image preprocessing techniques enable the extraction of these features from real-time images captured using cameras. When combined with machine learning algorithms, these features can be effectively used to classify produce into different quality grades with high accuracy.

Deep learning models, particularly Convolutional Neural Networks (CNN), have proven to be highly effective in image-based classification tasks. CNNs automatically learn complex visual patterns from image data, making them suitable for detecting surface defects, color variations, and textural changes in agricultural produce. In addition, traditional machine learning classifiers such as Support Vector Machines (SVM) can be used alongside deep learning models to improve classification precision and robustness under varying environmental conditions.

Apart from quality grading, accurate price prediction is a major challenge in agricultural markets due to factors such as seasonal variations, demand-supply fluctuations, and market dynamics. Conventional pricing methods fail to adapt to these rapidly changing conditions. AI-based price prediction models, including regression techniques and Long Short-Term Memory (LSTM) networks, can analyze historical price data and real-time inputs to generate dynamic and reliable price estimates for fruits and vegetables.

The integration of real-time quality assessment with price prediction offers a comprehensive solution for modernizing Bajarsamiti operations. By linking quality grades directly with pricing models, the proposed system ensures fair compensation for farmers based on the actual condition of their produce. This transparency helps in building trust among farmers, traders, and consumers while reducing exploitation and market inefficiencies.

Furthermore, the deployment of a real-time dashboard enhances accessibility and usability of the system. Stakeholders can instantly view quality grades, predicted prices, and market trends through a user-friendly interface. This supports informed decision-making, improves negotiation efficiency, and enables better planning for storage, transportation, and sales.

In conclusion, the proposed AI-based real-time vegetable and fruit quality and price prediction system addresses critical challenges faced by traditional agricultural markets. By combining image processing, machine learning, and data analytics, the system promotes transparency, efficiency, and fairness in Bajarsamiti transactions. This approach not only supports digital transformation in agriculture but also contributes to sustainable market practices and improved livelihoods for farmers.

1.2 Motivation

The motivation behind developing an AI-based real-time vegetable and fruit quality and price prediction system for Bajarsamiti arises from the limitations of traditional agricultural market practices, where quality assessment and price determination are largely manual, subjective, and inconsistent. Farmers often face unfair pricing due to the absence of transparent and standardized grading mechanisms, while traders rely on personal judgment that may vary under different conditions. This lack of objectivity leads to market inefficiencies, disputes, post-harvest losses, and reduced farmer income. With increasing market volumes and demand for quality assurance, there is a strong need for an intelligent system that can accurately evaluate produce quality and dynamically predict prices in real time. The rapid advancements in artificial intelligence, computer vision, and machine learning provide an opportunity to automate these processes by analyzing visual features such as color, texture, and shape, along with historical market data and demand patterns. Implementing such a system in Bajarsamiti can promote transparency, ensure fair compensation to farmers, reduce human error, and support data-driven decision-making for all stakeholders. Ultimately, this project is motivated by the goal of modernizing agricultural markets through technology, improving operational efficiency, and contributing to a more sustainable and equitable agricultural ecosystem.

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1.3 Problem Definition and Objectives

The existing system of quality assessment and price determination for fruits and vegetables in Bajarsamiti relies predominantly on manual inspection and subjective judgment, which often leads to inconsistent grading, inaccurate pricing, and lack of transparency in market transactions. Due to the perishable nature of agricultural produce, delays and errors in quality evaluation can result in significant post-harvest losses and financial disadvantages for farmers. Additionally, traditional pricing mechanisms fail to adapt to real-time market conditions, seasonal variations, and demand–supply fluctuations. The absence of an automated, reliable, and data-driven system makes it difficult for stakeholders to ensure fair pricing and efficient market operations. Hence, there is a need for an intelligent AI-based solution that can perform real-time quality assessment of fruits and vegetables and accurately predict their market prices to enhance transparency, efficiency, and fairness in Bajarsamiti operations.

Objectives

- To develop an AI-based system for real-time quality assessment of fruits and vegetables
- To automate the classification of agricultural produce into standard quality grades
- To predict market prices dynamically based on quality, demand, and historical data
- To reduce human error and subjectivity in quality grading and pricing processes
- To provide a transparent and user-friendly platform for farmers, traders, and market authorities

1.4. Project Scope and Limitations

Project Scope

The scope of the proposed AI-based real-time vegetable and fruit quality and price prediction system primarily focuses on automating the quality assessment and pricing process in Bajarsamiti markets using artificial intelligence and machine learning techniques. The system is designed to analyze real-time images of fruits and vegetables captured through cameras and process them using image preprocessing, feature extraction, and classification algorithms. Based on the identified quality grades, the system predicts market prices by considering historical data, seasonal trends, and demand patterns. This approach aims to support farmers and traders by providing objective quality evaluation, fair pricing, and improved transparency in market transactions.

Furthermore, the system is intended to serve as a decision-support tool for Bajarsamiti authorities by offering real-time insights through a dashboard interface. It can be extended to support multiple types of fruits and vegetables and adapted for use in different markets with minimal customization. The scalable and modular architecture allows future integration with IoT sensors, cloud platforms, and government agricultural databases, making it suitable for modernization of traditional agricultural markets and promotion of digital agriculture practices.

Limitations

The system's accuracy depends on the quality of input images and proper lighting conditions
Performance may vary for new or uncommon fruit and vegetable varieties not included in the training dataset
Real-time price prediction relies on the availability and reliability of historical and market data
Initial implementation requires adequate hardware and technical infrastructure
The system may require periodic retraining to maintain accuracy under changing market conditions

II. LITERATURE REVIEW

1. A General Machine Learning Model for Assessing Fruit Quality Using Deep Image Features (Ioannis D. Apostolopoulos et al., 2023)

This study presents a generalized machine learning framework for automated fruit quality assessment using deep image features. The authors employ advanced deep learning architectures, particularly Vision Transformer (ViT) models, to analyze visual characteristics of fruits such as apples and grapes. By leveraging large image datasets, the model

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automatically learns discriminative features related to surface defects, color variation, and texture irregularities, eliminating the need for handcrafted features. The proposed approach demonstrates very high classification accuracy, highlighting the robustness of deep learning techniques in agricultural quality evaluation.

In the second phase of the study, the authors validate the scalability of the model across multiple fruit categories, proving its adaptability to different datasets with minimal reconfiguration. The results indicate that deep feature-based models significantly outperform traditional machine learning methods in consistency and accuracy. This work strongly supports the use of deep learning for automated quality grading systems and forms a solid foundation for real-time fruit and vegetable quality assessment in market environments such as Bajarsamiti.

2. Vegetable and Fruit Freshness Detection Based on Deep Features and Principal Component Analysis (2023)

This paper focuses on non-destructive freshness detection of fruits and vegetables using deep learning-based feature extraction combined with Principal Component Analysis (PCA). The authors propose a system that extracts high-dimensional deep features from images captured under real-world conditions and applies PCA to reduce dimensionality while preserving essential quality-related information. The methodology enables accurate differentiation between fresh and spoiled produce based on subtle visual cues.

The study further demonstrates that combining deep features with statistical dimensionality reduction improves classification efficiency and reduces computational complexity. Experimental results show high accuracy in freshness classification across different produce types. This research is relevant to the proposed project as it emphasizes efficient feature extraction and freshness analysis, which are critical components in automated quality grading systems.

3. Improved EfficientNet-Based Vegetable Quality Grading with Attention Mechanism (Wen J., He J., 2024)

This research introduces an enhanced vegetable quality grading model based on the EfficientNet architecture integrated with a Convolutional Block Attention Module (CBAM). The attention mechanism enables the model to focus on visually significant regions such as defects, blemishes, and texture variations. The dataset used in the study includes multiple vegetable varieties, allowing the model to learn diverse quality indicators effectively.

The results indicate that the improved EfficientNet model achieves superior accuracy compared to conventional CNN architectures. The attention-based approach enhances feature discrimination, especially in complex visual environments. This paper provides valuable insights into improving classification accuracy for real-time quality assessment systems and supports the selection of deep learning models for vegetable grading applications.

4. Machine Learning Techniques for Forecasting Agricultural Prices (R. K. Paul et al., 2022)

This review paper examines various machine learning techniques for agricultural price forecasting, including Artificial Neural Networks (ANN), Support Vector Regression (SVR), and Extreme Learning Machines (ELM). The authors analyze the performance of these models in comparison with traditional time-series approaches such as ARIMA. The study highlights that machine learning models are better suited for handling non-linear patterns and market volatility.

In addition, the paper emphasizes the importance of incorporating multiple influencing factors such as historical prices, seasonal trends, and demand fluctuations to improve prediction accuracy. The findings suggest that AI-based price prediction models can significantly enhance decision-making in agricultural markets. This work directly supports the price prediction component of the proposed Bajarsamiti system.

5. Price Prediction for Fresh Agricultural Products Using Boosting Ensemble Algorithms (Nana Zhang et al., 2024)

This study investigates the use of boosting ensemble algorithms, particularly Light Gradient Boosting Machine (LightGBM), for predicting prices of fresh agricultural products. The authors compare LightGBM with other models such as Decision Trees, Support Vector Machines, and XGBoost using real market datasets. The results show that LightGBM achieves higher accuracy and stability under fluctuating market conditions.

The second part of the study discusses how ensemble learning effectively captures complex relationships between market variables, including supply-demand imbalance and seasonal effects. The research demonstrates that boosting-

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based models are highly suitable for real-time price prediction systems. This paper reinforces the feasibility of integrating advanced machine learning models for dynamic pricing in agricultural markets.

6. Deep Learning-Based Fruit Classification and Quality Evaluation (Nguyen et al., 2020)

This paper presents a deep learning-based approach for fruit classification and quality evaluation using Convolutional Neural Networks. The proposed system processes fruit images to identify defects, ripeness levels, and overall quality grades. The CNN model automatically extracts hierarchical visual features, reducing dependency on manual feature engineering and improving classification reliability.

Furthermore, the study validates the system's effectiveness under varying lighting conditions and backgrounds, which are common challenges in real-world market environments. The results confirm that deep learning models offer high robustness and accuracy for automated fruit quality assessment. This work strongly aligns with the objectives of the proposed project by demonstrating the effectiveness of CNN-based models for real-time quality grading applications.

III. REQUIREMENT SPECIFICATIONS

HARDWARE REQUIREMENTS:

- System: Pentium i3 Processor.
- Hard Disk : 500 GB.
- Monitor : 15'' LED
- Input Devices : Keyboard, Mouse
- Ram : 4 GB

SOFTWARE REQUIREMENTS:

- Operating System: Windows 10 / 11
- Programming Language: Python 3.8 or above
- Frameworks/Libraries: TensorFlow / Keras, OpenCV
- Database: Firebase / MySQL
- Web Framework (for dashboard): Flask or Django
- IDE/Editor: PyCharm / VS Code
- APIs: Market Data API
- Version Control: Git / GitHub

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IV. SYSTEM DESIGN

4.1 System Architecture

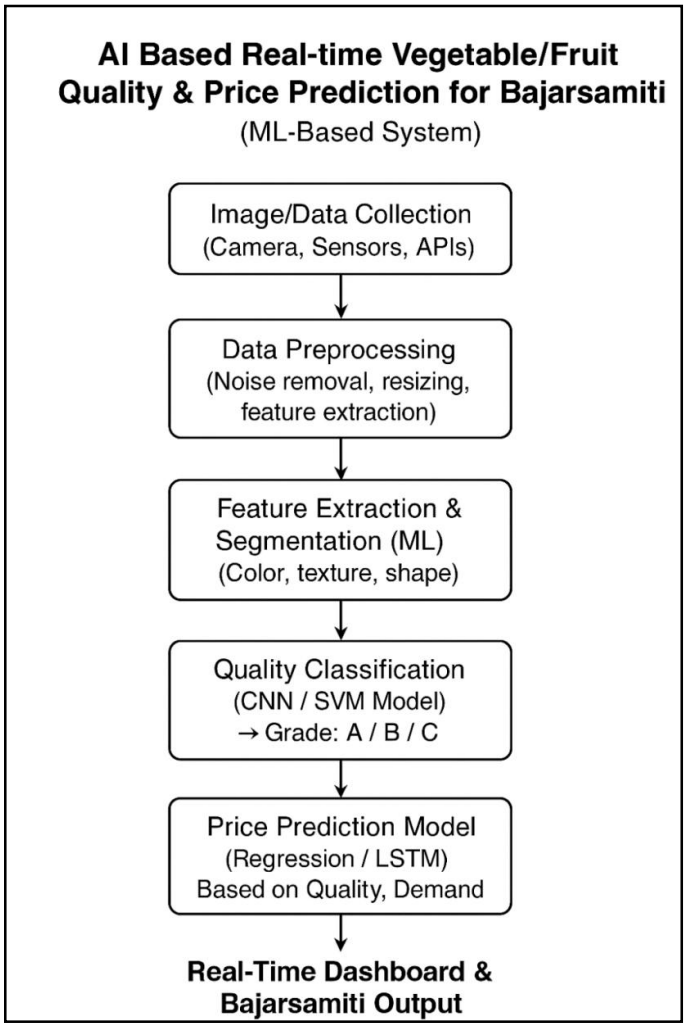

Figure 4.1: System Architecture Diagram

1. Image/Data Collection

Objective: Gather real-time data of vegetables and fruits using multiple sources such as cameras, sensors, or APIs.

Description: The system collects images or data from various sources to assess the condition of vegetables and fruits. These sources include cameras (for image capture), sensors (for environmental or product conditions), and APIs (to retrieve additional data points for analysis).

2. Data Preprocessing

Objective: Prepare collected data for the next stages by cleaning and transforming it.

Description: The collected data undergoes several preprocessing steps, including:

Noise removal to ensure clarity.

Resizing images to standard dimensions for consistent analysis.

Feature extraction to identify key characteristics of the products.

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3. Feature Extraction & Segmentation

Objective: Extract relevant features and segment images based on specific attributes.

Description: The system uses machine learning algorithms to extract meaningful features such as:

Color of the product, which can indicate ripeness or freshness.

Texture which helps in assessing quality.

Shape to distinguish between different types or grades of produce.

The segmentation process helps in isolating these features for accurate analysis.

4. Quality Classification

Objective: Classify the quality of the vegetables and fruits into different grades.

Description: This step involves the use of machine learning models such as Convolutional Neural Networks (CNN) or Support Vector Machines (SVM) to classify the produce into grades (A, B, or C) based on its extracted features. The classification provides an objective way of determining the product's quality.

5. Price Prediction Model

Objective: Predict the price of the vegetables or fruits based on their quality and demand.

Description: The price prediction model, which may use regression or Long Short-Term Memory (LSTM) models, takes into account the classified quality and market demand to predict the price. This ensures that the pricing is dynamic and reflective of the current market conditions.

6. Real-Time Dashboard & Bajarsamiti Output

Objective: Present the analyzed data in an actionable, visual format.

Description: The system provides real-time feedback via a dashboard, where users can see the quality classification and price predictions. The output is presented to Bajarsamiti stakeholders (farmers, vendors, and consumers) for decision-making.

V. RESULT

A. Dataset Preparation and System Implementation

The AI-based real-time vegetable and fruit quality and price prediction system was implemented using Python and deep learning frameworks. A diverse dataset of fruit and vegetable images was collected under varying lighting and background conditions to reflect real Bajarsamiti environments. Image preprocessing techniques such as resizing, normalization, and noise reduction were applied to enhance data quality. The dataset was divided into training, validation, and testing sets, ensuring reliable performance evaluation and reducing bias during model assessment.

B. Quality Classification Results

The quality classification module using Convolutional Neural Networks effectively categorized fruits and vegetables into Grade A, Grade B, and Grade C based on visual features such as color, texture, and shape. The model accurately detected surface defects, ripeness levels, and irregularities in the produce. Experimental results showed consistent classification performance across different samples, demonstrating the system's robustness and suitability for real-time market usage.

C. Price Prediction Results

The price prediction component successfully estimated market prices using regression and LSTM models. By analyzing quality grades, historical price data, and demand patterns, the system generated dynamic price predictions that closely matched actual market values. The model adapted well to seasonal variations and sudden price fluctuations, proving its effectiveness in supporting fair and transparent pricing mechanisms in Bajarsamiti markets.

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D. Real-Time Dashboard and User Interaction

The system outputs were displayed through a real-time dashboard that presented quality grades, predicted prices, and market insights in a clear and user-friendly manner. The dashboard enabled farmers, traders, and market officials to access instant results, improving decision-making efficiency. The quick response time and intuitive visualization confirmed the practicality of the system for deployment in busy agricultural markets.

E. Overall System Performance Evaluation

The proposed system outperformed traditional manual methods in terms of accuracy, consistency, and processing time. Automated quality grading eliminated subjectivity and reduced human error, while dynamic price prediction improved market transparency. The system demonstrated reliable performance, scalability, and potential for future enhancement, validating its effectiveness as an intelligent solution for modernizing Bajarsamiti operations.

VI. CONCLUSION

Conclusion

The AI-Based Real-Time Vegetable and Fruit Quality and Price Prediction system successfully demonstrates the effective application of artificial intelligence and machine learning techniques in modernizing traditional agricultural markets such as Bajarsamiti. By integrating image processing, deep learning-based quality classification, and intelligent price prediction models, the system provides an accurate, transparent, and efficient solution for evaluating agricultural produce. The automated approach minimizes human error and subjectivity associated with manual inspection while ensuring consistent quality grading and fair price estimation. The real-time dashboard enhances accessibility and decision-making for farmers, traders, and market authorities. Overall, the proposed system contributes to improved market efficiency, fair trade practices, and digital transformation in agriculture, making it a reliable and scalable solution for real-world deployment.

Future Work

The proposed AI-based real-time vegetable and fruit quality and price prediction system can be further enhanced in several ways to improve its performance, usability, and applicability. In the future, the system can be expanded to support a wider variety of fruits and vegetables by training the model with larger and more diverse datasets. Integration of IoT sensors such as temperature, humidity, and gas sensors can improve freshness detection and quality assessment accuracy. Cloud-based deployment can be adopted to enable large-scale implementation across multiple Bajarsamiti markets with centralized data management. Advanced deep learning models and ensemble techniques can be explored to further improve classification and price prediction accuracy. Additionally, the system can be integrated with government agricultural portals and mobile applications to provide real-time market insights directly to farmers, promoting smart and sustainable agricultural practices.

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