ARIMAX Model for Mango Price Prediction System Using Image Processing

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Abstract: The Nigeria agriculture sector, which contributes 10% of GDP, relies on fruit cultivation. Farmers, particularly mango farmers, face unpredictable crop demands, affecting their economy and causing excess food waste. This is due to inadequate education, outdated traditional beliefs, and a lack of understanding of customer consumption trends. Establishing a proper mango price prediction system is crucial to address these issues. Farmers face financial losses due to plant issues, including illnesses and insect infestations, limiting growth and affecting yield. Manual identification is challenging, and limited availability of agricultural experts leads to delays, insufficient problem recognition, and insufficient understanding of fertilizers and pesticides. Mango fruit in Nigeria has high market value, but farmers lack knowledge on harvest quality. This study aims to identify factors affecting these areas and develop a mobile app with price predictor, pest and disease identification, fertilizer suggestion, and mango quality predictor. The system aims to guide users towards effective resource sharing and high-quality decision-making.

Keywords: ARIMAX Model, Time Series Model, CNN, Image Processing, Agriculture, Quality, Real-time Database.

I. INTRODUCTION

Agriculture is Nigeria's backbone, with mango being a significant economic contributor and cherished fruit among its inhabitants. Mango cultivation in Nigeria is a significant agricultural landscape, with cultural significance, practices, and economic impact explored in this research paper. Mango cultivation in Nigeria has a long history, with its tropical climate and fertile soils enabling the cultivation of various varieties across various regions. Mango orchards are found in various agro-climatic zones, from wet lowlands to drier intermediate and upland areas. Mango markets rely heavily on the mango price, which exhibits rapid fluctuations throughout the year. Identifying key factors affecting these fluctuations is crucial.

Factors such as US dollar value, consumption, post-harvest losses, pests, and government import/export laws impact mango prices. Farmers often follow traditional two-year cycles due to poor market intelligence, leading to high prices in one year and subsequent production. This results in a glut and lower market prices, causing financial losses and time waste. Human predictions are error-prone and not reliable due to limited data processing. A computerized system for predicting crop fluctuations and future market prices is needed to ensure farmers receive accurate harvest prices, as human predictions are error-prone and limited. Diseases are a major factor contributing to

plant loss in Nigeria, reducing productivity from 10%-95%. Common leaf diseases include Anthracnose, powdery milde, and black soothy mold, particularly in mango fruits. Agricultural pests, such as trips, fruit fliers, and mealy bugs, significantly harm cultivation and cause significant economic losses. Various methods to control plant diseases include manual harvesting, mechanical cultivation, and pesticide use. However, hiring experts for ongoing monitoring is expensive and time-consuming. Excessive fertilization can increase plant growth but reduce quality, especially for infected mangoes. Accurate mango fruit prediction is crucial for growers to assess harvest quality, suitability for export or local markets, and identify unsuitable fruit. The proposed system improves quality classification accuracy by providing growers with data, news, and articles, enabling informed decision-making and optimal utilization of the crop. Real-time system provides growers with accurate information on mango crop quality, enabling informed decisions for marketing strategies and increased profitability. The system accurately classifies mangoes based on quality and suitability for markets, enabling growers to strategically target specific markets, optimize returns, and enhance market penetration, customer satisfaction, and profitability.

We thoroughly believe that our selected scope will generate more efficient, effective and accurate system. As rest of the

excess parameters we payed attention or we did announce large crowd is the primary fact for the existence of our application the reliability and efficiency.

II. RELATED WORKS

In Research paper [1,4] is not mentioned about factors that are affect to decide retail market prices. But our research we considered about some of factors that are used to decide mango price. As well as, the researcher has done the research on the about price of several fruits and here we have done the research only on the mango fruit.

Research paper focus on some factors that are used by farmers to decide their prices. By comparing that, that researcher focuses only on fruit quality and fruit types. But here we consider more factors than that.

P. Joshi et al. (2022) - This review article provides an overview of the recent developments in mango fruit disease detection using image processing techniques. It covers various methods, such as ML and deep learning algorithms, used for disease detection and classification. The article also discusses the challenges and opportunities in this field.

"Automated Detection of Mango Defects Using Convolutional Neural Networks" by S. S. Akhtar et al. (2019) - This research article proposes a mango defect detection system using convolutional neural networks (CNNs). The system analyzes various features, such as fruit color, shape, and texture, and uses a CNN-based algorithm to detect and classify mango defects, such as spots and bruises.

According to the research paper that has been studied [15] there are various ways to control and reduce these insects. But our proposed application provides new and environmentally friendly methods easily.

"Identification of Mango Diseases using Digital Image Processing Techniques" by S. Balamurugan and R. S. Rajeswari: This paper proposes the use of digital image processing techniques for identifying diseases in mangoes. The authors capture images of mango leaves with different diseases, and then use color histogram analysis and texture analysis to identify different types of diseases. The authors report that their approach is effective in accurately identifying different diseases in mangoes.

They have only discussed small area. But the proposed project provides use of modern technologies in hopes of resolving the issues that exist with the current systems. The farmer is more comfortable with their environment when it comes to from mobility and earnings due to online marketing. This project has been effective because it supports our Nigerian farmers.

III. SYSTEM IMPLEMENTATION

A) Price predictor

Farmers in emerging economies like Nigeria struggle to produce healthy crops due to a lack of machinery. They have high expectations for the next season but struggle to sell their crops for fair prices due to low marker intelligence. To ensure fair prices, the government must be involved in agricultural commodity prices and implement crop price forecasting.

The objective of the research, as mentioned in the research article [9], was to predict price changes for a few major agricultural crops in Taiwan. They obtained the market prices for Taiwan's 100 different crops for their study from a trustworthy website run by the Council of Agriculture (COA). The authors of the research analyzed historical data on agricultural crop price changes and discovered some patterns. Following that process, Our aim is to develop a mango price predicting system using time series models to predict fruit prices, utilizing mobile apps and ICT techniques. The research uses 5 years of price data. Selecting the optimal ARIMAX model from multiple experiments is an effective and simple strategy for improving time series. Authors[10] used data from the 2.csv, which has plenty of data regarding before pricing of selected items, for this. Pre-Processing: the 'date' column to Date Time format removing columns with NaN values and removing columns that are not needed.

Processing: Perform trend and seasonality checks, determine if data fits Gaussian curve, divide into sections, calculate means and variances, determine stationarity, and perform differencing for stability.

Evaluation: For evaluating the model's performance, the Mean Squared Error (MSE) was calculated. Without considering into account their direction, MAE calculates the mean size of the mistakes in a set of prediction.

The accuracy of a prediction was calculated and displayed as a percentage. Actual data for the originally displayed 30 days were obtained from the same source and compared for accuracy. We used the mean absolute error (MAE) method to assess

accuracy. Mango disease Identifier A detailed methodology for identifying mango diseases using image processing and CNNs involves several components.

Figure 1: CNN model for mango disease identifier

The study presents a method for detecting mango diseases using image processing and CNNs, utilizing a large dataset of mango leaves, preprocessing techniques, and segmentation techniques. Segmenting mango leaves involves retrieving attributes like healthy and diseased traits using shape-based, texture descriptors, color histograms, and transfer learning methods. This process combines deep learning and pre-trained CNN models.

Next phase involves creating CNN architectures for mango disease detection, modifying popular models like VGGNet, ResNet, and Inception Net, defining filters, layers, and activation functions our thorough methodology combines CNNs and image processing methods to create a system for identifying mango leaf diseases. In order to facilitate prompt intervention and preventive actions in mango.

A split dataset with training and validation sets is used to train a CNN model. Data augmentation techniques improve generalization, and hyper parameters are adjusted for optimal results. Validation accuracy is tracked throughout training. Validation set assesses CNN model's effectiveness in detecting mango diseases, comparing results with other studies, Implemented mango disease identifier system aids farmers, agricultural specialists.

Validation set assesses CNN model's effectiveness in detecting mango diseases, comparing results with other studies, Implemented mango disease identifier system aids farmers, agricultural specialists. Utilizes CNNs and image processing for early detection of mango leaf diseases, promoting prompt intervention and preventive

B) Pest Identifier

This study presents a comprehensive methodology for identifying mango pests and diseases using image processing methods and convolutional neural networks (CNNs). The process involves gathering a large dataset of photos afflicted by various pests, such as mango fruit fly, Thrips, Mealy bug, and mango leaf hoppers. Preprocessing techniques, such as resizing, noise reduction, contrast improvement, and color space conversion, are used to improve the quality of the images. The images are then segmented using algorithms like thresholding, edge detection, or region-based methods to separate the affected areas. Feature extraction is performed to identify unique traits of the identified pests and diseases.

Figure 2: Classification using CNN

The CNN architecture considers problem complexity, dataset size, and processing resources. It is using augmentation methods and assessing model performance. A user-friendly interface or mobile application allows farmers and specialists to input pest images, enabling early detection and precise categorization of diseases affecting mango plants. This efficient system reduces damage and improves crop management techniques.

C) Mango external quality identifier based on shape, color, spots, and bruises

The research paper uses a methodical technique to identify mangoes' external quality using image processing and CNN based on their form, color, spots, and bruising. With the help of form analysis, color data, and a preprocessed photo dataset, the research uses image processing to determine the quality of the mangoes. The app offers farmers features like ripeness, handling, and storage, as well as mango color identification using a CNN model.

[1] Research proposes automated mango classification using CNNs for accurate, efficient grading using a dataset of mango images.
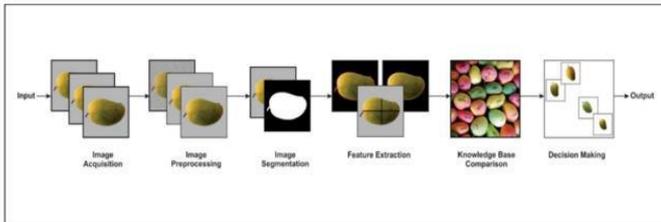

Figure 3: Flow processing of classification of fruit and processing of grading

[2] CNNs improve image recognition by extracting color properties and assessing mango quality.[3][4] Color value and distribution are important measurements, while size is a significant factor, classified as large, medium, or small. [5] Image texture measures color arrangement, enhances fruit recognition accuracy by combining color and texture features.[6] Unique, ambiguity-free, complete shape description is essential for fruit analysis. [7] Shape measurements are categorized into size-dependent and size-independent metrics. Predict the stage of mango fruit Export quality, Local quality, unable to use using analyzed data.

The system analyzes mango stages, identifying export quality and local suitability for domestic use, and identifying damaged ones. It improves fruit quality, yield, distribution, market efficiency, and satisfaction through feature choice, model evaluation, and data preparation.

[8],[9] Algorithm sorts mangoes by ripeness, dataset includes unripe, ripe, semi-ripe. Extracts color, size, classifies grades: 1, 2, 3, rejected. Preprocessing assesses export quality. Computer vision measures skin defect, assigns classes via color image.

(a)   (b)

Figure 4: (a) Original Image (b) Binarized image were defective skin is represented as white

[4] The algorithm sorts mangoes into two groups: flawless and defective. It extracts features from segmented images, prioritizing color for ripeness. Choosing appropriate classifiers hinges on the dataset, complexity, and accuracy. Preprocessing, cross-validation, and metrics assess models. [2] Mangoes analyzed using Fourier Descriptors for shape retrieval, enhancing real-world image recognition and enhancing image pre-processing for star-fruit differentiation.

IV. RESULT ANALYSIS AND DISCUSSIONS

During the testing phases, the application was regularly tested in its natural context. While the team was engaged with the agile methodology, several testing sessions were conducted and the results were evaluated. To achieve the most accurate results and best user experience, the team took care to implement the system with greater user interaction. Implementing an established and optimized agricultural platform is the main goal of the research.

So, farmers, consumers and vendors can make proper decisions and share their knowledge and resources. After developing the idea, we used the solutions we found to justify our attempts. Many of the researchers to who we turned for guidance were on a theoretical level. Therefore, it is necessary to provide additional theories along with supporting proof and conclusion when using it on a practical level. For each and every component of the study that collectively generates the research solutions, we created outstanding options.

Arimax model accurately predicted 5-year crop sale values, proving high accuracy. However, comparing actual sales with predicted values was overlapped with 4% related news and articles.
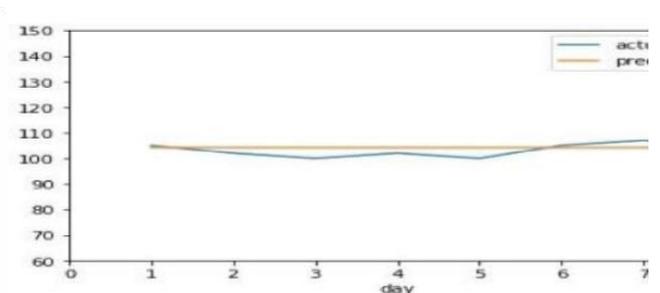

Figure 5: Price Comparison

The pest and disease identifying component tested over 12,000 unhealthy and healthy leaves under various environmental conditions. A trained convolutional neural

network accurately identified diseased plants over healthy ones, but some leaves misclassified due to similarity. Only a few leaves were incorrectly classified for each class.

Leaf Disease	Health y	Anthracnos e	powder y mildew	Bacteria l Blight	Cercospor a Leaf Spot	Accurac y
Healthy	24	0	1	0	0	96%
Anthracnos e	0	25	0	0	0	100%
Powdery mildew	2	0	22	1	0	88%
Bacterial Blight	0	0	0	25	0	100%
Cercospora Leaf Spot	0	1	0	0	24	96%
Average						**96%**

Figure 6: Pest and disease identifying graph result

When the above method was tested, a problem built because some pests had similar shapes. When we done the testing with those pests, we could achieve an accuracy of up to 90–95%.

This systematic approach employs image processing and CNNs to assess mangoes' external quality via attributes like shape, color, spots, and bruising. Using a diverse dataset, it's inspired by the mango identification module, testing over 5000 mangoes across conditions, showcasing CNN's proficiency in distinguishing fruit quality. Despite resemblance challenges, misclassification was limited. In parallel, targeted testing achieved 90-95% accuracy, highlighting the method's resilience in predicting mango quality—Export, Local, and unfit stages—through meticulous data analysis.

V. CONCLUSIONS

The price prediction component anticipates future market prices for crops and provides accurate information for detecting diseases and pests. The optimized platform advances agriculture by leveraging decision-making abilities, knowledge sharing, and resource sharing. It identifies fruit attributes like shape, color, spots, and bruises, and predicts mango fruit stages, categorizing them as export quality, local quality, or unfit for use. The platform also informs growers about harvest quality through accurate classification, relevant information, and agricultural-related news and articles. In this research we have discussed about price predictions, pest identifications, disease identification and quality identification for mango fruit. Price predictions for some selected areas, identification of some selected mango diseases, identification of some selected pest types and quality check using some selected factors are the limitations of this research. As for the future work this approach can be expanded

to the other fruit types by using various technologies.

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