IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

ARECA NUTS CLASSIFICATION BASED ON SIZE AND COLOR USING CNN MODEL

[1]Yash Nagda, [2]Sulabh Anand, [3]Lohit B. Nijaguni, [4]Madhukar B., [5]Kavitha,
[1]Student, [2]Student, [3]Student,[4]Student,[5]Professor
[1]Computer Science Engineering, [2]Computer Science Engineering, [3]Computer Science Engineering, [4]Computer Science Engineering, [5]Computer Science Engineering
[1]Dayananda Sagar College of Engineering, Bengaluru, India, [2]Dayananda Sagar College of Engineering, Bengaluru, India, [3]Dayananda Sagar College of Engineering, Bengaluru, India, [4]Dayananda Sagar College of Engineering, Bengaluru, India, [5]Dayananda Sagar College of Engineering, Bengaluru, India

Abstract : Areca nut, also known as betel nut, is a tropical crop. India holds the position of the world's second-largest producer and consumer of areca nuts, which undergo various challenges throughout their life cycle. Farmers traditionally rely on their visual senses to identify diseases in the nuts. This paper explores multiple image processing techniques aimed at categorizing areca nuts based on properties like color and texture. In real-world applications, computer detection models have gained popularity for their quick, efficient, accurate, and transparent testing capabilities. Unlike manual separation methods employed thus far, this study proposes the use of a sophisticated color sorting mechanism that considers external nut properties such as color, texture, shape, and size. The captured image is analyzed using various approaches to extract relevant information, including the classification of areca nuts based on their size and color. The efficient planning of areca nuts requires consideration of all these traits. The classification models developed in this research serve as valuable tools for stakeholders in the areca nut industry, including farmers, traders, and processors, enabling them to optimize sorting processes and tailor their products to meet specific market demands. When given training data, it categorizes the data into healthy and unhealthy areca nuts based on colour and quality. Areca nut is separated using CNN classifiers.

Keywords: **Convolution Neural Network (CNN), Machine Learning (ML), Artificial Intelligence (AI), Artificial Neural Network(ANN),Arecanut,Nutclassification,Size-basedclassification,Color-basedclassification**

1. INTRODUCTION

Areca nuts is one of the largest commercial plants available in India. Areca nut, a major commercial crop in India, is traditionally assessed manually, consuming valuable time for farmers. The classification and grading of areca nuts are pivotal for the industry, which experiences a growing demand due to its cultural significance and use as a stimulant. This project aims to streamline this process by developing a machine learning-based model. Leveraging image processing techniques, the model will automatically classify and grade areca nuts based on size, color, and texture. Training the model using a dataset of expert-classified images ensures accurate results, offering a more efficient and automated solution for maintaining product quality. The primary innovation centers around employing a carefully curated dataset that features images of Areca nuts, expertly classified to train the machine learning model. This dataset acts as a comprehensive repository containing a diverse array of Areca nut samples, each intricately labeled based on distinct criteria such as size, color, and texture. Through exposure to this extensive dataset, the machine learning model acquires the ability to discern intricate patterns and relationships within the data. Consequently, this training enables the model to make precise classifications when presented with new and unseen images. This strategic use of a specialized dataset forms the cornerstone of the project, fostering the model's accuracy and adaptability in assessing Areca nuts.

1.1 Literature Survey

The experiment was developed utilising the KNN algorithm and an 800-photographic database of four classes with two-color characteristics and four-grade scales. The division of the green areca nut is accomplished through the utilization of histogram color and color times in conjunction with KNN separators. A separate image is utilised in the second stage to extract elements. Color histogram and color timing approaches were used to extract this color information. The areca nut is divided into four classes in the third stage. KNN, ANN, and SVM are three well-known category designers that we employ to divide.**[1]**

The author has devised a new method for classifying areca nuts into two groups based on color. Innovative procedures and methods for the raw areca nut separation have been put forth. The classification process involves distinct steps such as Segmentation, Masking, and Classification The classification is based on two different colors: red and green areca nut phases in the region. Test performance success rates ranged from 97 to 98 percent depending on the category.**[2]S**uggested a CNN-based method for categorising images of areca nut illnesses. Distinguish between diseases such as rot, split, and rot. The proposed technique outperforms the competition in terms of classification, memory, accuracy, and F steps, according to results from a four-phase data set.**[3]**

Through the application of image processing and computer vision, the areca nut is effectively separated and modified. To distinguish the areca nut category, the author uses color, size, and texture. The main goal of this article is to give a comprehensive description of the areca nut, Computer Vision, and technological needs and applications based on areca nut categorization and grading.**[4]**

Texture-based methods, such as LBP, are commonly employed in image analysis to capture and represent local patterns within an image, and in this context, they are utilized for assessing the texture attributes of areca nuts for classification and grading purposes. Through the application of image processing and computer vision, the areca nut is effectively separated and modified.To distinguish the areca nut category, the author uses color, size, and texture.**[5]**

Classification and Grading of Areca nut Using Texture Based Block-Wise Local Binary Patterns. The main goal of Bharadwaj, N. K.'s study, as indicated by the title "Classification and Grading of Areca nut Using Texture Based Block-Wise Local Binary Patterns," is to develop a method for classifying and grading areca nuts. The study specifically focuses on utilizing a texture-based approach, employing Block-Wise Local Binary Patterns (LBP) as a technique for achieving accurate classification and grading of arecanuts.**[6]**

1.2 Problem Statement

Design and implement a machine learning model that can classify areca nuts into different categories based on size and color. The goal is to create a reliable and efficient model that can assist in sorting and grading areca nuts for quality control and market placement.

Fig. 1. A representative image of an Areca nut

1.3 Contributions

This project presents an innovative solution for the automated classification and grading of areca nuts, a crucial commercial crop in India. By leveraging the capabilities of machine learning and image processing, the system aims to streamline the assessment process, ultimately saving time for farmers and significantly improving overall efficiency compared to conventional manual methods.

The key contributions of this project include:

- Implementation of advanced image processing techniques to enhance the efficiency of quality assessment, resulting in quicker and more accurate evaluations compared to traditional manual approaches.
- Integration of machine learning algorithms to assess essential attributes such as size, color, and texture. This ensures consistent product quality, thereby contributing to the overall enhancement of the areca nut industry.
- Recognition of the cultural significance of areca nuts and their increasing demand. The project aspires to make a positive economic impact by providing a more efficient and automated solution for quality control in the production process.
- Demonstration of the applicability and potential benefits of cutting-edge technologies, including image processing and machine learning, in traditional agricultural practices. This showcases a pathway towards modernizing and optimizing agricultural processes.
- Creation of a valuable dataset comprising expert-classified areca nut images. This dataset serves as a valuable resource for further research, benchmarking, and training in the fields of agricultural image analysis and machine learning, fostering advancements in agricultural technology.

1.4 Motivation

Engaging in a project within the agricultural and food processing domain holds personal significance for us, as we have keen interest in leveraging technology and automation to enhance these sectors. The prospect of contributing to advancements in areca nut quality assessment aligns with our passion for improving processes in agriculture. Undertaking this project serves as a valuable avenue for learning and skill development. The acquisition of these skills not only enriches our personal knowledge base but also contributes to our professional growth, opening doors to diverse opportunities. Quality assurance emerges as a compelling motivator, recognizing the pivotal role it plays in customer satisfaction and industry reputation. We are motivated by the prospect of contributing to the creation of safer and higher-quality consumer products, thereby positively impacting public health. Furthermore, the project offers a platform for innovation and technology exploration. Working with cutting-edge technologies such as machine learning, computer vision, and real-time image processing provides an intellectually stimulating and personally rewarding experience. The opportunity to be at the forefront of innovation motivates us to contribute meaningfully to the evolution of agricultural practices through technological advancements.

2.RESEARCH METHODOLOGY

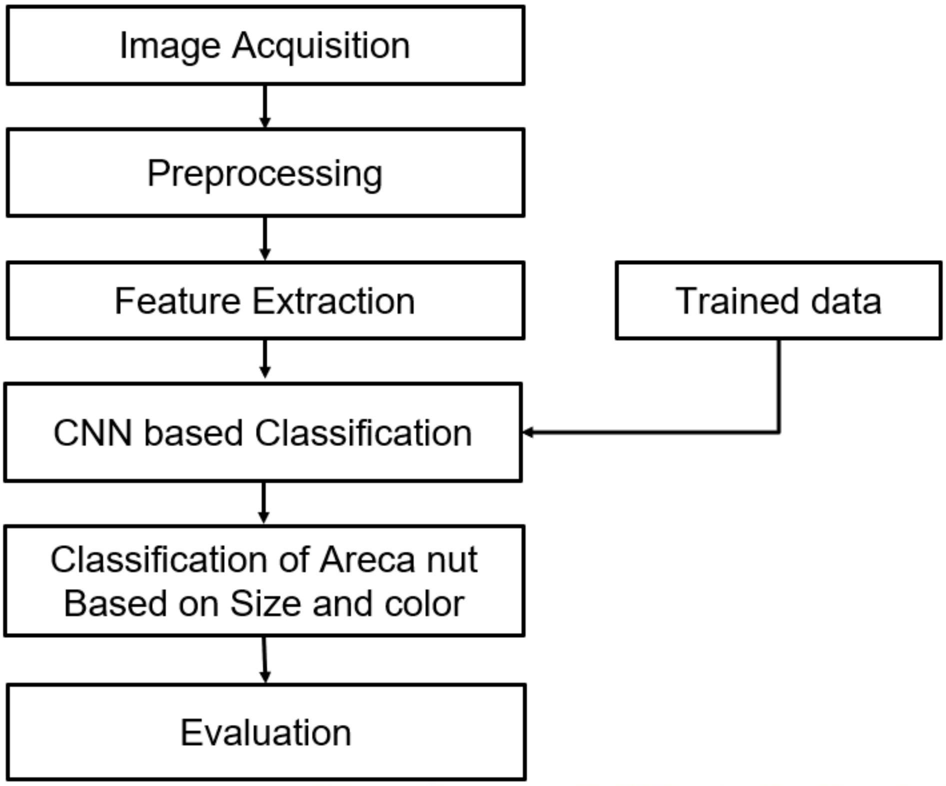


Fig. 2. Framework of the Proposed CNN Areca Nut Classification Model

- **Image Acquisition**: The image acquisition phase marks the initiation of our research endeavour. In this step, we systematically captured a diverse array of images depicting both healthy and unhealthy areca nuts using contemporary smartphones. These images serve as the fundamental building blocks of our dataset, ensuring a comprehensive representation of the variability inherent in areca nut conditions. Rigorous attention was paid to lighting conditions, angles, and focus during the capture process to minimize potential biases and ensure the dataset's robustness.

- **Pre-processing**: Following image acquisition, the pre-processing phase was imperative to enhance the quality of the areca nut images. This intricate step involved a series of adjustments and modifications aimed at noise reduction and overall improvement in image clarity. Techniques such as image smoothing, contrast adjustment, and artefact removal were systematically applied to address distortions or noise that may have been introduced during the image capture process. The careful execution of pre-processing contributes to the integrity of subsequent analyses.

- **Feature Extraction and Classification**: With pre-processed images in hand, the focus shifted to feature extraction, a pivotal stage in our methodology. Feature extraction involves the transformation of raw pixel data into a set of discriminative features. These features encompass a spectrum of characteristics, including colour profiles, textural attributes, geometric forms, and edge patterns. For instance, the measurement of skewness asymmetry around pixel distributions provided valuable insights into the subtle nuances of areca nut characteristics. The robustness and in formativeness of these extracted features lay the foundation for subsequent classification. The classification phase is the core of our methodology, where the extracted features are fed into a Convolutional Neural Network (CNN) for accurate categorization of areca nuts. Both training and testing stages are meticulously executed to ensure the model's ability to generalize beyond the training dataset. We opted for the VGG-19 architecture, known for its simplicity and effectiveness in image-related tasks. Comprising 3x3 convolutional layers and 2x2 max-pooling layers in a uniform structure, culminating in three fully connected layers, VGG-19's versatility and pre-training on extensive datasets contribute to its suitability for our classification objectives.
- **Evaluation**: Model evaluation constitutes a critical step in the machine learning workflow, wherein the performance of our trained model is rigorously assessed to gauge its generalization capabilities to new, unseen data. Various metrics and techniques are employed in the evaluation process to comprehensively understand the strengths and weaknesses of our model. In crafting this methodology, we ensured a meticulous approach to each phase, from image acquisition to model evaluation. The selection of VGG-19 underscores our commitment to leveraging well-established architectures for optimal results. There are two model evaluation methods explaining about the performance of the model.

  Confusion matrix: A confusion matrix is a tool employed in classification to assess the effectiveness of a machine learning model. It offers a concise representation of the model's predictions and their correspondence with the true classes or labels. The utility of the confusion matrix is especially prominent in binary classification scenarios, involving two classes (positive and negative); however, its applicability extends to multiclass classification.

Classification Report: A classification report is a comprehensive evaluation metric used in machine learning for assessing the performance of a classification model. It presents key metrics such as precision, recall, F1-score, and support for each class in a multiclass classification problem. Precision measures the accuracy of positive predictions, recall gauges the ability to capture all positive instances, and the F1-score balances precision and recall. The support metric denotes the number of actual occurrences of each class in the dataset. The classification report provides a detailed overview of the model's performance across different classes, aiding in the interpretation and assessment of its predictive capabilities.

3. RESULTS AND DISCUSSION

Agriculture contributes significantly to the country's socioeconomic development. It is the backbone of the Indian economy, accounting for 18.5 percent of the country's GDP. There is a need for every agricultural product. concentrated quality assessment, which is more accurate and dependable. We employ classification and grading processes that we do manually which entirely rely on humans to discern between different sorts of fruits and veggies. To do this, an automated model must be implemented. Reduce the amount of effort, the time it takes to complete the procedure, and the number of errors. Areca nut is one of India's key cash crops. Every Indian's day-to-day life revolves around it. As a source of rejuvenation as well as tradition and culture, family is important. Our project's goal is to significantly enhance the efficiency in the classification and grading of Areca nuts, crucial components in global cultural practices and a substantial industry in India. The overarching objective is to markedly improve the sorting, grading, and packaging capabilities within the industry, ultimately fostering enhanced market competitiveness and assist farmers.

Farmers will benefit from image analysis based on texture and colour features. Sorting and grading according to size and colour. This project addresses the crucial need for efficiently classifying and grading Areca nuts, a vital aspect of global cultural practices and a major industry in India. Using advanced machine learning and image processing, we integrate Convolution Neural Network (CNN) algorithm to enhance sorting, grading, and packaging capabilities based on size and color, ultimately improving market competitiveness. Overcoming challenges in data collection, including lighting variations, was crucial for a diverse dataset. Rigorous experimentation and fine-tuning were key in developing precise machine learning models. We optimized the model for real-time inspection, prioritizing user-friendliness for successful adoption.

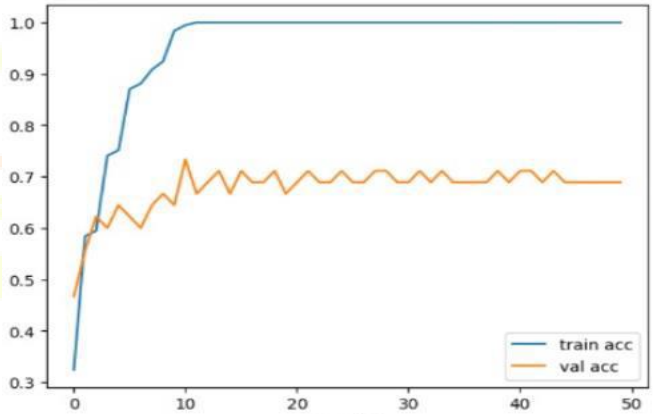
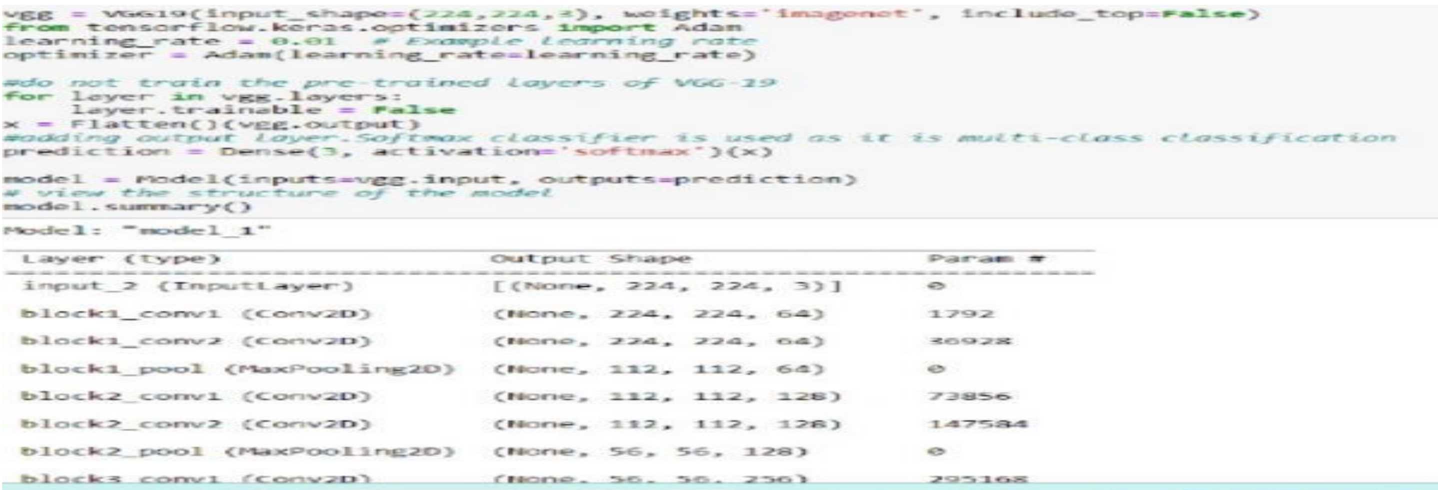


Fig3.accuracy value



```
vgg = VGG19(input_shape=(224,224,3), weights='imagenet', include_top=False)
from tensorflow.keras.optimizers import Adam
learning_rate = 0.01   # Example learning rate
optimizer = Adam(learning_rate=learning_rate)

#do not train the pre-trained layers of VGG-19
for layer in vgg.layers:
    layer.trainable = False
x = Flatten()(vgg.output)
#adding output layer.Softmax classifier is used as it is multi-class classification
prediction = Dense(3, activation='softmax')(x)

model = Model(inputs=vgg.input, outputs=prediction)
# view the structure of the model
model.summary()
Model: "model_1"
```

Layer (type)	Output Shape	Param #
input_2 (InputLayer)	[(None, 224, 224, 3)]	0
block1_conv1 (Conv2D)	(None, 224, 224, 64)	1792
block1_conv2 (Conv2D)	(None, 224, 224, 64)	36928
block1_pool (MaxPooling2D)	(None, 112, 112, 64)	0
block2_conv1 (Conv2D)	(None, 112, 112, 128)	73856
block2_conv2 (Conv2D)	(None, 112, 112, 128)	147584
block2_pool (MaxPooling2D)	(None, 56, 56, 128)	0
block3_conv1 (Conv2D)	(None, 56, 56, 256)	295168

Fig4.VGG model implementation

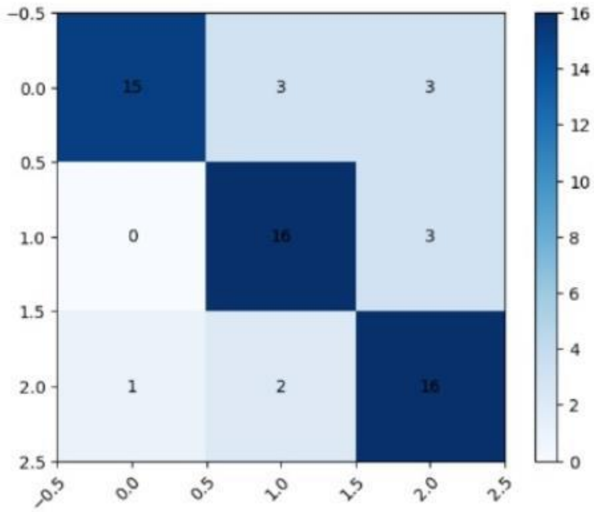


Fig5.Confusion Matrix

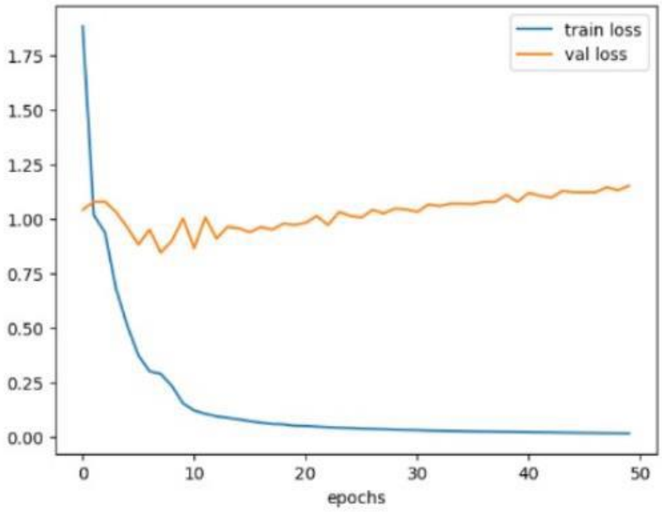


Fig6. Loss Value

```
from sklearn.metrics import classification_report
print(classification_report(test_y,y_pred))
              precision    recall  f1-score   support

           0       0.94      0.71      0.81        21
           1       0.76      0.84      0.80        19
           2       0.73      0.84      0.78        19

    accuracy                           0.80        59
   macro avg       0.81      0.80      0.80        59
weighted avg       0.81      0.80      0.80        59
```

Fig7.classification report

In a noteworthy achievement, our CNN model achieved above 80% accuracy, surpassing the performance of previous benchmarks identified in literature surveys. This improvement underscores the effectiveness of our approach in enhancing the accuracy of Areca nut classification, emphasizing our commitment to elevating industry standards.

4. CONCLUSIONS AND FUTURE WORKS

In conclusion, this project successfully addresses the manual challenges in the classification and grading of areca nuts by introducing an innovative machine learning-based model. Leveraging advanced technologies such as machine learning and image processing, the project streamlines the quality assessment process, significantly improving efficiency for farmers and stakeholders in the areca nut industry. The accuracy achieved by the Convolutional Neural Network (CNN) model, 80% signifies a notable advancement in the automated classification of areca nuts based on size, color, and texture. The contributions of this project extend beyond automation, encompassing enhanced efficiency, improved quality maintenance, and a positive impact on the cultural and economic aspects of the areca nut industry. By showcasing the practical integration of advanced technologies, the project sets a benchmark for the intersection of traditional agricultural practices and cutting-edge innovation. Building on the success of this project, several avenues for future work emerge. Firstly, there is scope for refining and expanding the dataset to encompass a broader range of areca nut variations, ensuring the model's robustness across diverse conditions. Additionally, further optimization of the real-time inspection model could enhance its applicability in large-scale areca nut processing facilities.

Exploring additional attributes for classification, such as taste and nutritional content, could contribute to a more comprehensive quality assessment. Collaborations with industry experts and stakeholders would provide valuable insights and facilitate the integration of the model into existing areca nut processing workflows. Moreover, the application of this technology to other crops within the agricultural sector presents an exciting area for future research. The insights gained from this project could be extended to improve the efficiency and accuracy of quality assessments in various agricultural contexts. In summary, the successful implementation of this project lays the foundation for ongoing advancements in automating agricultural processes, with the potential to bring transformative changes to the areca nut industry and beyond.

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