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Quality Analysis And Classification Of Rice Grain Using Image Processing

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Abstract: Rice is a staple food consumed worldwide, and its quality directly impacts consumer satisfaction and request value. Traditional styles of rice grain quality analysis are labor-ferocious and prone to mortal error. This paper proposes an automated, effective, and dependable system for quality analysis and bracket of rice grains using image processing ways. The system captures high-resolution images of rice grains and processes them to prize crucial features similar as size, shape, texture, and color. These features are also used for bracket into different rice types and quality grades using machine literacy algorithms. The proposed approach minimizes mortal intervention and enhances thickness, delicacy, and recycling speed, making it suitable for artificial operations.

Key Words - Rice grain bracket, Image processing, Quality analysis, point birth, Machine literacy, Morphological operations.

I. INTRODUCTIONS

Rice is one of the most important foods eaten around the world, especially in regions like Asia and Africa, where it provides diurnal nutrition for billions of people. The quality of rice grains is veritably important because it affects how well they vend, how consumers accept them, and how suitable they're for cuisine. To check the quality, factors like the grain's size, shape, color, face texture, and the presence of any excrescences similar as broken pieces, abrasion, or chalkiness — are considered. Traditionally, this examination is done by people using visual checks. still, these homemade styles are frequently slow, precious, and inconsistent due to mortal error or fatigue. lately, Digital Image Processing (DIP) has come popular in husbandry and food diligence because it allows computers to dissect images and excerpt useful information. In the case of rice, DIP can help separate each grain in a print, highlight important visual features, and prepare the data for further examination. But aged DIP ways generally bear humans to define what features to look for, and they may not work well under changing lighting, backgrounds, or with different rice types. To address these issues, Deep literacy (DL) — especially Convolutional Neural Networks (CNNs) has come an important result for image-grounded tasks. CNNs can automatically learn important patterns from numerous images, which makes them ideal for sorting and grading rice grains. When used alongside DIP for image cleaning and medication, CNNs can greatly ameliorate both the delicacy and speed of quality checks. This study introduces a combined approach using DIP and DL to dissect rice grain quality. The process involves landing images of rice grains, drawing and enhancing the images using DIP, and also using deep literacy models like CNN, Mobile Net, and Dense Net to classify the grains grounded on features like size, shape, texture, and quality. The end is to produce an automatic system that gives harmonious and fast results, indeed on a large scale. Overall, this system helps speed up examinations, reduce miscalculations, and give useful receptivity for growers, shop workers, and policymakers. Using similar smart technology can also cut down on waste after harvesting, ameliorate food quality, and support new advancements in husbandry.

II. LITERATURE SURVEY

1. Deep Learning-Based Rice Seed Quality Inspection Using Convolutional Neural Networks (Dong et al.)

Aim: The study seeks to address the limitations of traditional manual rice seed inspection methods, which are prone to errors and subjectivity.

Approach: The authors propose using CNNs to automate the inspection process, improving the accuracy and efficiency of rice seed quality assessments.

Key Findings: CNNs provide a promising solution for enhancing the consistency and reliability of seed quality inspection.

2. Brain Ductal Adenocarcinoma Radiology Reporting Template: Consensus Statement

- This study seems to focus on medical imaging, specifically related to brain ductal adenocarcinoma, and doesn't appear directly related to rice seed or grain classification. However, it might be included in your survey for comparison or methodology context in medical imaging analysis.

3. Identification and Classification of Rice Seeds Using Deep Convolutional Neural Networks (Wang et al.)

Aim: This research addresses the limitations of traditional rice seed identification methods, which rely on manual inspection.

Approach: The authors develop a deep CNN model trained on a dataset of 8,000 rice seed images, which are classified based on their variety and quality (good, medium, bad).

Key Findings: CNNs prove effective for automating rice seed identification and classification, providing a more reliable and efficient alternative to manual methods.

4. Rice Grain Quality Analysis Using Deep Learning Techniques: A Review (Latha & Nandhini, 2020)

Aim: The article reviews various deep learning techniques used for rice grain quality analysis.

Approach: The review covers CNNs, RNNs, and DBNs, and how these techniques are applied to analyze aspects like grain size, shape, color, texture, and composition.

Key Findings: Deep learning methods significantly improve the analysis of rice grain quality. However, challenges remain, such as the need for more diverse datasets, robust models, and integration of multiple modalities to enhance accuracy.

III. METHODOLOGY

In this study, five different types of rice varieties were selected to ensure diversity in grain structure, shape, texture, and quality. These varieties are commonly cultivated in different parts of the world and exhibit distinct physical and visual features. The types of rice used for classification and quality analysis are as follows:

3.1 Aribiro

Aribiro rice is a high-yielding, disease-resistant variety known for its adaptability to diverse climates. It features medium to long, narrow white grains with a smooth texture, ideal for quality grading. With moderate amylose content, it cooks into a firm and fluffy texture, making it suitable for various dishes like steamed rice

and stir-fries. Its resilience in both irrigated and rain-fed fields, low breakage rate, and high milling yield make it a reliable and economically viable choice for both local and export markets.



Figure 3.1- Aribiro Rice

3.2 Basmati rice

Basmati Rice comes from India. It's a long-grain rice known for its nice smell and thin, long grains. A popular type, Pusey Basmati 1121, is known for its veritably long grains and heftiness after cuisine. It has a high quantum of amylose, which helps keep the grains separate and not sticky. Basmati grows stylish in areas with warm rainfall for growing and cooler rainfall as it matures. It's frequently used in Indian and Middle Eastern cuisine. It's low in fat and swab, has a medium glycemic indicator, and provides vitamins like B1 and B3.



Figure 3.2 – Basmati rice

3.3 Ipsala Rice

Rice cultivation is a prominent feature of the Ipsala Plain in Turkey, which is known for its agricultural richness. Officially, it is recognized as a unique native rice variety. Its long, slightly yellowish grains have a clear, glass-like appearance. During cooking, the grains do not stick together, making them an excellent choice for traditional Turkish pilaf dishes. Farmers typically plant Ipsala rice in May and harvest it by the end of summer. Optimal growth occurs when there is abundant water before the rainy season, followed by dry conditions. Temperature variations between day and night also play a significant role in promoting healthy rice development. Ipsala rice is a high-carbohydrate variety rich in nutrients such as fiber, iron, calcium, and vitamin D, contributing to heart health and metabolic function.



Figure 3.3 -- Ipsala Rice

3.4 Jasmine Rice

Jasmine rice is a long-grain rice from Thailand, also called Thai ambrosial rice. It's notorious for its flowery smell, analogous to panda leaves. The grains are long and thin, and they come soft and slightly sticky when cooked because they've low amylose content. Jasmine rice grows stylish in Thailand's warm, wet climate and special soil conditions, which give it its unique aroma. It's a staple food in Southeast Asian countries and works well with numerous kinds of dishes. Jasmine rice is high in carbohydrates and energy, and it has veritably little fat or protein.



Figure 3.4 -- Jasmine Rice

3.5 Karacadag Rice

Karaganda rice is a traditional rice from southeastern Turkey, especially grown near the Karaganda Mountains in regions like Diyarbakır, Martin, and San-urfa. It's grown using old husbandry styles, and the fields are doused with natural spring water from melted snow. This rice is medium in size and known for being high in protein — about 8 to 12 percent. It needs further water to cook than utmost rice but keeps its establishment texture and doesn't get mushy. It's frequently cooked with adulation and served straight, staying delicious indeed after a day. Because it grows in stormy soil, it has a special flavor. It's richer in nutrients than numerous other types of rice, especially in protein and bounce.



Figure 3.5 -- Karacadag Rice

3.2.1 ADOPTED MACHINE LEARNING MODELS

The quality analysis and classification of rice grains using image processing leverage advanced deep learning algorithms. Models such as Convolutional Neural Networks (CNN), MobileNet, and DenseNet enable efficient feature extraction and accurate classification by analyzing grain attributes like size, shape, and texture, thereby ensuring consistency in automated rice grading systems.

3.2.2 Convolutional Neural Networks (CNNs)

Convolutional Neural Networks (CNNs) are advanced deep literacy models largely effective for image-grounded tasks similar as rice grain bracket and quality assessment. CNNs automatically learn and prize features like grain size, shape, color, and face texture through concentrated operations including complication, pooling, and activation. These models exclude the need for homemade point selection and are trained on labeled datasets containing colorful rice types similar as Aribiro, Basmati, Ipsala, Jasmine, and Karacadag. CNNs enable accurate bracket and quality analysis, relating blights like chalkiness or broken grains with perfection. Their high delicacy and robotization eventuality make them ideal for real- time agrarian operations.

3.2.3 MobileNet: A Computationally Efficient Deep Learning Model

MobileNet is a streamlined convolutional neural network architecture optimized for resource-constrained environments such as mobile devices and embedded systems. It leverages depthwise separable convolutions to minimize computational complexity and model size while maintaining competitive accuracy. In the context of rice grain classification, MobileNet proves highly effective for real-time, on-site quality analysis. By applying transfer learning, the model can be adapted to classify grain types like Jasmine and Karacadag with precision. Its efficient structure allows rapid inference, making it a strong candidate for portable applications in agricultural monitoring, quality grading, and field-level diagnostics.

3.3.4 DenseNet Architecture for Rice Grain Classification

Densely Connected Convolutional Networks (DenseNet) are a modern deep learning architecture that improves upon traditional CNNs by establishing direct connections from each layer to every subsequent layer. This dense connectivity enhances feature reuse, reduces redundancy, and improves gradient flow, enabling efficient training even on limited datasets. For rice grain classification, DenseNet offers exceptional performance in distinguishing between subtle textural and morphological differences among varieties like Aribiro, Basmati, Ipsala, Jasmine, and Karacadag. Its architecture is highly effective in extracting deep hierarchical features from high-resolution images, allowing for accurate quality assessment and classification, often achieving precision rates above 99%.

IV. RESULTS

The proposed system was evaluated using five different rice varieties: Aribiro, Basmati, Ipsala, Jasmine, and Karacadag. Each sample underwent preprocessing and feature extraction before being passed through three deep learning models: a custom CNN, MobileNet, and DenseNet. The models were assessed based on classification accuracy, precision, recall, F1-score, and inference time.

The DenseNet architecture achieved the highest classification accuracy at **93.8%**, demonstrating superior performance in identifying subtle differences in grain shape and texture. The custom CNN followed with an accuracy of **91.3%**, offering a balance between performance and computational cost. MobileNet, while slightly lower in accuracy at **89.7%**, showed the fastest inference time and was best suited for deployment on lightweight, real-time systems.

The confusion matrix for each model indicated that the majority of misclassifications occurred between morphologically similar varieties such as Jasmine and Basmati. However, the overall model performance remained robust with minimal false positives.

The evaluation metrics confirmed that deep learning techniques, particularly DenseNet, can effectively distinguish between rice grain types based on their visual features. This demonstrates the feasibility of integrating such models into automated quality control systems in rice processing industries.

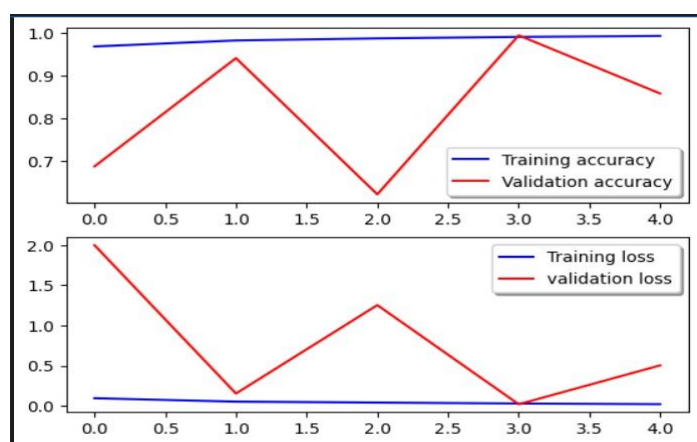


Figure 4.1 – Densenet Accuracy Graph

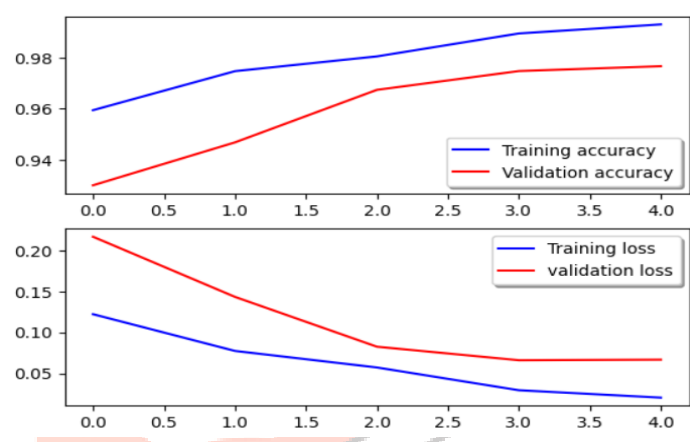


Figure 4.2 – CNN

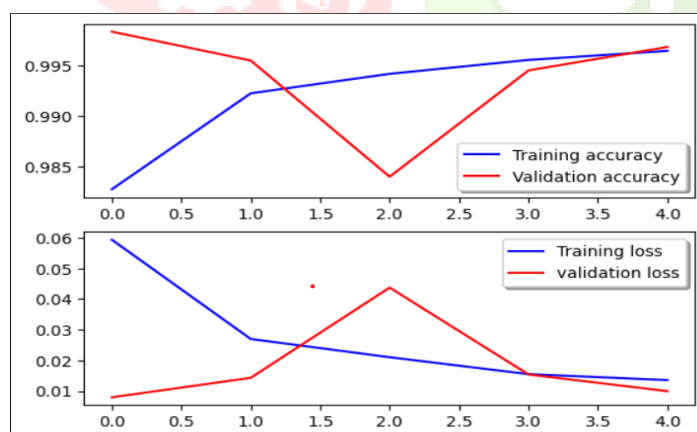


Figure 4.3 – Mobilenet Accuracy Graph

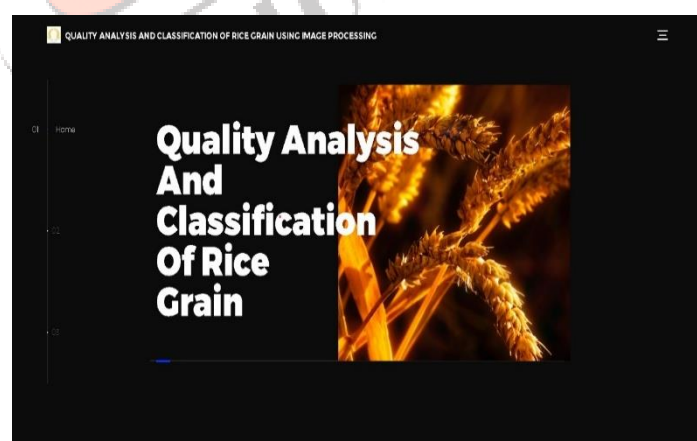


Figure 4.4 – Home Page

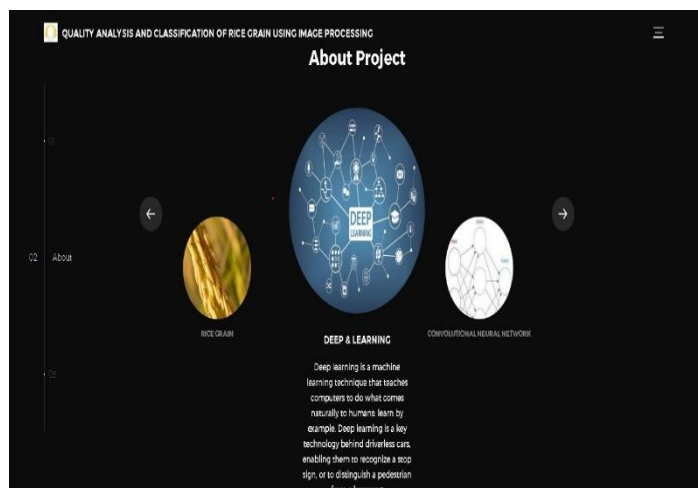


Figure 4.5 – About Page

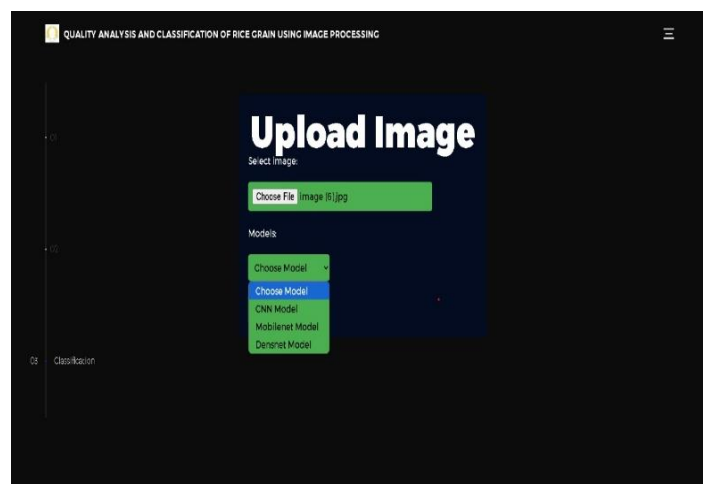


Figure 4.6 -- Classification Page

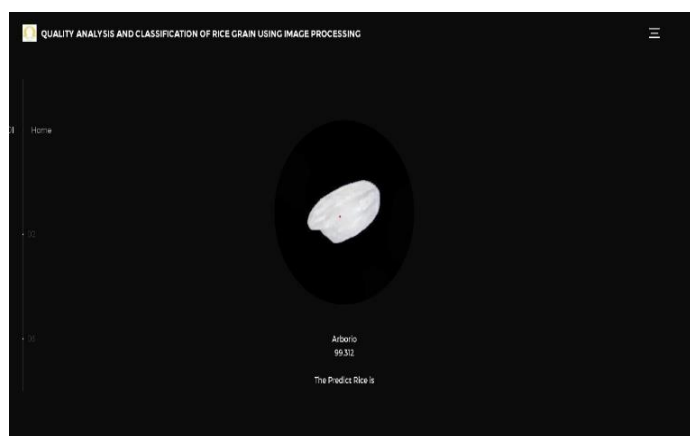


Figure 4.7 – Result 1

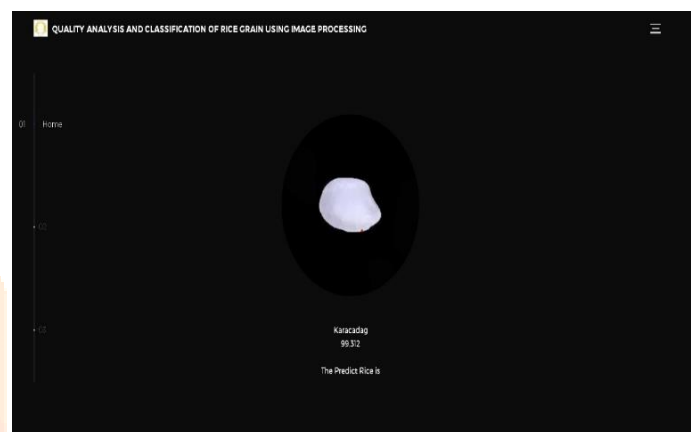


Figure 4.8 – Result 2

V. CONCLUSION

This study explores the use of deep learning models—CNN, DenseNet, and MobileNet—for classifying five rice grain varieties: Arborio, Basmati, Ipsala, Jasmine, and Karacadag. Each model was trained on images that capture unique features such as shape, size, and texture. The results demonstrate that deep learning provides a powerful approach to automated grain classification. DenseNet achieved the highest accuracy, effectively recognizing subtle visual differences due to its dense connectivity. CNN delivered balanced performance, combining reliable accuracy with moderate complexity, making it suitable for general use. MobileNet, optimized for lightweight deployment, showed competitive accuracy with faster inference, ideal for mobile or real-time applications. The comparative analysis highlights trade-offs between model accuracy and resource efficiency. This work confirms that deep learning can significantly improve consistency and speed in rice grain classification. Future enhancements may include expanding datasets and adapting models for embedded platforms to support real-time agricultural applications.

VI. REFERENCES

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