Rice Grain Quality Analysis

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Abstract— **Numerous studies have utilized machine vision to assess the visual quality of rice. Rice, along with other food crops like wheat, potatoes, soybeans, and maize, is a staple food consumed by people worldwide, particularly in Asian countries. Rice is primarily categorized based on its grain shape, colour, and other characteristics. Grains serve as the main source of agricultural income for our nation. However, these grains often contain contaminants such as stones, weed seeds, chaff, and damaged seeds. Currently, evaluating grain quality requires low levels of automation and a significant human workforce, resulting in increased costs and testing time. To address this issue, we propose a grain classification system that utilizes machine learning and image processing algorithms to identify different types of grains and determine their purity based on parameters such as size and shape. This system utilizes the Python programming language and software for all machine vision operations. Grain classification using image processing techniques has been widely applied to differentiate rice varieties based on unique features including shape and length, this paper examines the characteristics of rice, including its chalkiness, colour, and internal damage. Additionally, it discusses and proposes methods for classifying four different rice varieties. Furthermore, the paper explores the use of image processing techniques to determine the purity percentage of rice grains by analyzing various features such as grain colour and shape.**

Keywords—Rice Analysis, Image Processing, Grain Purity Assessment, Quality Control

I. INTRODUCTION (*HEADING 1*)

The agricultural sector, with its rich history, faces the ongoing challenge of assessing grain quality. This study presents an innovative solution for evaluating and grading rice grains using image processing techniques.

Traditionally, rice grading relies on manual size classification, prone to human error. Integrating image processing offers a non-destructive and cost-effective method, enhancing accuracy and objectivity. Rice quality is multifaceted, encompassing physical and chemical attributes.

While conventional methods like dial micrometres are time-consuming and prone to errors, image processing provides a faster and more accurate alternative. Machine vision eliminates human biases and fatigue, ensuring precise grain classification.

This paper outlines the procedure for determining rice quality percentage and discusses various physical and chemical attributes involved. Ultimately, the adoption of image processing techniques promises to revolutionize grain quality assessment, providing a more efficient and reliable method for the agricultural industry.

II. LITERATURE SURVEY

A. Advancements in Food Quality Detection:

Food quality detection has evolved significantly with the integration of machine learning and image processing techniques. Fifteen research papers delve into various applications, including deep learning for quality assessment, fruit ripeness detection, and automated bakery and fish inspection systems. Techniques such as convolutional neural networks, support vector machines, transfer learning, and decision trees are employed to enhance food safety and consumer satisfaction.

B. Exploring Diverse Applications:

These studies also cover disease detection in vegetables, contaminant detection, egg quality assessment, and milk spoilage detection. Through innovative computational methods, they aim to address challenges in ensuring the integrity and excellence of food products, representing a significant advancement in the food industry's quality control practices.

III. METHODOLOGY

The system is divided into smaller modules. The modules are as follow Using an image processing method, the evaluation of the quantity of rice seeds is carried out, followed by categorizing them according to specific factors such as length, width, and the ratio between length and width. More specifically, the term "length" refers to the average measurement of rice grains in the longitudinal direction, while "width" pertains to the average measurement in the transverse direction. The length-to-width ratio is calculated using the formula L/B = [(Average length of rice grain)/(average width of rice)]*10.

The entire system is divided into smaller modules, which are as follows:

A. Image Pre-Processing:

During the first stage, the image pre-processing process takes place, wherein a filter is used to remove any noise that may have been generated during the image acquisition. This filter not only eliminates noise but also enhances the sharpness of the image. Additionally, a threshold algorithm is employed to separate the rice grains from the black background. The filter is specifically applied to eliminate any noise that might occur during the image acquisition, while also improving the overall sharpness of the image. The utilization of a threshold algorithm facilitates the segmentation of the rice grains from the black background.

B. Shrinkage Morphological Operation:

To tackle the issue of segmenting rice kernels that are touching, a shrinkage morphological operation is utilized. This procedure starts with erosion, which effectively separates interconnected characteristics of the rice grains while ensuring the integrity of each individual grain is maintained. Erosion is applied to separate the touching features of the rice grains without compromising the integrity of any single feature.

C. Edge Detection:

The identification of rice grain boundaries is crucial, and edge detection plays a significant role in achieving this. To efficiently detect these edges, the canny algorithm is employed. In the realm of vision and motion toolbox, there are six available methods for edge detection, including differentiation, gradient, permit, Roberts, sigma, and Sobel. Each method determines the specific type of edge detection filter to be utilized. In our proposed methodology, we utilized the Sobel method for edge detection.

D. Object Measurement:

In the fourth stage, the process involves measuring the objects, specifically determining the number of rice grains. Once the grains are quantified, algorithms for edge detection are utilized to obtain endpoint values for each individual grain. By using a calliper, the endpoints can be connected, allowing for the measurement of both length and breadth. These dimensions are then used to calculate the ratio between length and breadth. Through the use of the calliper, we can join the endpoints and measure the length and breadth values for each grain, ultimately enabling us to calculate the length-breadth ratio.

E. Object Classification:

During the last phase of the algorithm, the task of object classification takes place. This involves gathering a set of standards, measured, and calculated results. To summarize, the systematic utilization of image processing methods, which include pre-processing, morphological operations, edge detection, measurement, and classification, constitutes a thorough approach for precisely measuring and categorizing rice seeds according to their size and shape characteristics.

F. Classification Criteria based on Aspect Ratio:

a) Aspect Ratio Calculation: The aspect ratio of each rice grain is calculated using the formula: aspect ratio = width/height. If the aspect ratio is less than 1, it is normalized to ensure a positive value: aspect ratio = 1/aspect ratio.

b) Slender: If the aspect ratio is greater than or equal to 3, the rice grain is classified as "Slender".

c) Medium: If the aspect ratio is between 2.1 and 3 (inclusive), the rice grain is classified as "Medium".

d) Bold: If the aspect ratio is between 1.1 and 2.1 (inclusive), the rice grain is classified as "Bold".

e) Round: If the aspect ratio is less than or equal to 1, the rice grain is classified as "Round".

f) Output format: The classification result is formatted as a string enclosed in parentheses, making it easier to concatenate with other information. In summary, the classification is based on the relative proportions of width and height, and each rice grain is categorized into one of the four classes: Slender, Medium, Bold or Round. The classification provides insights into the shape characteristics of the rice grains.

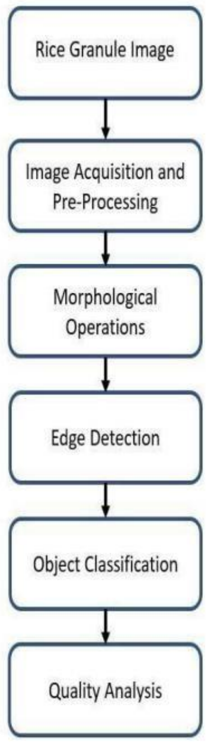

Figure 1: Architecture Diagram of the proposed model

Grain Shape	L/B ratio
Slender	Over 3
Medium	2.1-3
Bold	1.1-2
Round	1 or less

Figure 2: Classification Criteria based on Aspect Ratio

IV. SOFTWARE REQUIREMENTS

1) The Software requirements are as follows:

Visual Studio Code: Visual Studio Code, developed by Microsoft, is a lightweight and open-source code editor. It offers a modern and customizable interface for software development on various platforms.

Python: Python is utilized as the programming language for the complete application. It offers a clear and easily understandable syntax, making it ideal for swift development.

Flask: Flask, a Python micro web framework, streamlines the creation of web applications by offering tools and libraries for typical web development duties. Within this code, Flask serves as the central framework that manages HTTP requests and responses.

OpenCV(cv2): OpenCV, also known as the Open-Source Computer Vision Library, is employed for computer vision purposes. In this particular application, OpenCV is utilized for carrying out image processing tasks, which encompass operations such as thresholding, filtering, erosion, dilation, and contour detection.

NumPy: NumPy is a robust Python library that offers extensive capabilities for performing numerical operations. It facilitates the handling of large arrays and matrices with multiple dimensions, as well as provides a wide range of mathematical functions. In the given code, NumPy is most likely employed to efficiently manipulate arrays within the realm of image processing.

a) Matplotlib: Matplotlib is a versatile library that allows you to create visualizations in Python, whether they are static, animated, or interactive. The code utilizes Matplotlib to produce a pie chart that displays the percentages of dust and rice grains.

b)Web Browser: The Flask web application is accessed by end-users through a web browser. HTML templates are utilized to create the user interface, and the outcomes are presented within the browser.

2) The implementation steps are as follows:

i) Image Processing Functions:

a) Get classification(ratio): The classification process sorts rice grains according to their aspect ratio, rounding the value to the nearest tenth and assigning them into categories such as Slender, Medium, Bold, or Round. The classification is indicated in parentheses.

b) Calculate_dust_percentage(img): The function computes the dust percentage in the provided image by applying a threshold to generate a binary image. It then identifies dust particles through contours and calculates the dust percentage as the ratio of dust pixels to the total number of pixels in the image.

c) Image Filtering and Transformation: The process starts by converting the input image into binary format using a threshold. Next, a 5x5 averaging filter is applied to smoothen the binary image. After that, erosion and dilation operations are performed to enhance the features of the image. Finally, the Canny algorithm is used for edge detection.

ii) Contour Detection: The processed image is analysed to detect the outlines of each rice grain, and a function is used to determine the number of grains detected. Additionally, the function iterates through each contour to calculate the aspect ratio of each rice grain.

a) Rice grain Information: The aspect ratio, classification, and average aspect ratio of rice grains are printed, and information about each grain is stores in a list named "grain info".

b)Dust percentage: To calculate_dust_percentage function is called to determine the percentage of dust in the image.

c)Visualization: The processed images are converted to base64 strings for display in the browser, while a pie chart is generated using Matplotlib represent the dust percentage and rice grain percentage.

iii)Flask Route (@app.route("/")):

The route handles both GET and POST requests, rendering the index.html template with an image upload form for GET requests, while processing the uploaded image and displaying the results on the result.html template for POST request.

iv) HTML Templates:

a) Index.html: A simple HTML form for uploading images.

b) Result.html: Displays processed images, a pie chart, grain information, average aspect ratio, and set percentage.

c)Project Report Integration: The interactive elements of the web application allow users to submit pictures for in-depth examination, with a focus on how the classification system categorizes rice grains. This is enhanced by visual representations such as pie charts, which effectively illustrate the percentage of dust and rice grains. These features provide a thorough comprehension of the code and its functionality within the project report.

V. EXPERIMENTAL RESULTS

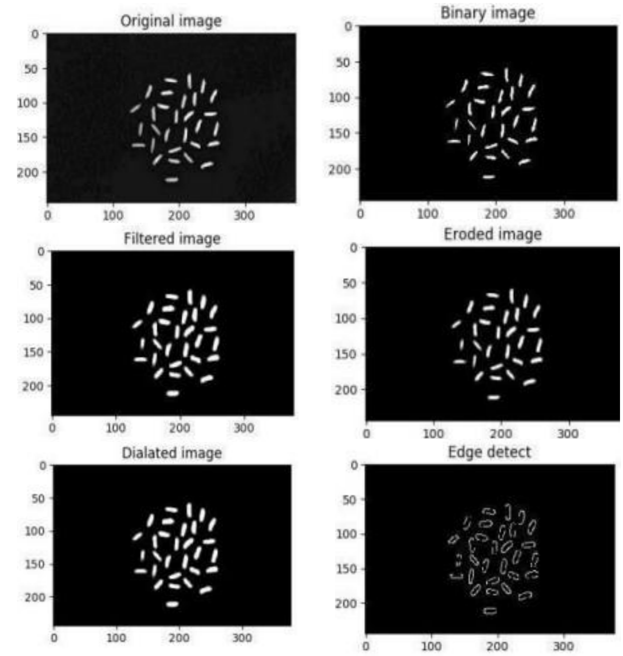

Figure 3: Results

***a) Binary Image**:* A binary image is a type of digital image where each pixel can only have one of two values, usually 0 (black) or 255 (white). It is often used for image segmentation or representing objects in a clear and simple way.

b) Filtered Image: A filtered image results from applying a filter or convolution operation to the original image. Filters modify the intensity of pixels based on their surrounding values.

***c) Eroded Image**:* Erosion is a morphological operation that expands or thickens objects in a binary image. It is achieved by moving a structuring element over the image and replacing each pixel with minimum value in its neighbourhood.

d) Edge Image: An edge image highlights boundaries or transitions between different regions in an image. It represents areas of rapid intensity change. However, it represents the distribution of two categories: "Dust Percentage" and "Rice Grain". The chart aims to visually convert the proportion of these two components in the processed image.

***e) Dust Percentage**:* This represents the percentage of the image covered by dust particles. The code uses image processing techniques to identify and calculate the area occupied by dust. The dust percentage is then displayed in the pie chart.

f) Rice Grain Percentage: This represents the percentage that complements the dust percentage and signifies the portion that is not covered by dust, but rather assumed to be occupied by rice grains. The calculation involves subtracting the dust percentage from 100%. Each section of the pie chart corresponds to either the "Dust Percentage" or the "Rice Grain Percentage." The chart is appropriately labelled, and the percentage values are indicated on each section. The colours employed in the pie chart are "light coral" for dust and "lightskyblue" for rice grains.

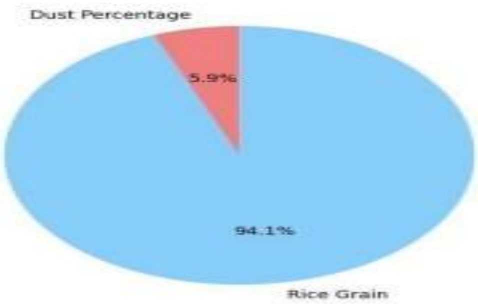

Figure 4: Pie-chart of Dust Percentage and Rice Grain Percentage

To simplify the classification process, a bar chart is used in this specific scenario to group similar data. This chart effectively presents information about the classification of rice grains. It is worth mentioning that the chart consists of two separate bars: the blue bar represents the total number of rice grains in the dataset, while the red bar represents the average aspect ratio of the rice grains.

Both the grouped bar chart and the pie chart play vital roles in conveying important information about the classification and quality assessment of rice grains.

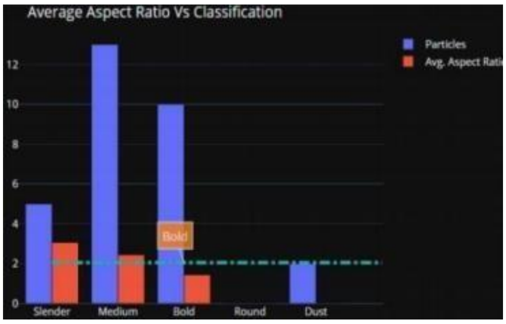

Figure 5: Grouped bar chart of Average Aspect Ratio Vs Classification

Aspect Ratio	Type
1.44	(Bold)
2.21	(Medium)
4.07	(Slender)
2.42	(Medium)
1.17	(Bold)
3.56	(Slender)
1.38	(Bold)
1.5	(Bold)
1.91	(Bold)
1.45	(Bold)
1.76	(Bold)
2.3	(Medium)
1.47	(Bold)
1.0	(Round)
4.75	(Slender)
1.06	(Bold)
1.13	(Bold)
1.51	(Bold)

Figure 6: Table for Individual Aspect Ratio and it's Type

VI. CONCLUSION AND FUTURE SCOPE

Conclusion:

Our project focuses on the comprehensive classification of rice grain samples and a meticulous analysis of their quality based on the aspect ratio. Our approach sets itself apart from existing works by not only identifying and quantifying rice grains, but also evaluating their quality and categorizing them accordingly. This is particularly important for efficiently grading a large volume of grains. Our methodology significantly speeds up this process, reducing the time and effort required for manual analysis.

To analyse the grains, we utilize image analysis algorithms on randomly arranged single-layer images of rice grains. We employ edge detection to identify boundary regions and determine the endpoints of each individual grain. Using a calliper, we then measure the length and breadth of each grain. These measurements enable us to calculate the length-breadth ratio, which further aids in assessing the quality of the grains**.**

The utilization of these algorithms demonstrates great effectiveness in assessing the quality of grains by considering their dimensions. Our suggested approach offers several key benefits, including a faster process, reduced time requirements, cost-effectiveness, and superior performance when compared to traditional manual techniques.

Future Scope:

In order to conduct a thorough quality analysis, it is necessary to utilize image processing techniques to measure a wide range of parameters. The next step in this research could involve developing a system that is capable of classifying rice grains based on each individual parameter, with the aim of improving the overall quality of the rice. It is important that such a system is cost-effective and minimizes the time required for quality analysis.

ACKNOWLEDGMENT ***(Heading 5)***

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