iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** VII **Month of publication:** July 2022

DOI: https://doi.org/10.22214/ijraset.2022.45335

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VII July 2022- Available at www.ijraset.com

Quality Testing of Food Grains Using Image Processing and Neural Network

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Abstract: ***The main crop for our nation to boost agricultural income is grains. While the crop is still in the ground, farmers notice yield the most, but once the grain has been processed and sold, quality becomes the main factor in determining its viability. Several contaminants, including stones, weed seeds, chaff, damaged seeds, etc., are present in these grains. Low automation levels and a large human workforce are required for assessing grain quality.***
Additionally, it increases the cost and length of the testing process. This contradiction is becoming more and more obvious as import and export trade expands. Prior to performing the next process during grain handling procedures, several types of grain and their quality are necessary.
For the identification of grain seed varieties and quality nowadays, we use scientific approaches. The scientific approach is also extremely labor-intensive and ruins the used sample. In contrast to the chemical approach, machine vision or digital image processing is a non-destructive method that is also a highly convenient and inexpensive process.
In order to identify different types of grains and determine the purity of grains using image processing techniques based on various parameters including grain size and shape, we proposed a grain classification system based on machine learning and image processing algorithms.
The Matlab programming language and Matlab software are used for all operations. Images are collected from a dataset that includes images of food grains. On the captured images, feature extractions, segmentation, and image processing techniques are applied.
That can be extracted in a non-contact method from the grains. This paper will also discuss and offers suggestions for how to categorize different types of food grains. It also determines the purity of the grain using image processing techniques based on characteristics like major axis length, minor axis length, area, and others.

I. INTRODUCTION

Food Grains is the most important food consumed by a huge population in Asian countries. Rice is a member of the Poaceae family of plants. Rice is grown in a variety of locations around the world. India is the world's second-largest producer of rice. The demand for high-quality food grains rises in demand with the rise of its consumption. Food grains are differentiated using manual classification methods based on local geometric features in local industries.

The suggested work employs a method for processing recorded digital photographs of food grains and extracting significant information. Morphological characteristics are examined to establish the type of food grain. To extract various information from the collected image, image processing techniques are used.

The food granules are evaluated by a neural network after picture processing. The results are acquired by putting the rice grains through a series of tests.

Using image processing and neural network technologies, this paper[5] performs quality grade testing and identification of rice granules. Images for rice are captured here using a webcam. MATLAB is used to conduct image pre-processing techniques such as Thresholding, segmentatione extraction on the obtained image. For training purposes, the features are supplied to the neural network. The trained network is then utilized to determine the quality of the unknown contaminants. The grading system was created to ensure product quality consistency.

The Neural Network Pattern Recognition Tool may be used to classify granules using this way. MATLAB provides many functions in the form of a toolbox that helps us in automating commonly used image processing techniques and workflows by enabling interactive segmentation of image data, comparison of image registration methods, and batch processing of large datasets. There are few toolbox that we have used in our project for front end part we have used GUIDE toolbox, for image processing we have utilised image processing toolbox and for training and testing we have used neural network toolbox.

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II. LITERATURE SURVEY

A. Quality Testing of Food Grains

Authors: Sheikh Bilal Ahmed, Syed Farooz Ali, and Aadil Zia Khan, "On the Frontiers of Rice Grain Analysis, Classification and Quality Grading".
Description:- This work organizes and categorizes rice grain classification and quality grading procedures into geometrical, statistical, supervised, unsupervised, and deep learning approaches in chronological sequence. They conclude in this paper that deep learning produces the greatest results. From 1996 to the present, this research examines the evolution of rice grain classification algorithms.

Authors: Nikhade Pratibha, Hemlata, "Analysis and Identification of Rice Granules Using Image processing and neural network".
Description:- This presented a study project based on Image processing and neural networks were used to establish the notion of quality grade testing and identification On the captured image, we use the image processing method in MATLAB to execute Image Pre-processing techniques, Ostu's Thresholding, Canny edge detection, and Feature extraction. A neural network is given with features as part of the training process. Unrecognized contaminants and quality are determined using the trained network. A PC webcam camera is used for the acquisition, which is done in uniform lighting. Smoothing collected images is done with a median filter. In our study, we use Otsu's thresholding technique to conduct thresholding. The quality of rice seeds is assessed using image processing. The size of the grains in the sample determines the grading of rice granules. Grade 1 describes approximately 55% of long grains. In the same way, 33.33 percent of tiny grains are classified as grade 2.

Authors: P. Neelamegam and S. Sudha, "Machine vision-based quality analysis of rice grains".
Description:- The web camera is used in this paper to inspect rice grains using image processing techniques. They employ the OTSU approach, Grayscale method, Bounding Box method, and Blob detection method in this paper. This paper employs a camera to inspect rice grain quality under two different conditions: non-overlapping and overlapping.
Experiments have shown that the system can function accurately and reliably in non-overlapping arrangement situations, with an average error of 0.47 percent. The mistakes from the overlapping arrangement tests were highly high in the testing under all conditions of 18 experimental designs, averaging 53.82 percent on average. However, as compared to the overlapping approach, the non-overlapping method produces less inaccuracy.

Authors: P.M Devi Analysis and Identification of Rice Granules Using Image Processing and Neural Network".
Description:- Using image processing and neural network technologies, this paper performs quality grade testing and identification of rice granules. Images for rice are captured here using a webcam. MATLAB is used to conduct image pre-processing techniques such as Ostu's Thresholding, Canny edge detection, and feature extraction on the obtained image. For training purposes, the features are supplied to the neural network. The trained network is then utilized to determine the quality of the unknown contaminants. The grading system was created to ensure product quality consistency. The Neural Network Pattern Recognition Tool may be used to classify granules using this way.

Authors: L.Shobha, "Rice Quality Evaluation Based on Image Processing A Survey".
Description:- A survey of image processing approaches utilized in automated rice grading systems in an agricultural context was described in this paper [8]. Image processing techniques such as background subtraction, feature extraction, training, and classification are used in this field. From the published literature, an image processing-based method for automatic rice detection, classification, and recognition of foreign particles from images of rice grains utilizing color and texture data is investigated. Image processing techniques have been widely used in agricultural applications. It has the potential to be a useful tool for determining the quality of food. For the realization of real-time requirements, there are numerous options.

Authors: Oliver C. Agustin and Byung-Joo Oh, "Weight Estimation and Classification of milled rice using Support Vector Machine".
Description:- For weight estimation and classification of milled rice kernels, this paper [2] use a Support Vector Machine. They developed a support vector regression (SVR) model for predicting rice kernel weight as well as a support vector classifier (SVC) for detecting rice defects. SVR outperformed linear regression (LR), according to the findings. The performance of the suggested SVR model was found to be superior to that of the LR model.

III. ARCHITECTURE AND DESIGN

A. *System Overview*

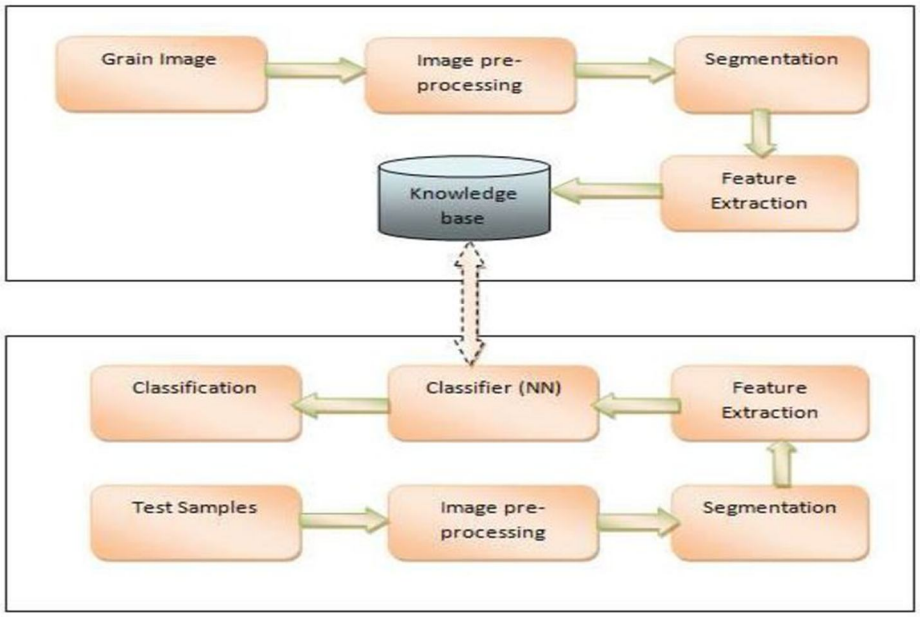


Figure 4.1: System Overview

The overview of the system is represented in Fig.4.1. It shows all the process involved in grading of food grains i.e,

Work Process of System

1) Image acquisition
2) Image pre-processing
3) Morphological operations
4) Image Segmentation
5) Feature Extraction

B. *Software Architecture*

1) System Block Diagram

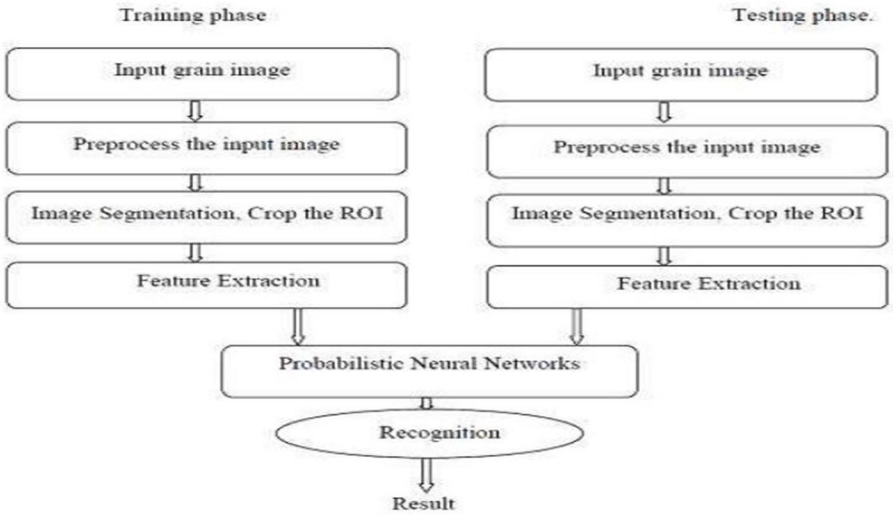


Figure 4.2: System Block Diagram

The overall block diagram of the proposed system is shown in Figure.4.2.

a) Capturing the image of grains/ images acquisition :The images are captured from the datasets. The dataset contains different images of food grains that have to be analysed and graded.
b) Image pre-processing : The images are enhanced to remove noise and any other distractions.
c) Image Segmentation and Identifying region of Interest
d) Feature Extraction: The morphological features of the each food grain is extracted and classification is done on those images.
e) Training and Testing: The data is fed to neural network for training and testing. The probalistic neural network is used for training and testing.

2) Data Flow Diagram

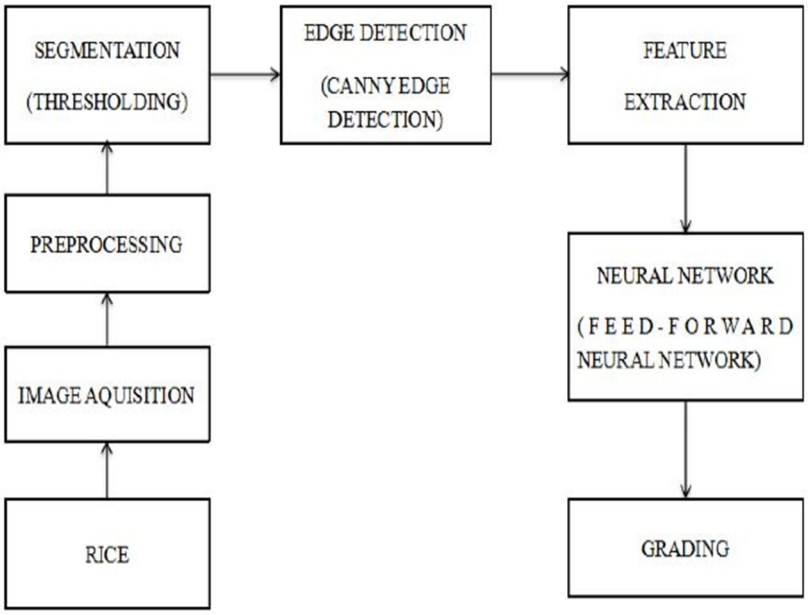


Figure 4.3: Data Flow Diagram

The flow of data right from its input stage to its final output stage is represented by the Data Flow diagram. It gives an overall overview of the system implementation without going deeply into the intricacies involved. Following is the step-by-step follow of data:-

The flow of data in the system is as follows:-

a) First the grain image is taken as input and preprocessing is performed on those images.
b) The morphological features of each food grain is extracted.
c) The extracted data is fed into neural network for training and testing.
d) The output is obtained whether the quality is A,B,C grade.

IV. IMPLEMENTATION

A. Implementation Platform

1) Hardware

- Processor: Intel Octal Core
- RAM: 8 GB
- GPU: NVIDIA GTX1080

2) Software

- Operating System: Windows (10) (64bit)
- Software Used: MATLAB R2019a
- Programming Languages: MATLAB
- Toolbox: Guide toolbox, Image processing toolbox, Neural network toolbox

B. Implementation Details

1) Image Acquisition

Acquiring food grain images is considered the most important step of the grain recognition process, as it determines the final grain image quality, which in turn dramatically affects the system's overall performance. Approximately 400 food grain images are acquired. A total of around 200 food grain images are acquired.The dataset contains images of different food grains such as wheat, horse gram, corn and rice.



Fig2.1 . Different kinds of grains considered for classification





Fig2.1 . Different kinds of grains considered for classification

2) Image pre-processing

Standard operating procedures are adhered in order to enhance the quality of an image through preprocessing techniques.For further noise reduction, the image is converted to black and white. Patches in an image are considered using matlab function bwlabel, Label connected components in binary image. The patches with size less than 70 pixels are assumed to be noise and are ignored. The other patches are the ones of interest. Smoothing is done using Median Filters. Median filter is used for pre-processing, because it preserves the edges of the image during noise removal. Median filtering is extensively used in digital imaging since it conserves the ends of the image during noise exclusion.

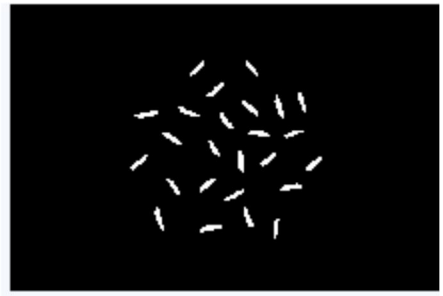


Fig2.2 Preprocessed image

- *Background Subtraction:* Background subtraction is a way of eliminating the background from image. To achieve this we extract the moving foreground from the static background. For correcting image defects resulting from nonuniform brightness, the use of a suitable background subtraction algorithm is useful. The background is removed from the images of grains for extracting the relevant featiures of an image.

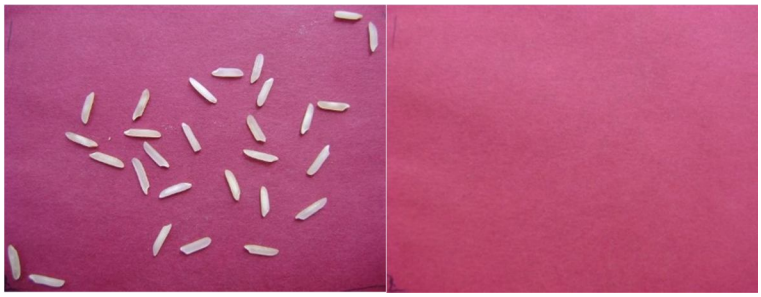


Fig2.3 Grain image Fig2.4 Background subtracted image

- *Grayscale Image:* A grayscale image is made up of only shades of gray, a kind of black-and-white or gray monochrome image. The contrast ranges from black at the lowest intensity to white at the highest. After background subtraction the images of food grains is converted into grayscale images for better segmentation of the images.Pixels in grayscale are derived only from intensity information. These black and white images are also known as Images of the sort. These are shades of gray, differing from black at the weakest intensity to white at the strongest = RGB2Gray (RGB) converts true-color RGB images to gray scale ingrayscaleages. RGB2Gray reduces hue and saturation details while retaining luminance.



Fig2.4 Grayscale image

3) Image Segmentation

Segmenting an image into different parts or objects is the first step in image analysis. Subdividing an image usually results in the objects of interest being separated from the background. The accuracy of segmentation determines the success or failure of computerized analysis procedures. Edge detection is one aspect of segmentation. Thresholding is another approach. By segmenting an image, you assign a label to every pixel, so that pixels with the same label have similar visual characteristics.

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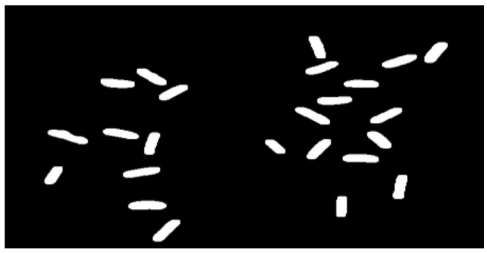


Fig2.3 Segmented image

C. Feature Extraction

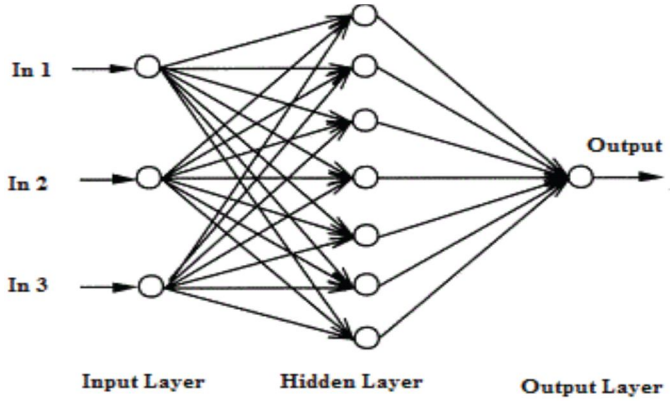
Feature extraction is the process of extracting quantitative information from segmented images. Different algorithms of morphological features are used to identify and classify objects. Features extracted from images of rice kernels are Perimeter, Area, Minor-axis Length, and Major-axis Length using contour detection, shown in Fig 5.3. The collected data were then used in a neural network pattern recognition system for grading rice kernels.

Following features were extracted from rice sample images:

1) *Area:* The total number of pixel covered by grain.
2) *Major axis Length (L):* The longest line that can be drawn through an object is called major axis length.
3) *Minor axis Length (I):* The longest line that can be drawn through an object, perpendicular to the major axis.
4) *Length (l):* Rice grain is enclosed in rectangular bounding and the length of this rectangle bounding box gives the length.
5) *Width (w):* Width of rectangle bounding box is known as width.

D. Training and Testing

Seven morphological and color features are extracted from the images and stored in the knowledge base. Essentially, a probabilistic neural network (PNN) maps any input pattern to one or more classifications. The probabilistic neural network is trained with eight different types of food grains namely Sonamasuri rice, Basmati rice, Horsegram brown, Horsegram white, yellow corn, Gujrat Wheat, OrangeCorn, and Khapli Wheat, with 200 samples. The final step of the grain recognition system is testing. The test phase is extracted from the testing set (which is different from the training set) in the testing phase. Then those features are matched with the feature from the database created for the training image. It will compute the shortest distance between the trained images stored in the database and the image that was chosen for testing. Then the image with the shorted distance is chosen to be recognized. To know the accuracy of the system, this process is repeated for all the test images.



E. The Algorithm: Recognition And Classification Of Food Grain

- Input: Original color Image Output: Classified food grains along with Quality
- Step1: Acquire the food grain images.
- Step2: Enhance image to remove noise and resizing.
- Step3: Identify Patches and Do the image segmentation.
- Step4: Extract color and morphological features.
- Step5: Use these features to recognize and classify the food grain image samples using Neural network

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VII July 2022- Available at www.ijraset.com

V. TESTING

The Testing was done using the neural network, We utilized MATLAB software for Training and testing. The code was written in matlab programming language. MATLAB provides many functions in the form of a toolbox that helps us in automating commonly used image processing techniques and workflows by enabling interactive segmentation of image data, comparison of image registration methods, and batch processing of large datasets. There are few toolbox that we have used in our project:

1) *Guide Toolbox:* This toolbox offers resources for designing complex, gracefully resizable MATLAB graphical user interfaces. The provided classes can be combined to create practically any user interface design.
2) *Image Processing Toolbox:* Perform image processing, visualization and analysis on the images in the dataset. You can perform image segmentation, image enhancement, noise reduction, geometric transformations, and image registration using deep learning and traditional image processing techniques. The toolbox supports processing of 2D, 3D, and arbitrarily large images.
3) *Neural Network Toolbox:* A neural network (also called an artificial neural network) is an adaptive system that learns by using interconnected nodes or neurons in a layered structure that resembles a human brain. A neural network can learn from data—so it can be trained to recognize patterns, classify data, and forecast future events. This toolbox is used to train images and get the results.

We tested on the around 200 images, each image containing different number of grains. During the training, neural network weights are initiated with random values after which they were adjusted based on error back propagation learning. The weights are stored during the end of training and the stored weights are used at the time of testing. When the training has completed, the network has been tested on 200 samples of food grain images.

VI. EXPERIMENTATION AND RESULTS

The food granules are graded by Neural Network system which is designed for this purpose. The neural network is trained with area, major axis, minor axis and perimeter of granules. The trained neural network is used to compute the grade by giving the grain input variables for the unknowable output (grades). The expectations of the expert are flexibly reflected by neural networks. Due to time constraints, the number of images captured for training and testing has been limited. For assessing the categorization of granule grade classification, 87 samples are employed. It can accurately classify all of the grains depicted when there is no grain overlap. The accuracy in this scenario is found to be 96 percent since the Neural Network cannot accurately distinguish if there is grain overlap.

A. Features Extraction (TRAINING PHASE)

Enter Grain Type: 1. Rice 2. Wheat 3.Corn 4.Horse Gram 5. Impurity
Enter Grain Grade: 1. Basamati 2.Sona Masuri
Select the Grain image for training phase

Table 2: Consolidated results of all grains with accuracy of testing

Grain Type	Grain Grade	Total Images Tested	Total Images Correctly Classified	Accuracy %	Grains identified
RICE	BASMATI	20	17	85	100
RICE	SONAMASURI	20	16	80	100
WHEAT	GUJRATWHEAT	20	18	90	100
WHEAT	KHAPLI	20	17	85	100
CORN	ORANGE	20	18	90	100
CORN	YELLOW	20	17	85	100
HORSE GRAM	BROWN GRAM	20	16	80	100
HORSE GRAM	WHITE GRAM	20	17	85	100

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B. Testing on Different food grains

1) Test Case-1: This is the front end part of the project which the user interface where we are able to select training folder, generate training data, training with NN, then selecting the images to test. Then performing the analyses and grading the quality of grains. The training folder containing different images of food grains is selected.

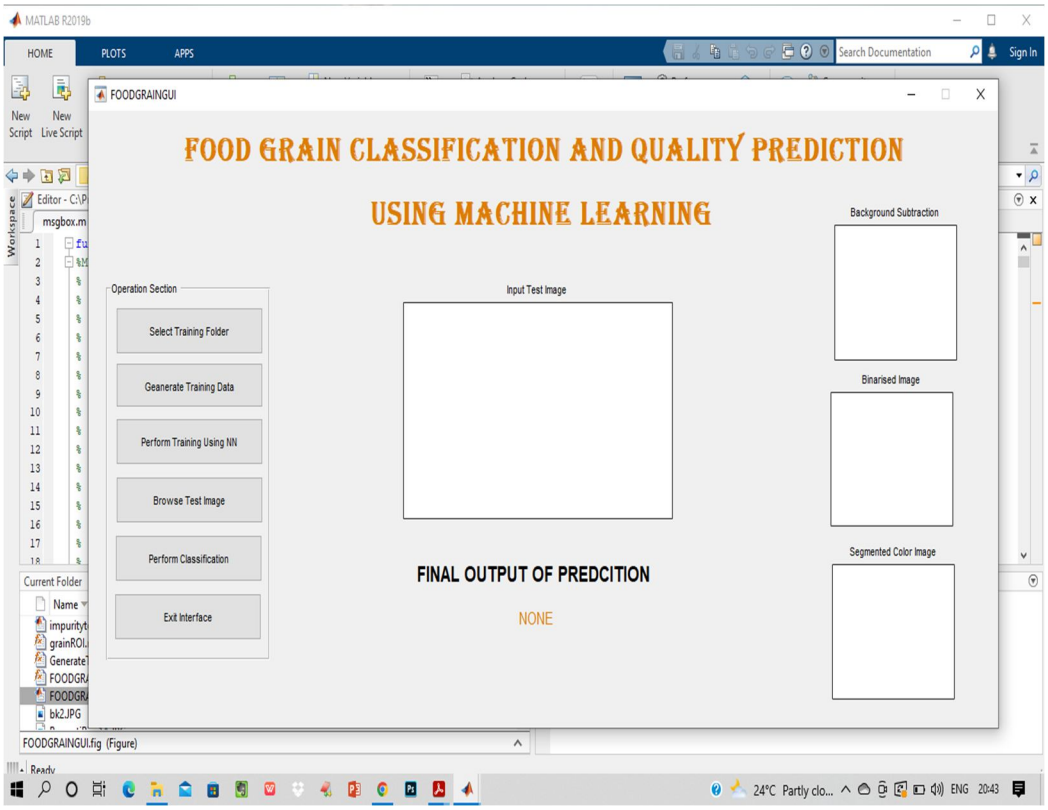


Figure 7.1: Userinterface to the working of the system

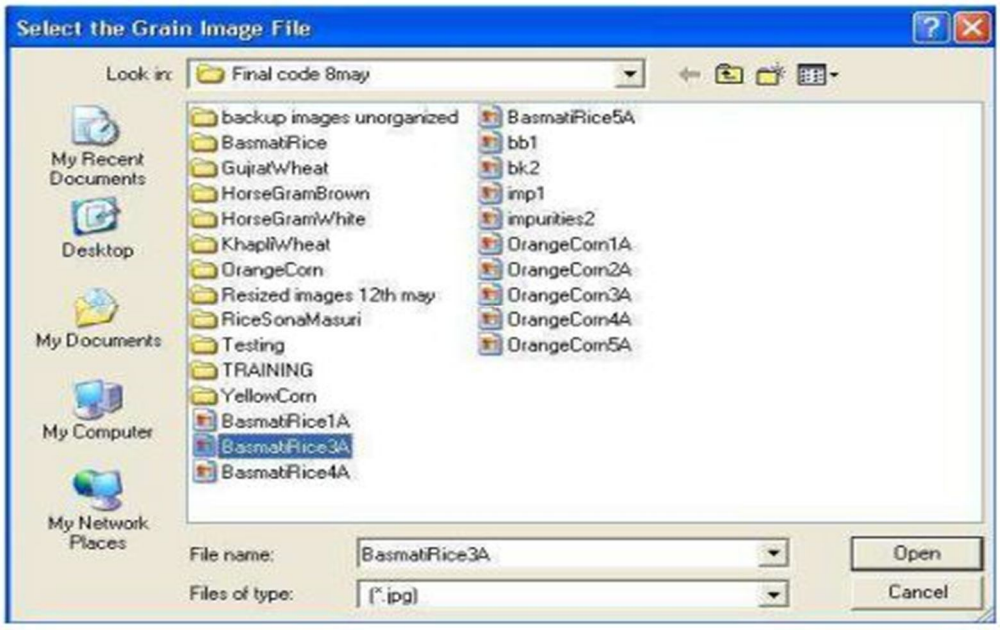


Figure 7.2 Snapshot to select the Grain image during testing phase

2) *Test Case-2:* Quality evaluation of grains is performed via image processing. Calculations of perimeter, minor axis length, area, major axis length are done for a given sample. The food granules are graded depending on the morphological features of grains present in the sample. At first the image of Basmati rice is considered for grading. Since the rice is good quality and there are no impurity its graded as A grade. All the process are performed on those images such as background subtraction, grayscaling and segmentation.

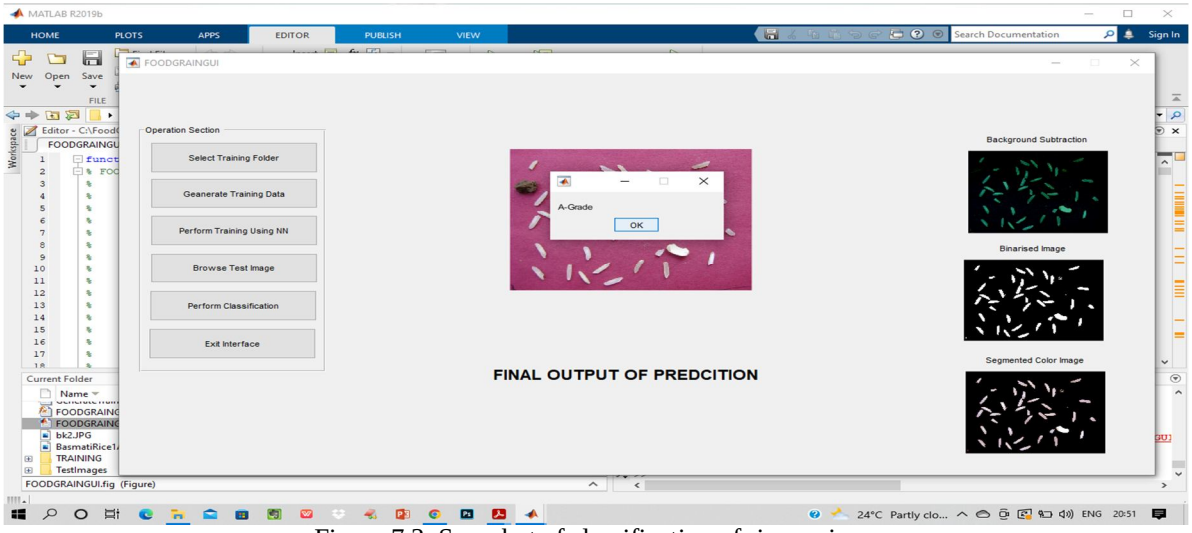


Figure 7.3: Snapshot of classification of rice grain

Output: The grain and the impurity is identified and its quality is

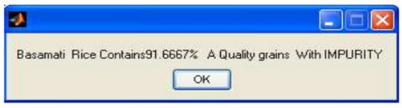


Fig 10: The result after testing

3) *Test case-3:* In this case we have tested Kapilwheat and corn for quality testing.Our model fetches all the features from the given image and analyses the quality and grades it based on quality.

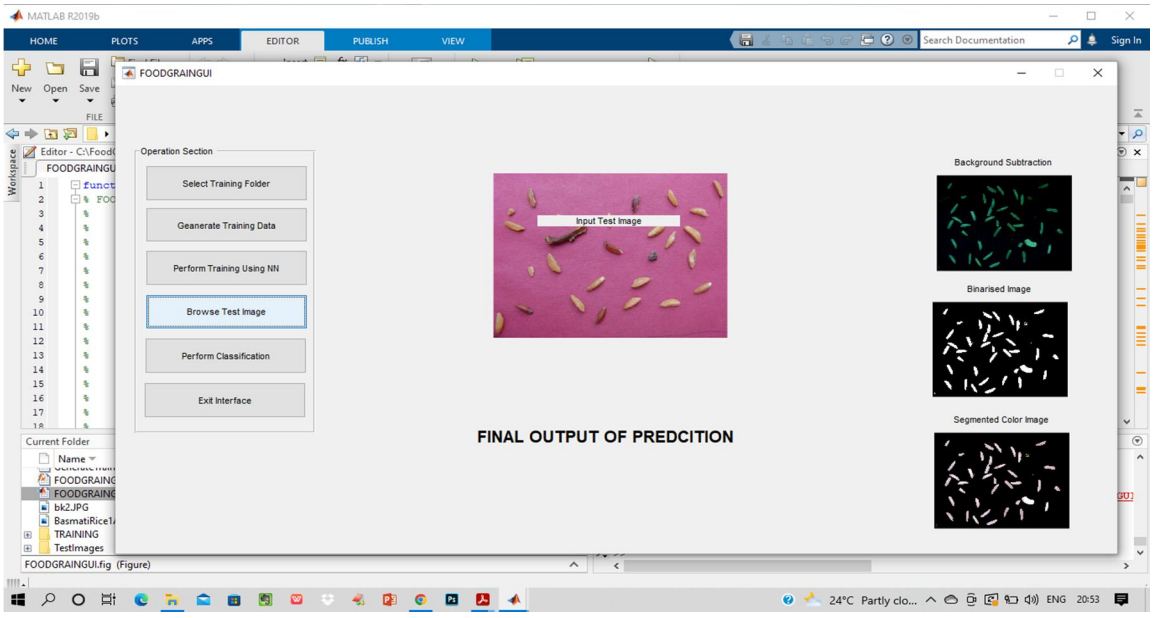


Figure 7.5: Kapilwheat with impurity

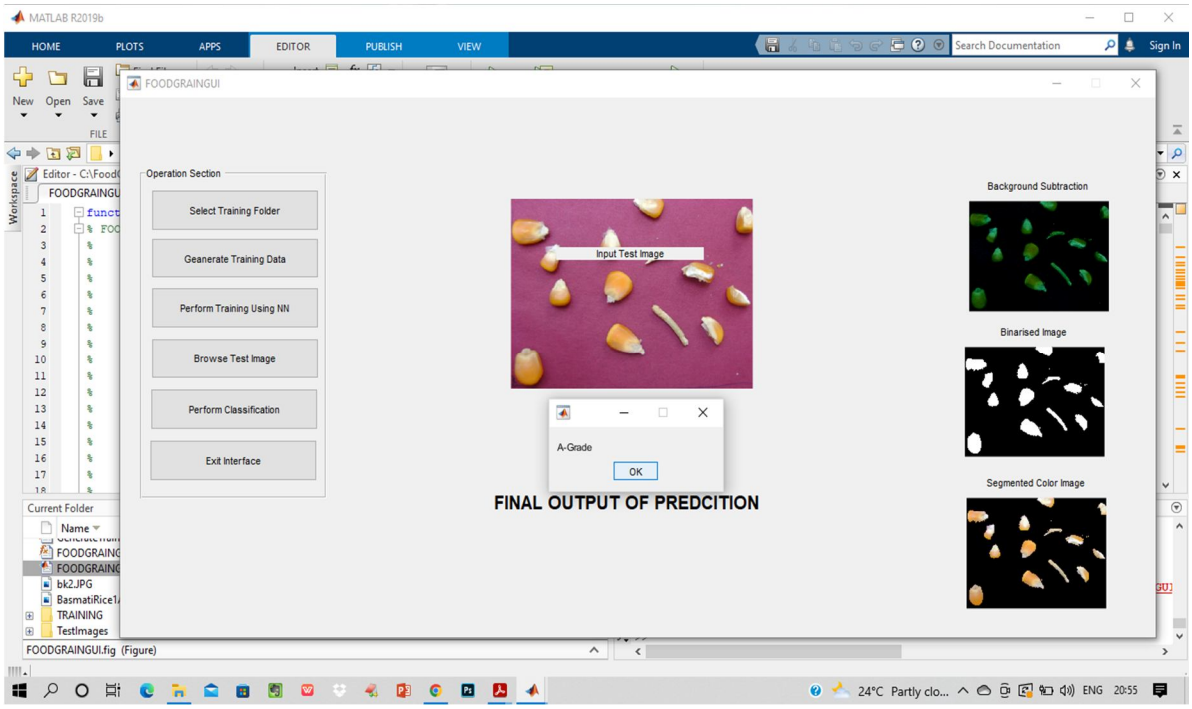


Figure 7.6: Snapshot of corn grading

4) *Test case-4:* In this test case, we have considered different food grains for grading.Performing all processes and idendifying the quality of the food grain.Our model is able to identify purity of grains.

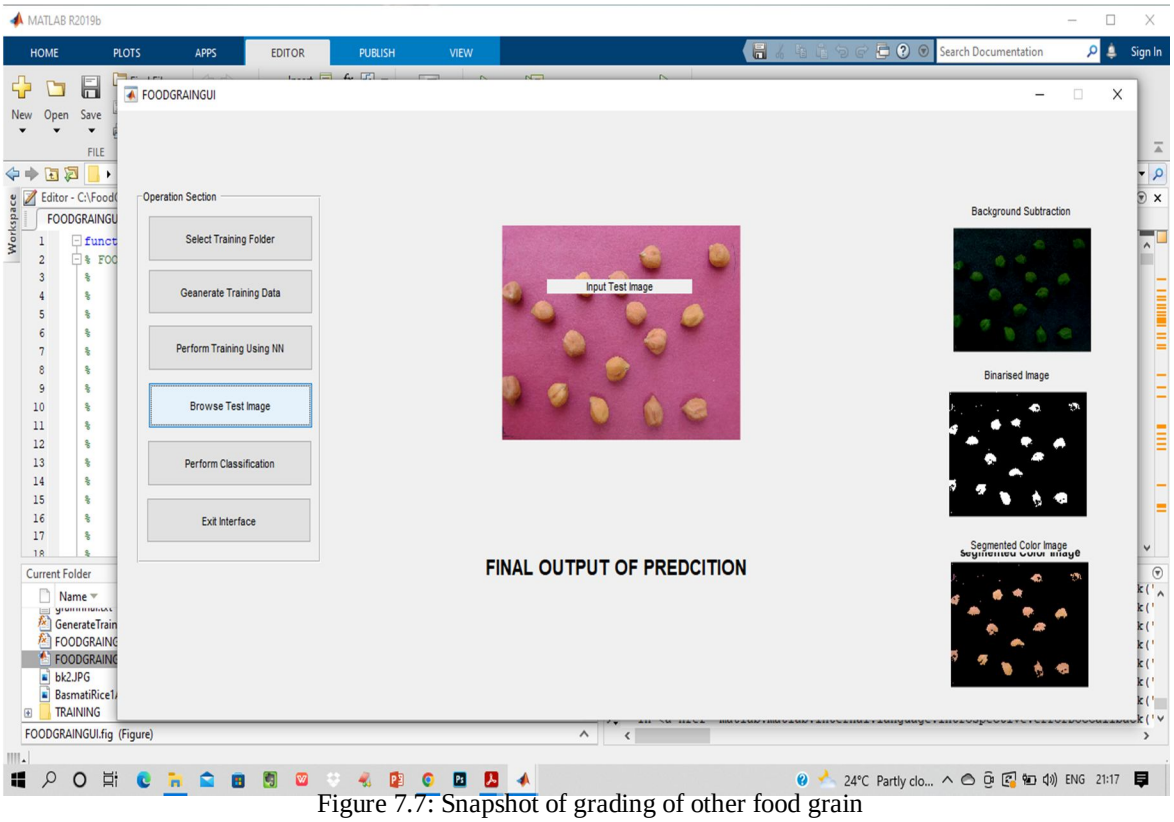


Figure 7.7: Snapshot of grading of other food grain

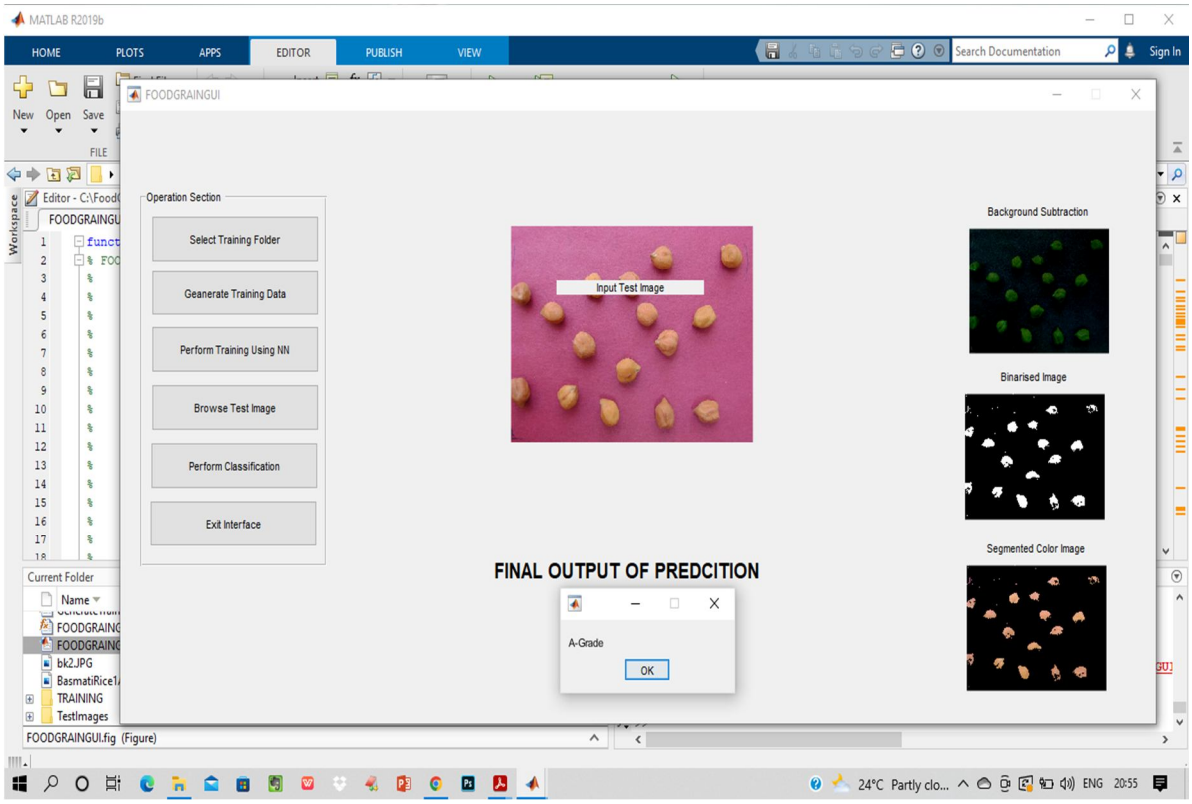


Figure 7.8: Output

VII. CONCLUSION

The complexity of the grading problem was significantly decreased through image processing and careful selection of the species that were taken into consideration in this work for extracting features from rice grains. Grading rice particles using a neural network is successful. The created neural network can also be used to grade different grains and food items.When there is no granule overlap, the Probalistic based Neural Network can classify well, but when there is granule overlap, it can categorise the test datasets with 90 percent accuracy.

We worked on the area detection on the rice grain and created an image processing system to grade the rice based on length, width, area, and area of chalky. Based on the findings, it can be said that some rice are better based on length, some are better based on breadth, and some may be considered to be of good quality based on area and area of the chalky. All of the traits need not, however, be represented in the rice grain. For further verification of our methods, additional data can be collected. The amount of moisture in a rice grain can be added to a grade to indicate the overall quality of the rice for more research.

A. Future Works

1) The preliminary work presented in the paper could be further enhanced by focusing on different sampling methods, sample preprocessing techniques, different features, and different neural network model to match the requirements of the rice industry.

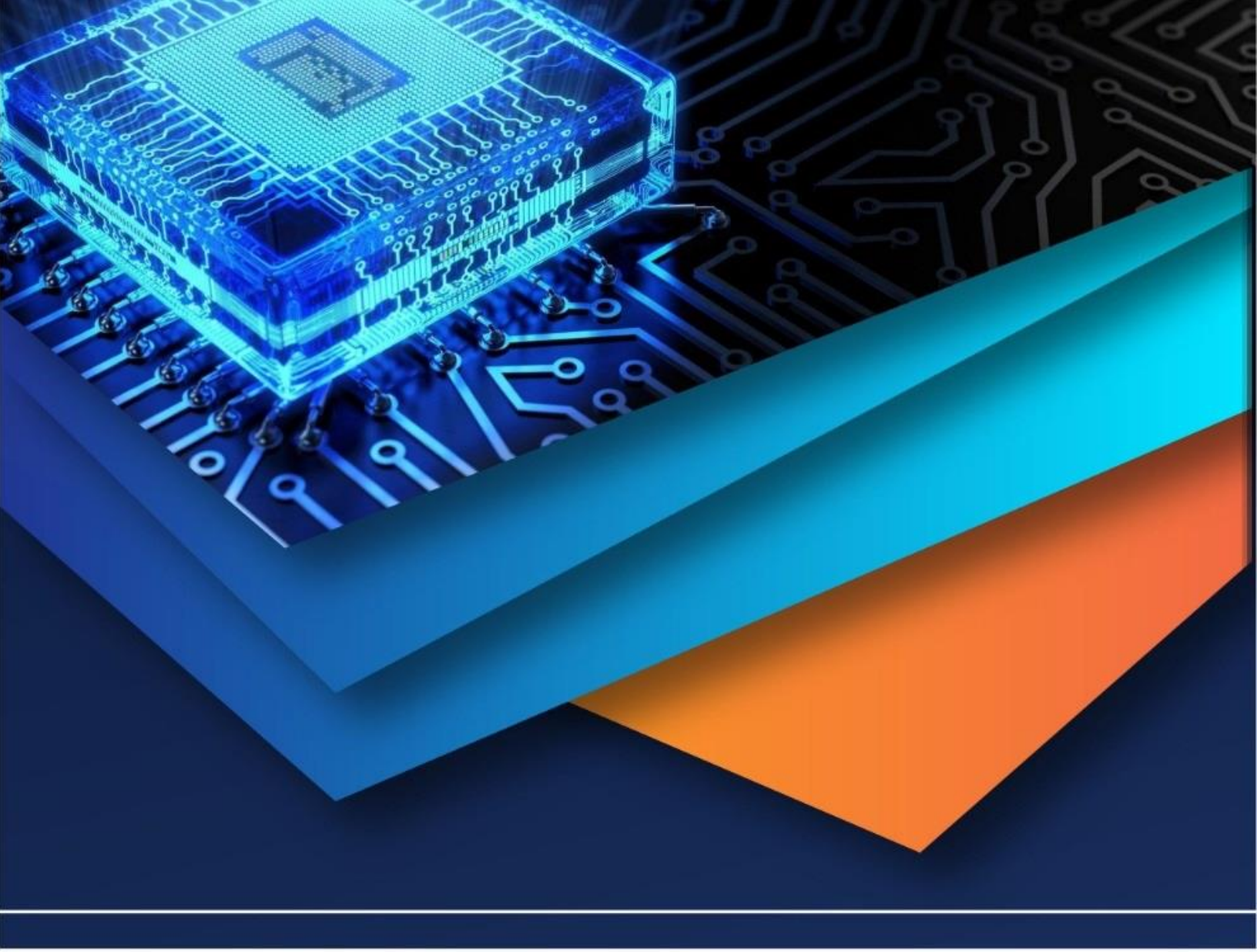
2) The quality of food grain includes not only exterior quality but also the interior one such as the texture, the nutrient component, the protein, moisture of the grain and producing area. The latter is not researched in this work because of the limitation of machine vision. It is difficult to test the features by visual image.

3) Even though the problem being worked upon is not completely new, the earlier approaches employed very large number of color, textural and morphological features which made the algorithm extremely slow because of the intensive computation.

4) An efficient method is proposed for classification of food grains which require limited features and thus overcoming the disadvantages like tediousness and time consumption.

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