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Classification and Quality Analysis of Food Grains

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Abstract: *In the present grain-handling scenario, grain type and quality are identified manually by visual inspection which is tedious and not accurate. There is need for the growth of fast, accurate and objective system for quality determination of food grains. An automated system is introduced which is used for grain type identification and analysis of rice quality (i.e. Basmati, Boiled and Delhi) and grade (i.e. grade 1, grade 2, and grade3) using Probabilistic Neural Network. This paper proposes a model that uses color and geometrical features as attributes for classification. The grading of rice sample is done according to the size of the grain kernel and presence of impurities. A good classification accuracy is achieved using only 6 features, i.e. mean of RGB colors and 3 geometrical features. The total success rate of type identification is 98% and total success rate of quality analysis and grading of rice is 90% and 92% respectively.*

Keywords: *Rice quality, Grain Type Identification, Color features, Geometric feature, PNN*.

I. Introduction

Almost as soon as digital computers became available, it was realized that they could be used to process and extract information from digitalized images. Need of accurate grading, sorting of fruits and foods, or agriculture products arises because of increased expectations in quality food and safety standards. This is being assessed through visual inspection by human inspectors. This process is tedious and time consuming. After hours of working the operator may loose concentration which in turn will affect the evaluation process. The farmers are very much affected by this manual activity in terms of returns for their crop. Hence these tasks require automation, so as to have a computer vision system as an alternative to this manual practice. Automated system of sorting food and agriculture products provides rapid and hygienic inspection with computer vision.

Computer vision and image processing are non destructive, accurate and reliable methods to achieve target of grading. Machine Vision Systems are successfully used for Identification and Classification of plants, leaves, flowers, bulk grain samples. In order to perform this task of pattern recognition by machines, considerable design effort is necessary. Characterization models were based on morphological features, color features or textural features. After isolating the grain, the region of interest was selected around the boundary of the edge. The morphological features were obtained from the binary images containing only pixels of the grain edge.

Grain quality is a term that refers to the quality of grain. However, what constitutes quality depends on the use of the grain .Overall quality of grain are affected by several factors which includes, growing practices, time and type of harvesting, postharvest handling, storage management and transportation practices. Grain grading and specification system assures that a particular lot of grain meets the required set standards customer. In many countries grading of grain depends on four main properties; (i) test weight (ii) moisture contents (iii) broken foreign material or the percentage fragments example broken corn foreign materials (iv) damaged kernels (i.e. total and heat damaged). There is no proper definition or description of rice quality, because as definition of quality, depends on several factors such cooking practice and region and usages for example rice miller he/she describe rice quality in terms of total recovery and or head and broken rice kernels while food processing will define concept of rice quality in terms of grain size, aroma, appearance and cook ability. Common physical properties of rice are size, shape, color, uniformity, and general appearance. Other factors contributes to general appearance of rice are cleanliness, free from other seeds, virtuousness, translucency, chalkiness, color, damaged and imperfect kernel. For the case of grain size, rice grain can be categories into three main groups (i) length (ii) shape and (iii) weight.

1.1. Motivation

Quality of grains is an important requirement for today's market, to protect the consumers from substandard products. The government imposes price control for essential commodities in order to protect the consumers from black marketing and inflated prices. As a result some traders unethically release sub-standard products to the consumer market. Because of such practices there are so many inferior quality grains arriving to the market day by day. These grains consists of several impurities like stones, damaged seeds, more broken granules etc. This is often seen today in rice trade where rice of low quality is sold

without being noticed. However, there is no convenient method to identify these inferior quality grains in the market. Therefore, this has become a serious issue for both the consumer and the government. Hence an automated Quality analysis of the food grains could be considered helpful.

1.2. Problem Statement

The aim of the project is to design a grain recognition and quality analysis system using its color geometrical features, which classifies the type of grain and its quality and grade for Rice. For implementation, we have considered 12 different types of grains, i.e. rajma, corn, cowpeas, rice, etc. For quality analysis of rice we have considered three quality of rice namely basmati, delhi and boiled rice, and each can be categorized into three grades, i.e. Grade1, Grade2 and Grade3.

1.3. Objective

The Objective of this work is to develop a real-time application capable of classifying the given grain type and its quality and grade in case of rice as per the definition. To do so we capture the grain image from the digital camera. Store them in the database. Read an image from the database, preprocess the image. Perform segmentation in order to extract the ROI i.e. each individual grain from the image sample.Extract the color and the geometrical feature from each ROI, store the extracted features in feature vector for training. Build the PNN for training and recognizing the grain type and its quality. Finally, test the system by giving different type of grain images as input.

II. Related Work

Lai et al. [2] suggested some pattern recognition techniques for identifying and classifying cereal grains. This method yielded 100% accurate prediction for the samples used in the study. The pattern obtained is selected out of a great number of possible ones. These are obtained by subjective judgment and by using trial and error approach. The grains considered here were Corn, Wheat, Soyabean and sorghum. Zayas et al. [3] illustrate the use of image analysis to discriminate between wheat and non-wheat components in a grain sample. They presented two methods, multivariate discriminate and a structural prototype method for pattern recognition. The main concern in this method is the misclassification of irregularly shaped stones as wheat. The limitations in the proposed method is the requirement to manually orient the kernels. N.S. Visen et al.[4] proposed algorithms to acquire and process color images of bulk grain samples of five grain types, namely oats, barley, rye, wheat, and durum wheat. The developed algorithms were used to extract over 150 color and textural features. A back propagation neural network-based classifier was developed to identify the unknown grain types. The color and textural features were presented to the neural network for training purposes. The trained network was then used to identify the unknown grain types. Classification accuracies of over 98% were obtained for all grain types. Better Accuracy was gained for these grain type samples. Huang et al. [5] proposed a method of identification based on Bayes decision theory to classify rice variety using color features and shape features with 88.3% accuracy. Majumdar and Jayas [6-7] developed classification models by combining two or three features sets (morphological, color, textural) to classify individual kernels of Canada Western Red Spring (CWRS). Anami B.S, et al. [8] have developed a Neural network approach to classify single grain kernel of different grains like wheat, maize, groundnut, redgram, greengram and blackgram based on color, area covered, height and width. The minimum and maximum classification accuracies are 80% and 90% respectively. Sanjivini et al., [9] In this approach, they perform texture and morphological based retrieval on a corpus of food grain images. Image Warping and Image analysis approach is being used in the following work. Normalization of food grain images has been employed in this method and hence eliminating the effects of orientation using image warping technique with proper scaling. The images have been properly enhanced to reduce noise and blurring in image. The approach has been tested on sufficient number of food grain images of rice based on intensity, position and orientation. A digital image analysis algorithm based on color, morphological and textural features was developed to identify the six varieties rice seeds which are widely planted in Chhattisgarh region.. The accuracy in the results was between 80% to 90%. In this case pre-processing and segmentation process was found to be tedious. D.Savakar, [10] illustrated an algorithm for recognition and classification of similar looking grain images using artificial neural networks. It shows that accuracy of 78-84% is achieved by using either individual color or texture feature, and accuracy of 85-90% is seen when both the features are combined. Harpreet Kaur, et al.,[11] proposed a machine algorithm to grade (Premium, Grade A, Grade B and Grade C) the rice kernels using Multi-Class SVM. Maximum Variance method was applied to extract the rice kernels from background, then, after the chalk has been extracted from rice. The percentage of Head rice, broken rice and Brewers in rice samples were determined using ten geometric features. Multi-Class SVM classified the rice kernel by examining the Shape, Chalkiness and Percentage of Broken (Head Rice, Broken and Brewers) kernels. The SVM classify accurately more than 86% .Based on the results, it was concluded that the system was enough to use for classifying and grading the different varieties of rice grains based on their interior

and exterior quality. H.K. Mebatsion, J. Paliwal, D.S. Jayas,[12] proposed a method for the Classification of cereal grains, namely; barley, rye, oats and wheat (Canada Western Amber Durum (CWAD) and Canada Western Red Spring (CWRS)). This was performed using morphological and color features. The combined model defined by morphological and color features achieved a classification accuracy of 98.5% for barley, 99.97% for CWRS, 99.93% for oat, and 100% for rye and CWAD. L.A.I.Pabamalie, H.L.Premaratne,[13] focused on providing a better approach for identification of rice quality by using neural network and image processing concepts. Here a back propagation neural network with two hidden layers has been developed for the quality classification. Thirty one texture and color features that have been extracted from rice images were used for discriminate analysis. Here foreign matters, type admixture and brown grain content are the three parameters considered for sample preparing. Tests on the system for the training and test sets show accuracy in between 94% to 68% for the four grades. The institute classifies rice into four quality categories according to several parameters.

III. Proposed Method

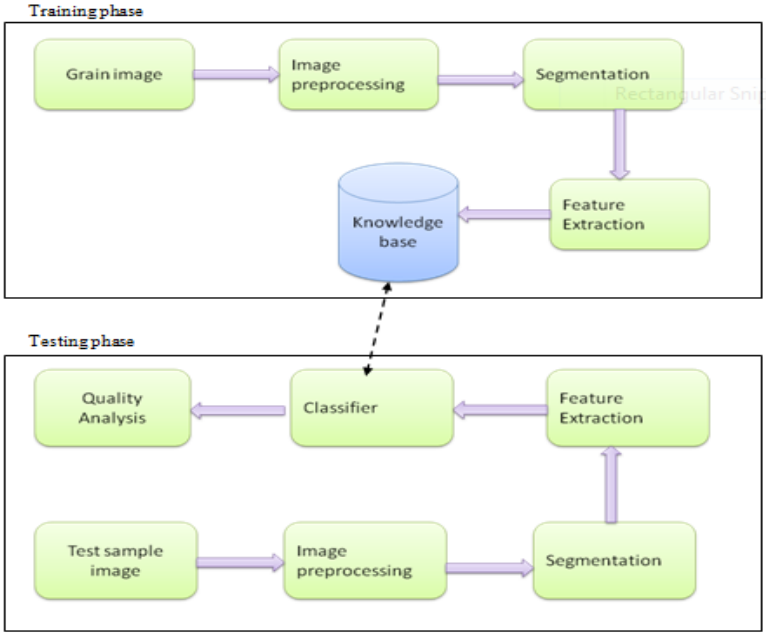

Fig 3.1. Dataflow diagram for the proposed approach

- **Image Acquisition**

The first step in using a machine vision system is to acquire a digital image. This can be achieved by either using a sensor and a digitizer or a digital camera. Proper illumination plays a very important role in order to obtain a good image. This can lead to distortion of object features in the image. Determination of an ideal illumination source is not easy and depends on the nature of the task.

Here we capture the images of different food grains using a digitized camera. The camera used here has a resolution of 8MP. We maintain a fixed distance between the camera and the grain samples, by using a stand which provides vertical movement. The images are captured under natural light avoiding the direct sunlight for proper illumination. We maintain a uniform background which is blue in color. The grains are spread on a blue sheet randomly. Although we place them randomly, we must make sure that they are not in contact with other, i.e. non touching fashion. Images for all set of variety of food grains are captured. The images were captured and stored in JPEG format automatically.

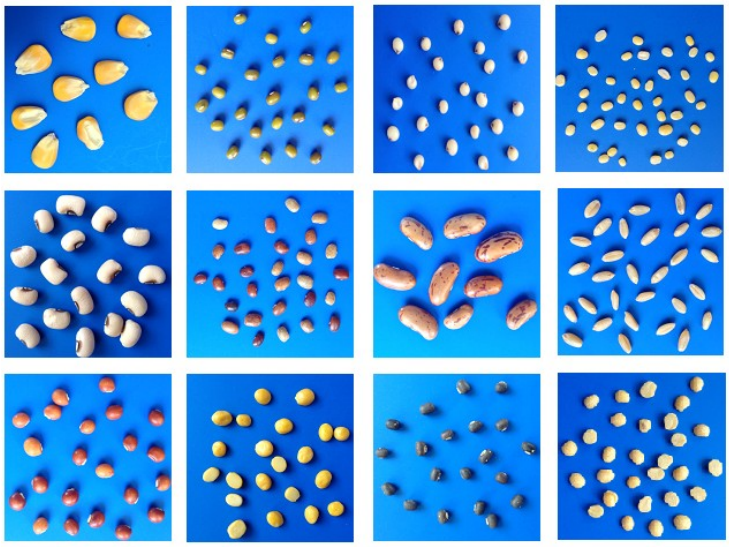

Fig 3.2. Different kinds of grains considered for classification

Fig 3.3 Three quality of Rice Grains namely Basmati, Boiled and Delhi Rice.

Fig 3.4 Grading of Basmati Rice i.e Grade 1, Grade 2, and Grade3 respectively

➢ **Image Preprocessing**

Preprocessing is one of the important steps for the enhancement of quality of the captured image. The preprocessing methods use a small neighborhood of a pixel in a image, to get a new brightness value in the output image. We apply the Gaussian filter for image smoothening. Here we have used threshold method in order to eliminate background. Then the grayscale image is binarized. Once the image is binarized morphological operations are performed, first we use erosion operation to eliminate the shadow of the grains, this is followed by dilation to enhance the image after the erosion and improve the boundary sharpness

Image Filtering

Images are often corrupted due to the variation in illumination, intensity or may have poor contrast and can't be used directly . Filtering helps to transform pixel intensity values to reveal certain image characteristics

- Enhancement: helps to improve the contrast of the image
- Smoothing: Remove the noise from the image.

Gaussian Filter: Gaussian smoothing is very effective for removing Gaussian noise

$$G(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{x^2}{2\sigma^2}}$$

The 2D Gaussian smoothing operator G(x,y), where x,y are the image co-ordinates and sigma is a standard deviation of the associated probability distribution

$$g(x,y) = \frac{1}{2\pi\sigma^2} \cdot e^{-\frac{x^2+y^2}{2\sigma^2}}$$

Fig 3.5. Orginal image

Fig 3.6. Filtered image

Background Elimination

Background elimination which is also called as Foreground Detection, is a technique in the fields of computer vision and image processing wherein an image's foreground is extracted for further processing, i.e. Object Recognition. Usually the images region of interest are a part of image foreground. Here we check the intensity of each pixel of the image with a precalculated value, and the pixel values falling with this range are set to zero.

Fig 3.7. Background eliminated

Binarization

Binarization of an image is a process representing an image using only two different pixel values. It is generally performed by classifying a gray scale image into two groups of pixels based on certain threshold value. Those pixel values greater than or equal to the threshold is set to a particular grey value and those below the threshold to another grey value. The quality of the binary image is much dependent on how appropriately the threshold for binarization are chosen or how fairly the pixels are classified into two groups of pixels.

If f (x, y) > T then f (x, y) = 0
else f (x, y) = 255

where T is a threshold value.

Morphological Operations

Morphological image processing is a collection of non-linear operations related to the shape or morphology of features in an image. Morphological techniques probe an image with a small shape or template called a structuring element. The structuring element is positioned at all possible locations in the image and it is compared with the corresponding neighborhood of pixels.

Erosion and Dilation

Erosion and dilation are the most basic morphological operations in image processing.

Erosion: Erosion removes small-scale details from a binary image but simultaneously reduces the size of regions of interest, to 0. In a binary image, if any of the pixels is set to 0, the output pixel is set to 0.

Dilation: Dilation has the opposite effect to erosion, it adds a layer of pixels to both the inner and outer boundaries of regions. The holes enclosed by a single region and gaps between different regions become smaller, and small intrusions into boundaries of a region are filled in. The value of the output pixel is the maximum value of all the pixels in the input pixel's neighborhood. In a binary image, if any of the pixels is set to the value 1, the output pixel is set to 1.

Fig 3.8. After morphological operations

- **Image Segmentation**

The aim of image segmentation is to cluster pixels into salient image regions. Image segmentation is an essential preliminary step in most automatic pictorial pattern recognition and scene analysis problem. Here we perform the segmentation using Component Labeling. Once the image is binarized, we perform labeling of connected components. By using labels and the similarity of grey level values, grains are segmented.

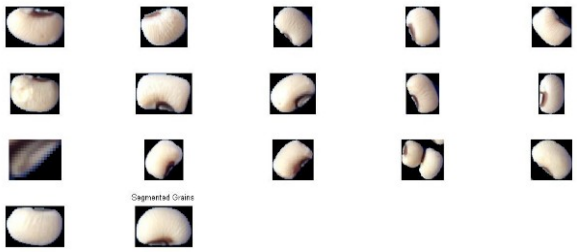

Fig 3.9. Image after segmentation

- **Feature Extraction**

In this process some qualitative information is being extracted from the objects to be analyzed in the image. These extracted attributes are called features and a pattern is defined as a vector of such features. The various features that could be extracted are color features, geometrical features and texture features. In this method we have extracted 3 color features and 3 geometrical features.

Color Features

Color features play a vital role in the classification process. We have extracted three color features from the captured image, i.e. the mean values of the RGB colors. The mean values of red, green and blue colors are extracted from the image.

Mean

$$\mu = \frac{1}{N}\sum_{i=0}^{N-1} Xi$$

Geometrical Features

The geometric parameters gives us the basic information regarding the size and shape of the grains.

Area: This refers to the amount of pixels in the region, i.e. the pixels with level "1".

MajorAxisLenght: Length of the major axis of the ellipse with the same second order normalized central moment of the object.

MinorAxisLenght: Length of the minor axis of the ellipse with the same second order normalized central moment of the object.

ConvexArea: Area of the smallest convex shape enclosing the object.

Eccentricity: Relation between the distance of the focus of the ellipse and the length of the principal axis.

- **Classification**

The classification approach is mainly based on the assumption that the digital image under consideration depicts one or more features, and these features correspond to one of the several distinct and exclusive classes. The two phases that are typically employed by the classification algorithms are training and testing. In the initial training phase, characteristic properties of typical image features are isolated and, based on

these, a unique description of each classification category, i.e. training class, is created. In the subsequent testing phase, these feature-space partitions are used to classify image features. In this method we use the PNN classifier. When an input is presented, the first layer computes distances from the input vector to the training input vectors and produces a vector whose elements indicates how close the input is to a training input. The second layer sums these contributions for each class of inputs to produce as its net output a vector of probabilities. Finally, a complete transfer function on the output of the second layer picks the maximum of these probabilities to choose the class.

- **Output**

Once the classifier is trained for a set of images, we consider a test sample for testing. At the first stage the grain is classified with respect to its type such as corn, jowar, green gram, rice, etc. If the grain type is classified as rice, we go for quality analysis wherein the quality and grade of the rice is given.
Grade1: premium, no impurities and whole kernels
Grade2: Medium, presence of impurities
Grade3: Poor quality, large number of broken kernels with or without impurities

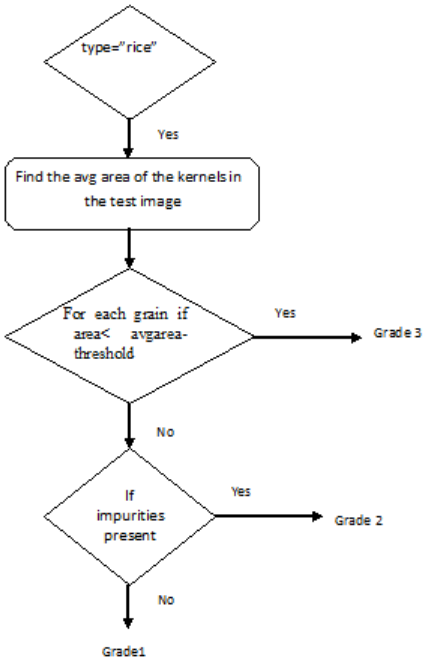

Fig 3.10. Flow diagram for the analysis of rice

IV. System Requirements

Hardware requirement

- Camera with 8MP or higher
- Pentium 4 Machine Or Higher
- 1GB of RAM
- 1GB of free hard disk space.

Software requirement

- Matlab 7 or higher version
- Windows Operating system, as implementation is in MATLAB. The work however is carried out on Windows XP platform.

V. Results

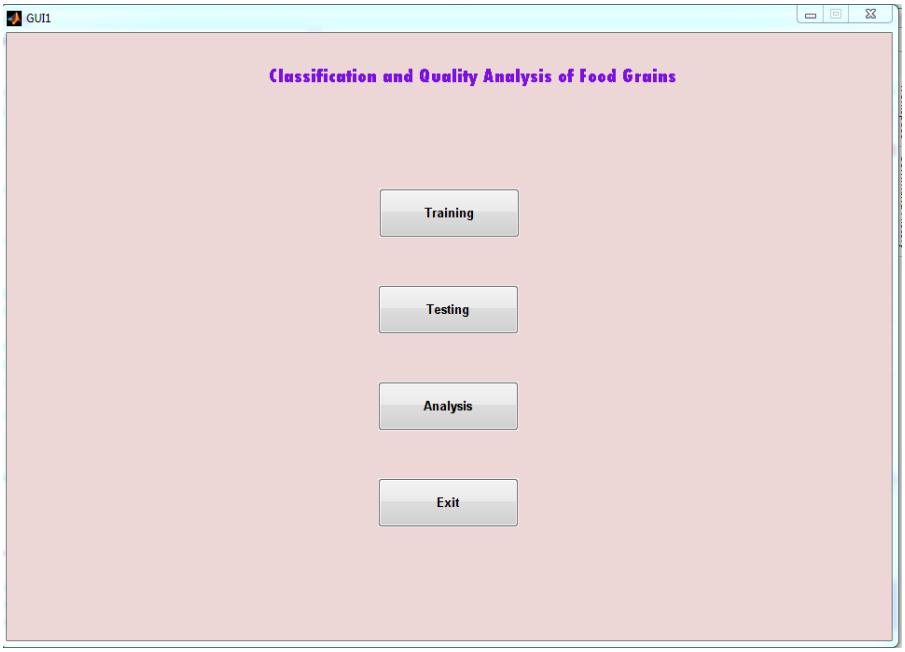

Fig 5.1 Snapshot of GUI

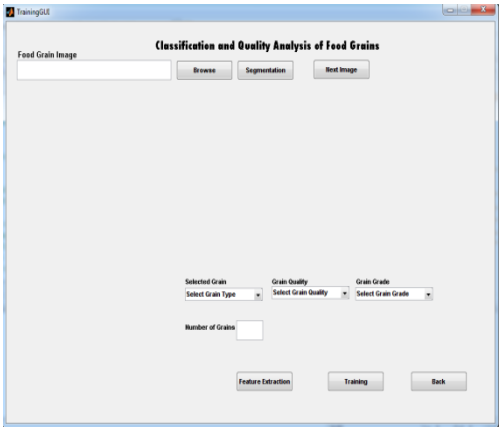

Fig 5.2 Snapshot of Training phase

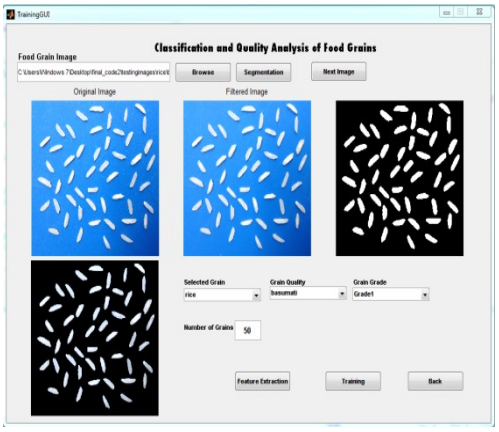

Fig 5.3 Image preprocessing and segmentation

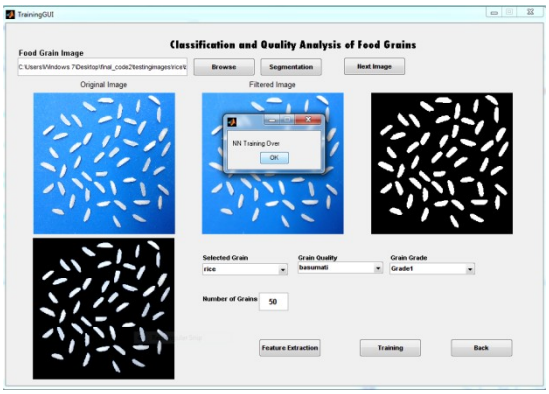

Fig 5.4. Traning is performed

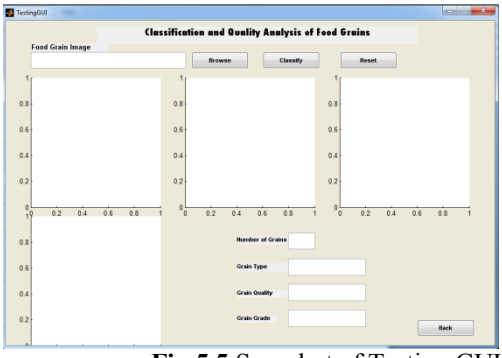

Fig 5.5 Snapshot of Testing GUI

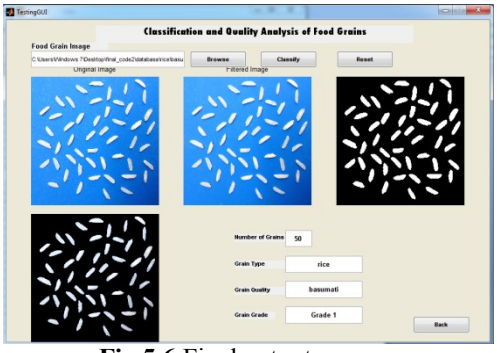

Fig 5.6 Final output

VI. Performance Analysis

The performance of Classification of food grains and the quality analysis of rice is evaluated using 330 different images of grains. For evaluation we mainly consider 15 images of each grain type. We use 5 images of each type for training and 10 remaining images for testing.

6.1. Testing results of grain type identification

Here 15 images of each of the type of grain are tested to evaluate the performance of the system. It is found that accuracy of identifying of grain type is 90-100%. PNN Classifier is used to classify testing samples, and the overall grain classification is shown in the table below.

Table 6.1 Test Result for overall Grain Type Classification

Grain Type	No of Images tested	No of images predicted correctly	Accuracy
Black Gram	15	15	100%
Corn	15	15	100%
Cowpeas	15	15	100%
Green gram	15	15	100%
Jowar	15	14	93%
Rajma	15	15	100%
Red Gram	15	14	93%
Rice	150	150	100%
Split Bengal gram	15	15	100%
Tur Dal	15	15	100%
Horse gram	15	15	100%
Moong	15	14	93%
Wheat	15	15	100%

6.2. Testing Results for Quality analysis and grading of rice

We mainly consider images of three quality of rice i.e. Basmati, Boiled and Delhi. We have 150 images of rice in total out of which we have 50 images of each quality. The accuracy of quality classification is approximately 90% and the accuracy of grading is approximately 92%.The Test results are as shown below

Table 7.2 Overall Rice Quality Classification results

Rice quality	Number of samples	Classification Results	Accuracy (%)
Basmati	50	49 are classified as Basmati	98%
Boiled	50	45 are classified as Boiled	90%
Delhi	50	41 are classified as Delhi	82%

Table 7.3 Overall Results for grading of rice

Rice Grade	Number of samples	Classification Results	Accuracy (%)
Grade 1	60	58 are classified as grade 1	98%
Grade 2	45	41 are classified as grade 2	91%
Grade 3	45	39 are classified as grade 3	86%

VII. Conclusion

This paper is focused on providing a better approach for identification of different types of grains and rice quality based on color and geometrical features using Probabilistic neural network and image processing concepts. Firstly the image is preprocessed and segmented, then color and geometrical features that have been extracted from grain images. The extracted properties are input to PNN classifier for further matching process. 13 types of grains are considered for identification. Three quality of rice is considered and each have been

graded into three grades. Tests on the system for the test sets show accuracy of 98% and total success rate of quality analysis and grading of rice is 90% and 92% respectively. 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. The experimental results show that the proposed method developed in this study gives better accuracy with only 6 attributes for classification. The number of training samples used here is comparatively small i.e. 5 samples of each type, hence it takes less training time. This is possible because we have considered non touching grain samples in the approach. Here we combine both the quality analysis and grading of rice.

Future Scope

The work presented in this project recognizes only three quality of rice. It can be extended to be able to detect other quality of rice. We can use a closed system for image acquisition, with a high definition camera i.e. CCD, this might help to avoid the grain shadow observed in the database acquired and will also give uniformity in the intensity of background color. The present work could be extended for remaining food grains also and few other features can also be extracted to increase accuracy. Also various infections on food grains like fissures can also be identified further.

References

[1]. Neelamma K. Patil, Ravi M. Yadahalli (2011), "Clasification of Food Grains Using HSI Color Model by Combining Color and Texture", Third International Journal on Computer Vision , Pattern recognition, and graphics,2011.

[2]. Lai FS, Zayas I, Pomeranz Y. Application of pattern recognition techniques in the analysis of cereal grains. Cereal Chemistry. 1986; 63(2):168–174.

[3]. Zayas I., Pomeranz Y., and F. S. Lai, "Discriminate between wheat and non-wheat components in a grain sample", Cereal Chem., vol. 66, no.3, 1989.

[4]. N. S. Visenl, J. Paliwall, D. S. Jayas1, and N. D. G.White, "Image analysis of bulk grain samples using neural networks", Can. BioSyst. Eng, vol. 46, 2004.

[5]. Huang, X.Y., Li, J., Jiang, S., Study on identification of rice varieties using computer vision, 2004.

[6]. Majumdar, S. and D.S. Jayas. 2000c. Classification of cereal grains using machine vision. III. Texture models. Transactions of the ASAE.

[7]. Majumdar, S. and D.S. Jayas. 2000d. Classification of cereal grains using machine vision. IV. Combined morphology, color, and texture models. Transactions of the ASAE.

[8]. B. S. Anami, D. G. Savakar, Aziz Makandar, and P.H. Unki (2005)." A neural network model for classification of bulk grain samples based on color and texture". Proceedings of International Conference on Cognition and Recognition, held at Mandya, India, on 22 & 23 December, 2005.

[9]. Sanjivani Shantaiya, Mrs.Uzma Ansari. Identification of Food Grains and Its Quality Using Patten Classification. Special Issue of IJCCT Vol. 2 Issue 2, 3, 4; 2010 for International, December 2010.

[10]. D.Savakar," Recognition And Classification Of Similar Looking Grain Images Using Artificial Neural Networks",Journal of Applied Computer Science and Mathematics,2012.

[11]. Harpreet Kaur, Baljit Singh, "Classification and Grading Rice Using Multi-Class SVM", International Journal of Scientific and Research Publications, Volume 3, Issue 4, April 2013.

[12]. H.K. Mebatsion, J. Paliwal, D.S. Jayas,"Automatic classification of non-touching cereal grains in digital images using limited morphological and color features" Elsevier ,Computers and Electronics in Agriculture 90,2013.

[13]. L.A.I.Pabamalie, H.L.Premaratne," A Grain Quality Classification System", Institute of Electrical and Electronics Engineers, 2010.