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A Method for Identification of Basmati Rice grain of India and Its Quality Using Pattern Classification

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Abstract

The research work deals with an approach to perform texture and morphological based retrieval on a corpus of Basmati rice grain images. The work has been carried out using Image Warping and Image analysis approach. The method has been employed to normalize food grain images and hence eliminating the effects of orientation using image warping technique with proper scaling. The approach has been tested on sufficient number of basmati rice 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 of basmati rice seeds which are widely planted in India. Nine color and nine morphological and textural features were used for discriminant analysis. 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.

It is also to find the percentage purity of hulled basmati rice grain sample by image processing technique. Commercially the purity test of basmati rice sample is done according to the size of the grain kernel (full, half or broken). By image processing we can also identify any broken basmati rice grains. Here we discuss the various procedures used to obtain the percentage quality of basmati rice grains.

Keywords— warping, Image rectification, Image segmentation, Edge Detection, blurring image, Thresholding, Percentage Purity, Pixel area.

I. INTRODUCTION

Basmati Rice is one of the most important and popular cereal grain crops of India the ever increasing population losses the quality of basmati rice and has distinct effect on the yield of rice, so the proper inspection of basmati rice quality is very important. During grain handling operations, information on grain type and grain quality is required at several stages before the next course of operation can be determined and performed. The varietals purity is one of the factors whose inspection is more difficult and more complicated than that of other factors. In the present grain-handling system, grain type and quality are rapidly assessed by visual inspection. This evaluation process is, however, tedious and time consuming. The decision-making capabilities of a grain inspector can be seriously affected by his/her physical condition such as fatigue and eyesight, mental state caused by biases and work pressure, and working conditions such as improper lighting, climate, etc. [2].The farmers are affected by this manual activity. Hence, these tasks require automation and develop imaging systems that can be helpful to identify rice grain images, rectify it & then being analyzed. In the early days of machine vision application to grain quality evaluation, Lai et al.(1986) suggested some pattern recognition techniques for identifying and classifying cereal grains. The same researchers (Zayas et al., 1986) also applied the digital image analysis technique to discriminate wheat classes and varieties. Luo et al.(1999) used a color machine vision system to identify damaged kernels in wheat. Substantial work dealing with the use of different morphological features for classification of different cereal grains and varieties was reported (Draper and Travis, 1984; Keefe, 1992; Myers and Edsall, 1989; Neuman et al., 1987; Sapirstein et al., 1987; Symons and Fulcher, 1988a; 1988b; Travis and Draper, 1985;Zayas et al., 1986). Some investigations were carried out using color features (Hawk et al., 1970; Majumdar et al., 1996; Neuman et al., 1989a; 1989b) for classification of different cereal grains and their varieties for correlating vitreosity and grain hardness of Canada Western Amber Durum (CWAD) wheat. Huang et al.(2004) 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 (2000) developed classification models by combining two or three features sets (morphological, color, textural) to classify individual kernels of Canada Western Red Spring (CWRS) wheat, Canada Western Amber Durum (CWAD) wheat, barley and oat.

The above studies showed that the classification accuracies are high when features are distinctly different among tested varieties. In the case where there is a high similarity among groups to be discriminated, the classification accuracies are not as high as before. In this paper, a new approach for identification of basmati rice grain variety using Feed-Forward Neural network was investigated.

II. PROPOSED METHODOLOGY

It is a methodology in which the image of bulk basmati sample may be acquired by creating a flat layer of grain on a conveyor belt. The sample grain images have been rectified by being scaled, enhanced and then segmented using image warping. And then 18 features were extracted from segmented images.

The block diagram illustrating the procedure for recognition and classification of basmati rice grain image samples is shown in Figure 1 and methodology is given Algorithm 1.

Algorithm 1: Recognition and Classification of basmati rice grain image samples.

Input: Original 24-bit Color Image
Output: Classified basmati rice grains
Start
Step1: Acquire the basmati rice grain images.
Step2: Crop individual basmati rice grain and scale it.
Step3: Enhance image to remove noise and blurring.
Step4: Do the image segmentation.
Step5: Extract Color, morphological and Texture features.
Step6: Use these features to recognize and classify the
Basmati rice grain image samples using Feed-Forward Neural network **.**
Step7: Apply binarization to obtain two different images.
Step8: Find out the region proportions.
Step9: Declare the result of purity.
Stop

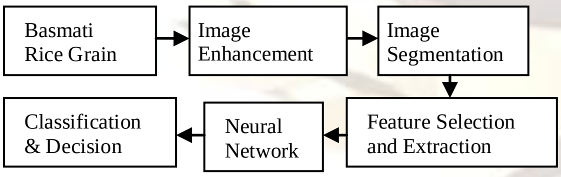


Fig1: Procedure for Basmati rice grain identification and classification

A. IMAGE ACQUISITION

A total of around 60 basmati rice grain images are acquired under standardized lighting conditions. The images are acquired with a color Digital Camera (Sony) was used to capture images of basmati rice grain samples keeping fixed distance of approximately 800 mm. To collect data a camera has been placed at a location situated with a plane normal to the object's path. The black & blue background was used. The environment was controlled to improve the data collection with simple plain background. The images acquired were 640 x 480 pixels in size. Images were captured and stored in JPG format automatically. Through data cable these images has been transferred and then stored in disk managing proper sequence.

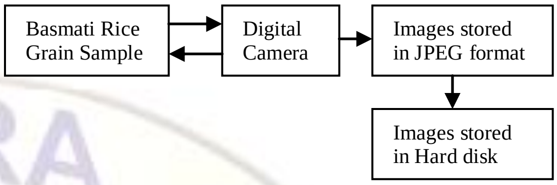


Fig2: Basic building block for image capturing

B. IMAGE SCALING

Image scaling is the process of resizing a digital image. Scaling is a non-trivial process that involves a trade-off between efficiency, smoothness and sharpness. As the size of an image is increased, so the pixels which comprise the image become increasingly visible, making the image appears "soft". Conversely, reducing an image will tend to enhance its smoothness and apparent sharpness. Since basmati rice grains looks smaller in image, selecting part(s) of an image, thus applying a change selectively without affecting the entire picture is been done.[3] This has been done with the help of cropping. Cropping creates a new image by selecting a desired rectangular portion from the image being cropped.

The unwanted part of the image is discarded. Image cropping does not reduce the resolution of the area cropped. Best results are obtained when the original image has a high resolution. A primary reason for cropping is to improve the image composition in the new image. From the sample basmati rice grain image, the object of interest has been cropped six times & has been scaled. After proper cropping band scaling of image now individual basmati rice grain from bulk sample image can be separated out for further preprocessing.

After this we find the pixel area of the each grain present in our binary image. Once we have the pixel area of each grain we can also map the pixel matrix of the whole image with the grain number for the grain area and zero for the rest of background. With the help of Mat lab software we can show the number of rice grains in the sample image.

C. IMAGE ENHANCEMENT

Image processing modifies pictures to improve them (enhancement, restoration), extract information by analysis, recognition, and change their structure i.e. Composition, image editing. Image enhancement improves the quality and clarity of images for human viewing. Removing blurring and noise, increasing contrast, and revealing details are examples of enhancement operations.[4] Noise reduction merely estimates the state of the scene without the noise and is not a substitute for obtaining a "cleaner" image. Excessive noise reduction leads to a loss of detail, and its application is hence subject to a trade-off between the undesirability of the noise itself and that of the reduction artifacts. Noise tends to invade images when pictures are taken in low light settings.

A new picture can be given an 'antiquated' effect by adding uniform monochrome noise. Due to scaling the image has been distorted, hence it is been enhanced by applying special median filtering to the image to remove noise. Image is been compressed using DCT compression. Complement of the image has been done and the image has been properly adjusted for plotting histograms.

Smoothing of the image is been done to reduce the number of connected components that is done by applying standard mask and then doing convolution with the image. Finally equalization of image has been done.

D. IMAGE SEGMENTATION

After image enhancement, the image has been segmented. Image segmentation i.e. subdividing an image into different parts or objects is the first step in image analysis. The image is usually subdivided until the objects of interest are isolated from their background. There are generally two approaches for segmentation algorithms. One is based on the discontinuity of gray-level values; the other is based on the similarity of gray-level values.[1] The first approach is to partition an image based on abrupt changes in gray levels.

The second approach uses thresholding, region growing, region splitting and merging. Segmentation of nontrivial images is one of the most difficult tasks in image processing.

Segmentation accuracy determines the eventual success or failure of computerized analysis procedures. Segmentation basically includes edge detection. Thresholding is also one of the fundamental approaches of segmentation. Another approach is for region oriented segmentation as Watershed segmentation for an example. In the present research work after enhancement of image the edges of the object in binary image has been detected using Canny and Sobel detector(mask).Using canny/sobel method edged has been detected. Edge detection using Sobel detector results more accuracy than using canny edge detector.

Edges are also been detected by applying Laplacian of Gaussian filter. Thresholding has been done according to properties of neighborhood. Thresholding can be done in terms of global or local thresholding. Generally local thresholding is been preferred if the background illumination is uneven. Also watershed segmentation & connected component segmentation can be used. Watershed segmentation is been used for region based segmentation. Thus Image Segmentation is an essential preliminary step in most automatic pictorial pattern recognition and scene analysis problem.

III. FEATURE EXTRACTIONS

A. COLOR FEATURE EXTRACTIONS

Algorithms were developed using MATLAB 7.0 Programming language to extract color features of individual rice seeds. From the red (R), green (G), and blue (B) color bands of an image, hue (H), saturation (S), and intensity (I) were calculated using the following equations

$$I = \frac{1}{3}(R+G+B) \qquad (1)$$

$$S = 1 - \frac{3}{(R+G+B)}[\min(R,G,B)] \qquad (2)$$

$$H = \arccos\left\{\frac{[(R-G)+(R-B)]/2}{[(R-G)^2+(R-B)(G-B)]^{1/2}}\right\} \qquad (3)$$

The mean value of H, the mean value of S, the mean value of I and the minimum, maximum of the Hue, saturation and Intensity were calculated in an image after segmentation. Nine color features were extracted.

B. Morphological Feature Extraction

Algorithms were developed in Windows environment using MATLAB 7.0 programming language to extract morphological features of individual basmati rice seeds. The following morphological features were extracted from images of individual basmati rice seeds:

Area: The algorithm calculated the number of pixels inside, and including the seed boundary (mm2/pixel).
Length: It was the length of the rectangle bounding the seed.
Width: It was the width of the rectangle bounding the seed.
Major axis length: It was the distance between the end points of the longest line that could be drawn

through the seed. The major axis endpoints were found by computing the pixel distance between every combination of border pixels in the seed boundary.

Minor axis length: It was the distance between the end points of the longest line that could be drawn through the seed while maintaining perpendicularity with the major axis.

Aspect ratio: K1=Major axis length/Minor axis length.

Rectangular aspect ratio: K2=Length/Width.

C. TEXTURAL FEATURE EXTRACTION

Algorithms were developed in Windows environment using MATLAB 7.0 programming language to extract textural features of individual basmati rice seeds. The following textural features were extracted from images of individual basmati rice seeds:

Mean: Average or mean value of basmati rice grain image is been calculated using following equation:

$$X_j = 1/n \sum_{i=1}^{n} x_i \qquad (4)$$

Standard Deviation: Standard Deviation of basmati rice grain image is been calculated using following equation:

$$D = 1/(n-1) \sum_{i=1}^{n} x_i - x \qquad (5)$$

IV. REJECTING THE BROKEN BASMATI RICE GRAIN

We know from the data we have, that the broken or the half grain kernels occupies the lesser pixel area as compare to the healthy grains. So we set a threshold value of the pixel area for the average healthy grain kernel and the values lower than that of threshold will be discarded. Here we obtain a new binary image without the broken or the half grain kernel.

By using this new binary image (fig.5) we can again find the connected components and get the information about Connectivity, Imagesize, Numobjects, PixelIdxlist . and with the help of the regionprops we can find the pixel area of each grain of this new binary image now we can also find the number of Basmati rice grains present in the resultant image.

N=

Connectivity: 8
ImageSize: [640 480]
NumObjects: 60 image
PixelIdxList: {1x60 cell}

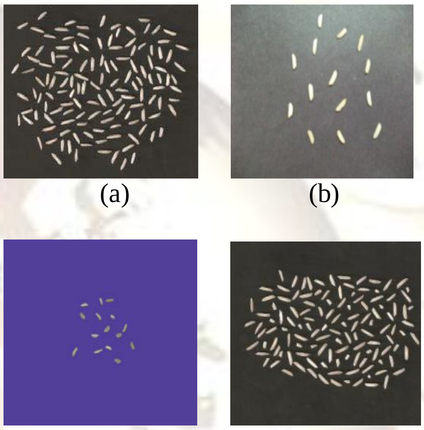
Here also we have the number of rice grain kernels and the pixel size of image.

V. PERCENTAGE PURITY OF GIVEN SAMPLE

On studying both the outputs of Mat lab command window we can clearly see that the second output (Fig. 4 & 5) has more healthy grains and also the number of grains are lesser because half or broken grains are discarded. Now if we divide the number of grains in the second output by the number of grains in first output (Fig. 5) and multiply it by 100. We can achieve the percentage purity of the given sample.

VI. RESULTS AND DISCUSSIONS

A. IMAGE SAMPLES



(a) (b)

(c) (d)

Fig 3: (a) & (b) unbroken images of basmati rice grain,
(c) & (d) broken images of basmati rice grain.

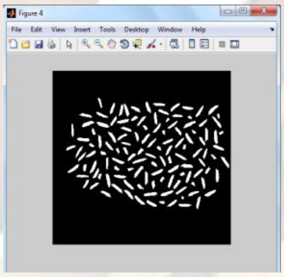


Fig 4: Binary image of broken basmati rice as in fig (d)

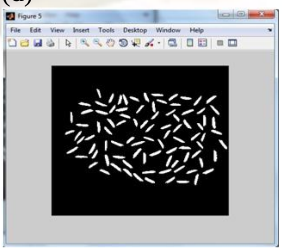


Fig 5: Resultant image with no broken basmati rice grain.

B. SAMPLE OF FEATURES EXTRACTED

From the 60 sample image of basmati rice grains following features are extracted. Sample of features extracted & their values are as follows.

Sl. No.	Features	Value
1	Length	20
2	Width	7
3	Rectangular Aspect Ratio	2.8
4	Major Axis	150
5	Minor Axis	115
6	Aspect ratio	1.2600
7	Area	105
8	Hue Mean	0.0310
9	Saturation mean	0.3130
10	Intensity mean	0.3127
11	Mean	0.2237
12	Standard Deviation	0.2932

Table 1: Features extracted

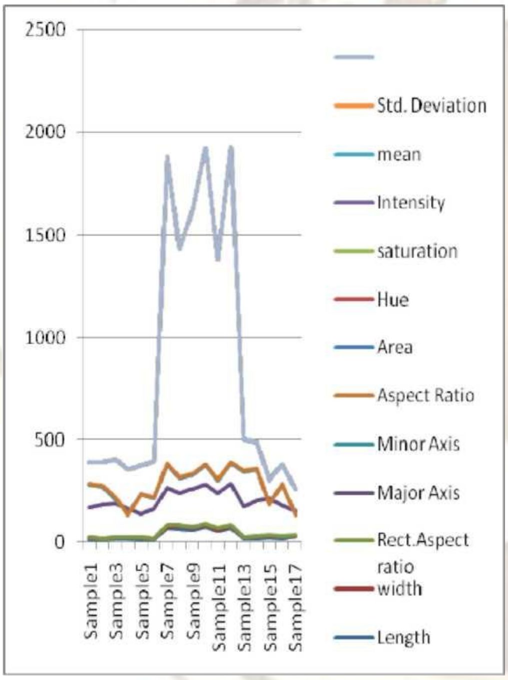


Fig 6: Graphical representation of feature extraction.

VII. NEURAL NETWORK

In order to train the neural network, a set of training basmati rice seeds was required, and the varieties were predefined. During training, the connection weights of the neural network were initialized with some random values. The training samples in the training set were input to the neural network classifier in random order and the connection weights were adjusted according to the error back-propagation learning rule. This process was repeated until the mean squares error (MSE) fell below a predefined tolerance level or the maximum number of iterations is achieved. When the network training was finished, the network was tested with test dataset (60 basmati rice seed), and the classification accuracies were calculated. The classification accuracies were 90.00%, 88.00%, 95.00%, 82.00%, 74.00%, 80.00% respectively.

VIII. CONCLUSION

An algorithm was developed to identify varieties of rice seed based on morphological features and color features. Nine morphological features and six color features of each image acquired with a color machine vision system were extracted. And fifteen features were extracted. A neural network was used to classify the rice seed. In the test dataset, the classification accuracies were 90.00%, 88.00%, 95.00%, 82.00%, 74.00%, 80.00% respectively.

Here, we conclude that purity percentage of rice samples can effectively be done by using the image processing techniques. With our coding in Mat lab software we can calculate that how pure is our sample. The setup used is also very common and easily available. This is also more accurate than the human visual inspection. All this leads to better quality in food processing by image processing.

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