International Journal of Computer and Communication Technology

Volume 3 | Issue 1 Article 3

January 2012

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Recommended Citation
SHANTAIYA, SANJIVANI and Ansari, Uzma (2012) "Identification Of Food Grains And Its Quality Using Pattern Classification," *International Journal of Computer and Communication Technology*: Vol. 3 : Iss. 1 , Article 3.
DOI: 10.47893/IJCCT.2012.1107
Available at: https://www.interscience.in/ijcct/vol3/iss1/3

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Identification Of Food Grains 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 food 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 images have been properly enhanced to reduce noise and blurring in image. Finally image has segmented applying proper segmentation methods so that edges may be detected effectively and thus rectification of the image has been done.

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. 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.

Keywords:-Image warping, Image rectification, Image EnhancementImage analysis, Image segmentation, Edge Detection, blurring image, Thresholding

I. INTRODUCTION

Rice is one of the most important cereal grain crops. The quality of rice has distinct effect on the yield of rice, so the proper inspection of 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, oat, and rye.

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 rice grain variety using Feed-Forward Neural network was investigated.

This research paper proposes a methodology in which the image of bulk 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

II. PROPOSED METHODOLOGY

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

Algorithm 1: Recognition and Classification of food grain image samples.

Input: Original 24-bit Color Image

Output: Classified food grains

Start

Step1: Acquire the food grain images .

Step2: Crop individual rice grain and scale it.

Step3: Enhance image to remove noise and blurring.

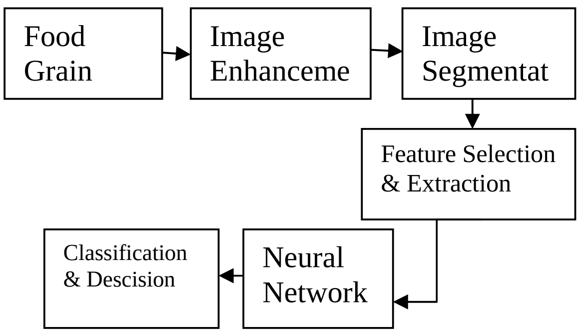
Step4: Do the image segmentation.

Step5:Extract Color ,morphological and Texture features.

Step5: Use these features to recognize and classify the food grain image samples using Feed-Forward Neural network **.**

Stop

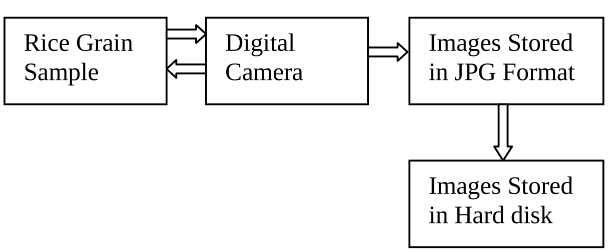
Fig 1. Procedure for food grain identification



A. IMAGE ACQUISITION

A total of around 60 food grain images are acquired under standardized lighting conditions. The images are acquired with a color Digital Camera (Sony) was used to capture images of 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. Few sample database of rice images have been collected from Plant Breeding Department of IGKV, Raipur.

Fig.2 Basic building block for image capturing is:-



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 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 rice grain image, the object of interest has been cropped six times & has been scaled.After proper cropping and scaling of image now individual rice grain from bulk sample image can be separated out for further preprocessing.

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 EXTRACTION

A. COLOR FEATURE EXTRACTION

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 (Zhang,1999):

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

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

$$H = across \frac{[(R-G)+(R-B)]/2}{[(R-G)^2+(R-B)(G-B)]^{1/2}} \quad (3)$$

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 rice seeds. The following morphological features were extracted from images of individual 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 rice seeds. The following textural features were extracted from images of individual rice seeds:

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

$$x_j = \frac{1}{n}\sum_{i=1}^{n} x_{ij} \quad (4)$$

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

$$s = \frac{1}{n-1}\sum_{i=1}^{n} x_i - x \quad (5)$$

IV. RESULTS AND DISCUSSION

A. *IMAGE SAMPLES*

Fig. 3 Sample Rice Grain Images


B. SAMPLE OF FEATURES EXTRACTED

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

Table 1. Features extracted

Sr. No	FEATURES	Value
1	Length	14
2	width	7
3	Rectangular Aspect ratio	2
4	Major Axis	146
5	Minor Axis	116
6	Aspect Ratio	1.2586
7	Area	102
8	Hue Mean	0.2723
9	Saturation Mean	0.0308
10	Intensity Mean	0.3127
11	mean	0.2237
12	Std. Deviation	0.2932

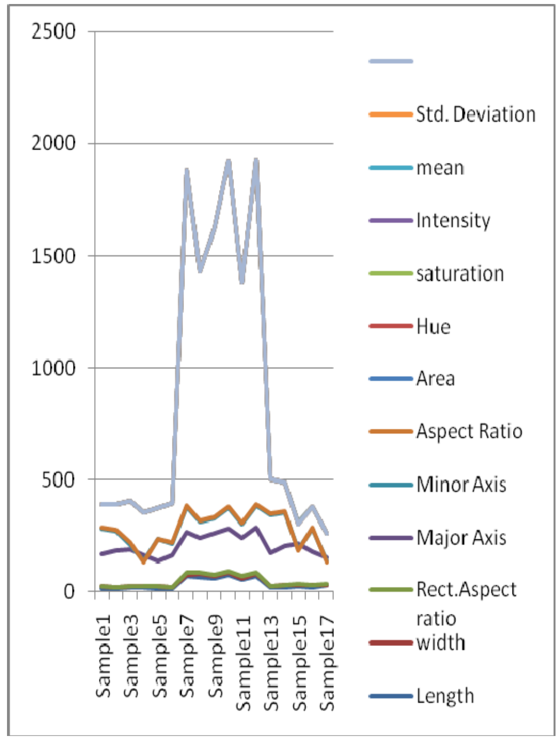


Fig 4. Graphical representation of feature extraction

V. NEURAL NETWORK

In order to train the neural network, a set of training 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 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.

VI. 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.

VII. Future Scope

The present work can be extended for other food grains also and some other features can also be extracted to increase accuracy. Also various infections on food grains like fissures; dockage can also be identified further.

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