Recognition and Classification of Similar Looking Food Grain Images using Artificial Neural Networks

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***Abstract*-This paper presents an recognition and classification of similar looking food grain images using artificial neural networks. Schemes for visual classification usually proceed in two stages. First, features are extracted which represents the image and Second, a classifier is applied to the extracted features to reach a decision regarding the represented type of images. We have considered four pairs of eight different types of similar looking commonly available Indian food grain images namely Jira, Badesoup, Mongdaal Woduddal. Ragi, Mustard, Soya, and Alasandi. The algorithms are developed to extract 18 color and 27 texture features. A Back Propagation Neural Network (BPNN) is used to classify and recognize the Food grain image samples using three different types of feature sets, viz, color, texture, combination of both color and texture features. The study reveals that the combination of color and texture features are out performed the individual color and texture features in recognition and classification of different similar looking food grain images samples.**

***Keywords:* Similar looking food grain images, feature extraction, artificial neural networks.**

I. INTRODUCTION

The decision-making capabilities of human-inspectors are being affected by external influences such as fatigue, vengeance, bias etc. Hence, development of a Machine Vision Systems (MVS) becomes essential as an alternative to this manual practice in the context of current technological era so as to overcome aforesaid influences.

Machine vision systems are successfully used for recognition of greenhouse cucumber using computer vision (Libin Zhang et.al ,2007). A method for the classification and gradation of different grains (for a single grain kernel) such as groundnut, bengal gram, wheat etc, is described in(B.S Anami et al. 2003). The effect of foreign bodies on recognition and classification of food grains is given I n(B.S Anami et al. 2009). Some researchers have used an artificial neural network approach to the color grading of apples(Kazuhiro Nakano1997). A novel method for segmentation of apple from Video via Background Modeling is carried out by (Amy L. Tabb, et.al 2006). A Robust algorithm for segmentation of food images from a background is presented by (Domingo Mery and Franco Pedreschi ,2008). A high spatial resolution hyper spectral imaging system is presented as a tool for selecting better multispectral methods to detect defective and contaminated food and agricultural products is given by (Patrick M. Mehl et.al. 2004). Some have developed a machine vision system for automatic grading of Mushrooms (P. H Heinemann, et.al, 1994). An artificial neural network approach is used to identify and classify the bulk grain samples (McCollum et.al, 2004, B.S Anami et al. 2008, 2006; Kivanc Kilic et al.2006). The present work pertains to the recognition and classification of eight different types(four pairs) of similar looking food grain images namely, Jira, Badesoup, Mongdaal Woduddal. Ragi, Mustard, Soya, and Alasandi .The images are pre-processed to highlight the discriminating features of the food grains. Thus, the feature vector is obtained and is subjected to categorization process. An artificial neural network based categorizer is developed which is trained using feed forward rule. In this work, we have considered more popular eight different varieties of similar looking food grains , their preprocessing, color and texture feature extraction, neural network model development for recognition and classification and finally testing of the proposed methodology against a large number of image samples.

The present paper is organized into five sections. Section 2.0 gives the proposed methodology, Section 3.0 describes recognition and classification of fruits using a neural network. The results and discussions are given in section 4.0. Section 5.0 gives conclusion of the work.

II. PROPOSED METHODOLOGY

The different food grain image samples used in this work are collected from different locations in Bijapur district of Karnataka state, India for the growing year 2010-11,from Agriculture Produce Market committee (APMC) and College of Agriculture Sciences, Bijapur. India.

A. Image Samples

Using imaging system nearly 1000 food grain images of each types i.e total of 8000 images are acquired .Eight different types similar looking food grains are used for image acquisition namely, Jira, Badesoup, Mongdaal Woduddal. Ragi, Mustard, Soya, and Alasandi are shown in Fig 1. Color features like red, green, blue, hue, saturation, intensity components and texture features like mean, variance, range, energy, entropy, contrast, inverse difference moment, correlation and homogeneity are used to classify food grains. Color and texture features are extracted from the set of images and used to train a linear classifier. And another set of images are used to test the proposed linear classifier.

The images are acquired with a color digital camera connected to a personal computer (Pentium IV 2.4 GHz). The camera has a zoom lens of 10-120mm focal length and a close-up set (72mm). The 24 bit color images of 300 x 225 pixels size are acquired. For each food grain type 1000 image samples are obtained by rotating and rearranging the food grain samples.

B. Methodology

The color and texture features are extracted considering the whole image for feature extraction. The extracted features are stored in the form of knowledge base. When a new image is encountered features are extracted from image sample. The extracted features are used to identify and classify using Neural Network. The block diagram illustrating the procedure for recognition and classification of food grain image samples is shown in fig.2 and methodology is given algorithm 1.

Fig 1: Image Samples of Food grains Samples

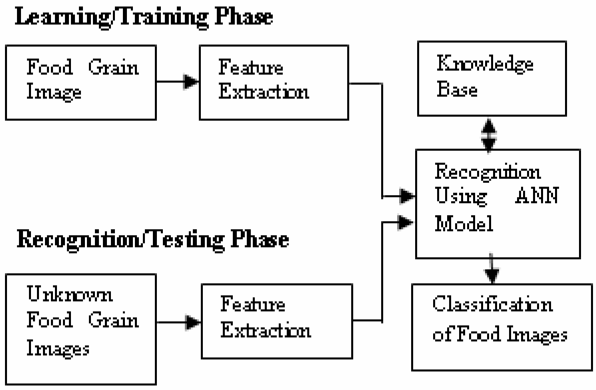

Fig .2 Block Diagram of Proposed Methodology

Algorithm 1: Recognition and **c**lassification of food grain image samples

Input: Original 24-bit color Image

Output: Classified food grain image of different types

Start

Step1: Read the food grain images.

Step2: Extract color and texture features.

Step3: Use these features to recognize and classify the food grain image samples using Artificial Neural Networks (ANN).

Stop

C. Feature Extraction

The developed algorithms are used to extract 18 color and 24 texture features from food grains Food grain sample images.

D. Color Feature Extraction

The RGB components are separated from the original image and the Hue (H), Saturation (S) and Intensity (I) components are extracted from RGB components.

The equations (1),(2) and (3) are used to evaluate Hue, Saturation and Intensity of the image samples. The mean, variance and range for all these 6 components are calculated and a total of 18 color features are stored suitably for later usage in training ANN. The steps involved in color feature extraction are given in algorithm 2.

$$H = \begin{cases} \theta & if \quad B \le G \\ 360 - \theta & if \quad B > G \end{cases} \qquad \ldots(1)$$

with

$$\theta = cos^{-1}\left\{ \frac{\frac{1}{2}[(R-G)+(R-B)]}{\left[(R-G)^2 + (R-B)(G-B)\right]^{1/2}} \right\}$$

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

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

Algorithm 2: Color feature extraction

Input: Original 24-bit color image.
Output: 18 color features.
Start
Step 1: Separate the RGB components from the original 24-bit input color image.

Step 2: Obtain the HSI components from RGB components using the equations (1), (2) and (3).

Step 3: Find the mean, variance, and range for each RGB and HSI components.
Stop.

E. Texture Feature Extraction

The food grain image samples exhibit different textures and provide information about the variation in the intensity of a surface by quantifying properties such as smoothness and regularity. The most widely accepted models are co-occurrence and run-length matrices and we have used the co-occurrence matrix. A total of 27 texture features extracted are stored suitably for later retrieval. The following equations are used to evaluate the texture features. Algorithm 3 is used for texture feature extraction.

$$C = \frac{1}{4}(P_{0^0} + P_{45^0} + P_{90^0} + P_{135^0}) \quad \ldots(4)$$

$$Energy = \sum_{x,y} P^2(x,y) \quad \ldots (5)$$

$$Entropy = -\sum_{x,y} P(x,y)log_2(P(x,y)) \quad \ldots(6)$$

$$Contrast = \sum_{x,y} |x-y|^k P^{\lambda}(x,y) \quad \ldots(7)$$

$$Inverse\ difference\ moment = \sum_{x,y;x\neq y} \frac{P^{\lambda}(x,y)}{|x-y|^k} \quad \ldots (8)$$

$$Correlation = \frac{\sum_{x,y}\left[(xy)P(x,y)\right]) - \mu_x\mu_y}{\sigma_x\sigma_y} \quad \ldots (9)$$

Where μ_x, μ_y are means and σ_x, σ_y are standard deviations defined by,

$$\mu_x = \sum_x x \sum_y P(x,y)$$

$$\mu_y = \sum_y y \sum_x P(x,y)$$

$$\sigma_x = \sum_x (x-\mu_x)^2 \sum_y P(x,y)$$

$$\sigma_y = \sum_y (y-\mu_x)^2 \sum_x P(x,y)$$

$$Homogeneit\ y = \sum_{x,y} \frac{P(i,j)}{1+|i-j|} \quad .. \quad (10)$$

Algorithm 3: Texture feature extraction

Input: RGB components of original image
Output: 27 Texture features
Start
Step 1: For all the separated RGB components Derive the Gray Level Co-occurrence Matrices (GLCM) $P_{\varphi,d}(x,y)$ for four different values of direction φ (0^0, 48^0,90^0 *and* 138^0) and $d=1$ which are dependent on direction φ.
Step 2: Compute the co-occurrence matrix, which is independent of direction using the equation (4).
Step 3 GLCM features namely, mean, variance, range, energy, entropy, contrast, inverse difference moment, correlation and homogeneity, are calculated using equations (5) to (10).
Stop

III. Recognition And Classification Of Similar Looking Food Grains Image Samples

This section gives details of the ANN model, classification models, training, testing and results of experimentation.

A. Artificial Neural Network (ANN) Model

A back propagation network (BPN) is best suited and thus is the most popular choice for classification of agriculture produce. The multilayer feed forward network model used and adopted back propagation algorithm for training. The number of neurons in the input layer is equal to the number of input features. The number of neurons in the output layer is equal to the number of categories of food grain samples considered (8 types). In case of recognition based on color the value of n is 18, based on texture 27 and 45 when features are combined. In all the cases, the output layer has 8 nodes. The network recognizes a pattern vector P as belonging to class O_i if the i^{th} output of the network is "high" while all other outputs are "low".

B. Classification Models

The color and texture features are stored for each food grain type. The classification is carried out using three different types of feature sets. The first set consists of all the 18 color features, the second set consists of all the 27 texture features and the third set consists of all the 45 combined color and texture features.

C. Training, Testing and Validation

Training, testing, and validation of neural networks are performed using food grains sample images. For training and validating the network, images are divided into three sets of training, testing, and validating sets. The network is trained using the training set and tested during its training using the testing set. Once trained, the network's performance is tested on the validating set.

IV. Results and Discussion

This section gives the results of exhaustive experimentation of developed methodology. A comparative study of the three feature sets used in the work is presented.

A. Using Color Features

An Artificial Neural Network consists of 18 input nodes and 8 output nodes, one for each type is used for the study. The summarized results of color based recognition and classification of food grains image samples are shown in Fig 3. The graph reveals that the recognition of Mustard is about 87% and for Soya is 78% .The classification is low since the grains pair exhibits similar colors.

B. Using Texture Features

The 27 Texture features are used for classification of food grains image samples. The maximum and minimum classification rate is 84% and 78% for Woduddal and Jira respectively based on Texture feature sets as shown in fig .4.

C. Using Combined Features

The color and texture feature sets are combined that consists of 45 input features.

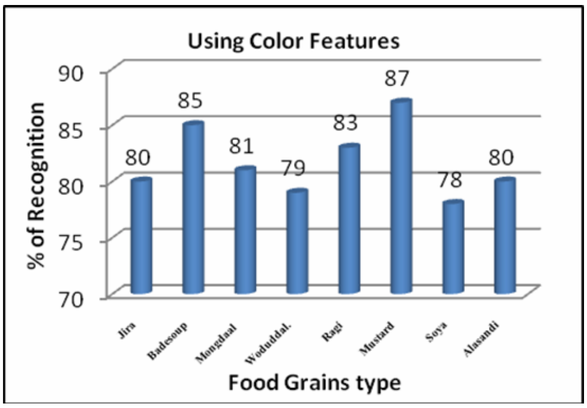

Fig.3. Recognition and classification of similar looking food grain image based on color features

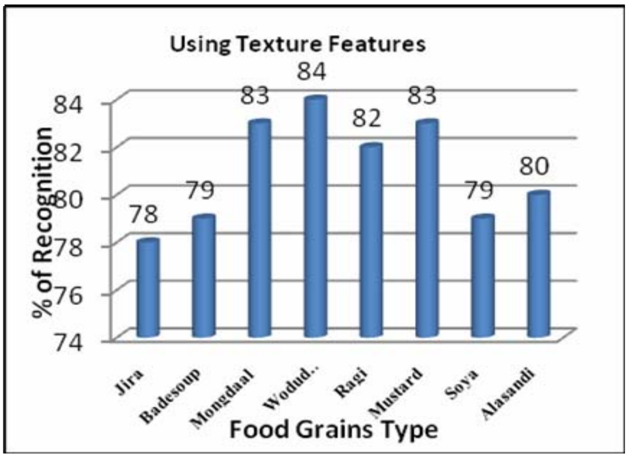

Fig.4. Recognition and classification of similar looking food grain image based on texture features

The study reveals that the classification of Jira is about 92% and Mongdal is 85% using color and texture feature sets as shown in Fig.5. From the fig 5, it is clear that classification using texture analysis is better than classification using color analysis. Best results are obtained by using the combination of both color and texture features.

V. Conclusion

The images in this study are acquired from clean grain samples. The maximum and minimum results is about 92% and 85% using color and texture feature sets for Jira and Mongdal respectively. The results from this study are useful in rapid recognition and classification of food grains types by designing an elevator that moves a food grain across camera.

The work carried out has relevance to real world recognition and classification of food grains types and it involves both image processing and pattern recognition techniques.

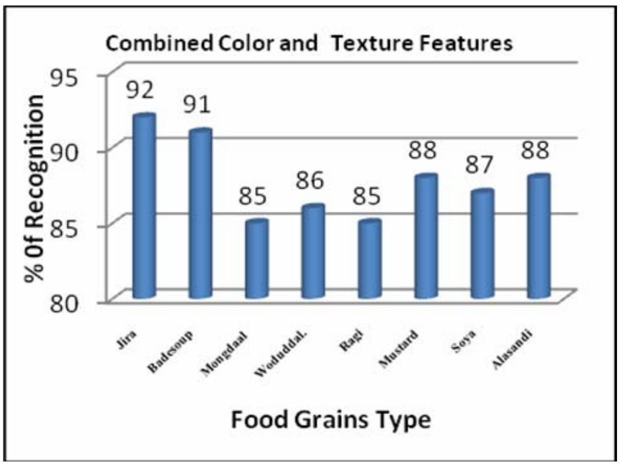

Fig.5 . Recognition and classification of similar looking food grain image based on combined color and texture features

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