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Adulteration Identification of Papaya Seeds in Black Pepper Using Digital Image Processing

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ABSTRACT: The major problem in food products like cereals, spices, grains, etc are adulterated with many unwanted materials like stones, weeds and low quality substances, which are harmful to the consumers. Such malpractices can yield very good margin to the sellers whereas the buyers and the customers get affected. The proposed system can be easily monitored by using a novel digital image processing technique to overcome the manual analysis by human vision. The images are captured using a normal digital camera. The pre-processing technique is used to remove noises and image features like contrast, shape and texture of the seeds are taken for analyzing the adulteration of papaya seeds mixed with black pepper. The set of features contains noisy or irrelevant information so the most suitable features are identified for accurate classification. The selected features are classified using k-NN classifier. The proposed method is implemented in MATLAB software.

KEYWORDS: Adulteration, Digital image, Pre-processing, Feature Extraction, k-NN Classifier.

I. INTRODUCTION

The binomial name of Black pepper is piper nigrum, which is a flowering vine under the family Piperaceae, cultivated for its fruit. When dried, the fruit is known as peppercorn used as spice and seasoning. Its spiciness is attributed to the presence of the chemical piperine. Black pepper is native to south India and is widely cultivated there and elsewhere in tropical regions. Black pepper is the world's most traded spice and is referred as "king of spices". Currently Vietnam, Indonesia, and India are the top leading producers of black pepper.

Dried black pepper has been used for its flavour and as a traditional medicine. Black peppercorns contain minerals like potassium, calcium, zinc, manganese, iron and magnesium. They are also rich in flavonoid polyphenolic anti-oxidants like carotenes, cryptoxanthin and Lycopene. These compounds help the body to remove harmful free radicals and help to protect from cancers and diseases.

Indian spices are well known for their rich aroma, flavor and taste as in olden days foreign countries exchanged gold for Indian spices especially black pepper popularly known as (Black gold). Such valuable spices are now a day's adulterated to yield more profit. Adulterations of unwanted substances like stone, weeds and low cost item increases the quantity of the product that encourages the fraudulent traders to do such malpractices. As it causes many health related problems to the consumers. Dried papaya seeds are generally mixed in bulk with Black pepper to have a good margin. Excessive consumption of papaya seeds may cause serious liver problems and stomach disorders.

II. LITERATURE SURVEY

Throughout the years, there have been a few directions made by the Government to control the adulteration of spices and other food products. Many schemes and measures are introduced to overcome the adulteration by human analysis but still there is a crisis in eradication of such malpractices. The accuracy of quality checking by human inspection may

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vary from person to person according to the inspector's physical circumstances such as work stress, loyalty of traders and pressure. By using computer vision technique we can reduce the adulteration in food industry as it overcomes the manual analysis by human vision.

[3]Substantial work for classifying and identifying varieties of rice granules has been reported by Priyankaran tanck and Bipan kaushal. Image processing technique is used to study the rice grain varieties and the acquired image is converted to gray scale and adulteration is identified using two parameters namely aspect ratio and perimeter respectively. Fairly accurate results are produced which provides an advantage over the traditional method of visual inspection by individuals.

III. METHODOLOGY

Pictures of the pepper and papaya samples are taken against a clear and neat background with high quality camera. The images are then stored in the computer. The background is white. Inside the field of view, the seeds are arranged in a random manner and position. Images are stored in jpeg or png format and the rgb image are converted to gray scale image. Using median filter as a pre-processing method, the noises are removed and image features are analysed and classified using k-NN classifier.

A. BLOCK DISCRIPTION

The block diagram explains the steps for capturing and saving the image for characteristics parameter analysis process is as given in fig 1

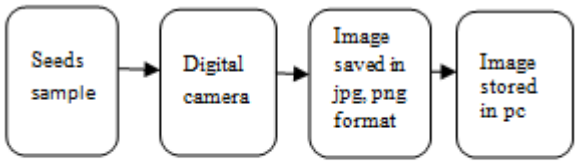

Fig.1 Basic Block of Image Capturing

The following figure 2 shows the block diagram employed for the extraction of features of the adulterated samples of papaya seeds in black pepper using MATLAB as a tool.

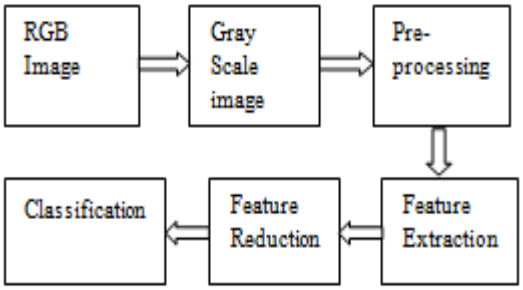

Fig 2 Procedure for seed future extraction

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B. Image Acquisition and Smoothing:

The first step of image processing is the acquisition of image. Its done by using digital camera under uniform lighting setup. Standard procedures such as image resizing, conversion to gray scale image, etc are done for improving the quality of an image through Pre-processing technique which is used to remove the unwanted noises present in the image and to compress the data for further analysis. Sobel filter, laplacian filter, canny edge filter, prewitt filter, wiener filter and median filter are the various filters applied on the input image for the image smoothing. Among the various filters the output of median filter is more effective in pepper and papaya image processing. Median filtering is very widely used in digital imaging because it preserves the edges of the image during the noise removal. Speckle noise and salt and pepper noise are particularly effective on median smoothing. Using median filter the noise in the input gray colour image is removed figure3 and figure4 shows the acquired and the smoothened images of black pepper and papaya.

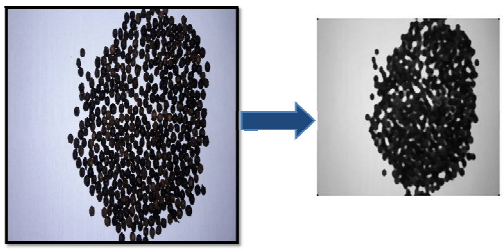

Fig.3 Acquired and smoothing Image of Black pepper

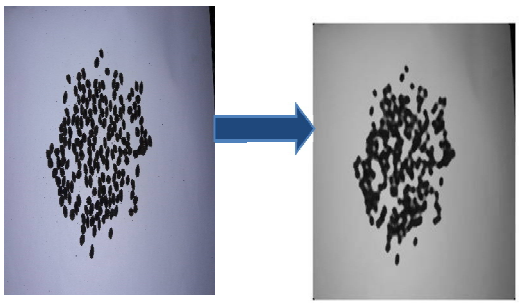

Fig.4 Acquired and smoothing Image of papaya seeds

C. Parameters used for comparison

Mean Square Error (MSE)

This error metric use to compare the various image compression techniques and MSE is the cumulative squared error between the compressed and the original image. The mathematical formulae is given by

$$MSE = \frac{1}{MN}\sum_{Y=1}^{M}\sum_{X=1}^{N}[I(X,Y) - I'(X,Y)]^2$$

Where I(x,y) is the original image, I'(x,y) is the approximated version (which is actually the decompressed image) and M,N are the dimensions of the images.

Peak Signal to Noise Ratio (PSNR)

Peak signal to noise ratio, often abbreviated as PSNR, is an engineering term for the ratio between the maximum possible power of a signal and the power of the corrupting noise that affects the fidelity of its representation. Because many signals have a very wide dynamic range, PSNR is usually expressed in terms of the logarithmic decibel scale. PSNR is given by:

$$PSNR = 20\log\frac{Maxi}{\sqrt{MSE}}$$

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The amount of noise removed from the sample after filtration is measured using the Peak signal-to-noise ratio calculation respectively.

COMPARISON TABLE OF PSNR VALUES

ITERATIONS	MSE	PSNR in DB
Black Pepper	33	32.97
Papaya	11.03	37.33
Mixed	10.83	37.84

D. FEATURE EXTRACTION

Gray Level Co-occurrence Matrix (GLCM):

It is the statistical method that assigns the spatial relationship of pixels. The contents of GLCM use the texture feature calculations to give a measure of the variation in intensity at a pixel of interest. The GLCM is a square matrix of order N×N, where N is the number of different gray levels in an image. Each elements of GLCM of an image are shown as p(i, j, d, θ). This represents the relative frequency, where i is the gray level of the pixel p at location (x, y), and j is the gray level of a pixel located at a distance d from p in the orientation θ. For original GLCM 11 features are calculated, however, typically only subsets of these are used. The following four GLCM derived features are described in Table 1 such as contrast, homogeneity, energy and correlation. Image features like contrast, correlation, variance, homogeneity, energy, entropy, standard deviation, kurtosis, skewness and smoothness are extracted for number of samples of pepper and papaya seeds. The values obtained are noted for different sample images and analyzed for variation in parameter ranges.

Contrast	$\sum_{ij} \lvert i-j \rvert^2 p(i,j)$
Correlation	$\sum_{ij} \frac{(i-\mu_i)(j-\mu_j)p(i,j)}{\sigma_i \sigma_j}$
Homogeneity	$\sum_{ij} \frac{p(i,j)}{1+\lvert (i-j) \rvert}$
Energy	$\sum_{ij} \{p(i,j)\}^2$

TABLE I. FEATURES EXRACTED FROM GLCM

Correlation output Graph

The output of the correlation window is show in the below figures where the normal range of value for the black pepper varies from the minimum of 0.900 to the maximum of 0.990 and the papaya seeds correlation value varies from minimum of 0.800 to the maximum of 0.920 respectively. From these pre-defined correlation values when an

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image of mixed sample is analyzed its value ranges from 0.800 to 0.930 approximately by which we can symbolically say that there is adulteration of papaya seeds in black pepper.

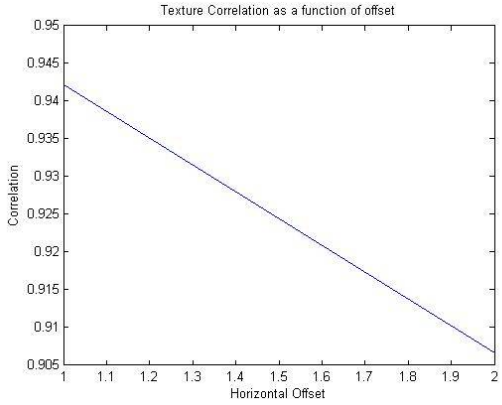

Fig .5 Correlation output of Black pepper

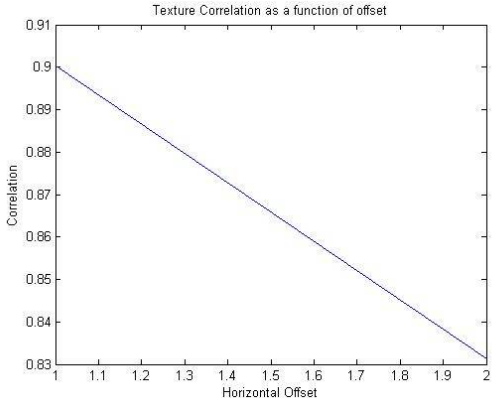

Fig .6 Correlation output of Papaya

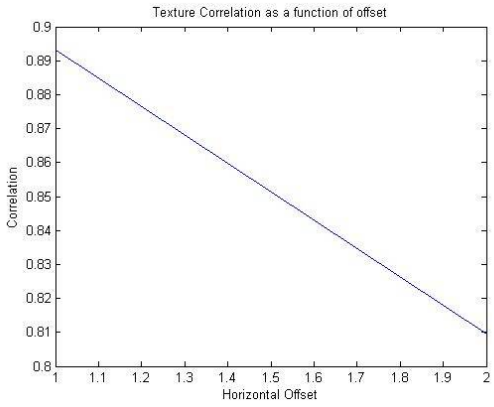

Fig .7 Correlation output of mixed sample

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IV. GRADING USING k-NN CLASSIFIER

To standardize the grading process and classification of seeds is a very complex one in manual means. For these reasons, in this project a simple method k-NN classifier as an approach is taken to see the performance. An object is classified based on the majority vote of its neighbors, where the object being assigned to the class is the most common amongst its k nearest neighbors (k is a positive integer). The motivation of this classifier is that patterns which are close to each other in the feature space are likely to belong to the same pattern class. In this work, the k-NN employs the standard deviation to analyze the adulteration of papaya seeds in black pepper from the features of samples tested and trained.

V. RESULTS

The data set consisting of 30 samples are trained and 20 samples are tested using k-NN classifier. First the digital image is converted to 0-255 gray level image and median filter is used to smoothing the image after which the amount of noise removed from the original image is measured using PSNR value where maximum noise is removed using median filter and features were determined with GLCM method using MATLAB. Correlation output provides the overview of adulteration ranges in graph. By using k-NN classifier, classification was made for variation of standard deviation values to distinguish from the papaya seeds. Accuracy was found to be 90%.

VI.CONCLUSION

The processing of digital image and careful analyses of various features for extracting features of black pepper considerably reduced the complexity in grading of pepper seeds. The developed k-NN classifier can be adopted for classification of other grains and cereals as well. The classification accuracy has been analyzed to be 90% and the results have been acquired under totally uncontrolled lighting condition. In future studies, to analyze under a controlled lighting environment and use of better classification method may improve the accuracy in detection of adulteration of black pepper when mixed with low quality products like papaya seeds, stones, weeds, etc.

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