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Review Paper on Analysis and Grading of Food, Grains Using Image Processing and SVM

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Abstract— Nowadays in food handling industry, grading of granular food materials is necessary because samples of material are subjected to adulteration. The food quality is became a major issue in health care. It is difficult to find the best food quality by ourselves in the market. In the past, food products in the form of particles or granules were passed through sieves or other mechanical means for grading purposes. In this paper analysis is performed on basmati rice granules to evaluate the performance using image processing and Support vector machine (SVM) is implemented based on the features extracted from rice granules for classification grades of granules. Digital imaging is recognized as an efficient technique to extract the features from rice granules in a non-contact manner. Images are acquired for rice using camera. Conversion to gray scale, Median smoothing, Adaptive thresholding, Sobel edge Detection, Canny edge detection, Morphological operations, Extraction of quantitative information are the checks that are performed on the acquired image using image processing technique through Open source Computer Vision (Open CV) which is a library of functions that aids image processing in real time. The morphological features acquired from the image are given to SVM. This work has been done to identify the relevant quality category for a given rice sample based on its parameters.

Keywords- *Digital Imaging, Median Smoothing, Adaptive Thresholding, Sobel Edge Detection, Canny Edge Detection, Support vector machine (SVM).*

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I. INTRODUCTION

Quality of food, grains is an important requirement for today’s market, to protect the consumers from substandard products. Also, yield is the most noticeable characteristic to farmers while the crop is in the ground but when the milled rice reaches the market quality becomes the key determinant of its sale-ability. However, 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, weed seeds, chaff, damaged seeds, more broken granules etc. This is often seen today in rice trade where rice in 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. It is easy for the consumer protection authority to refrain from executing the duties as the classification of a product such as rice with respect to the foreign objects, broken granules etc. is vague. Therefore it is required to explore the possibility of using technology for a suitable solution. The accuracy of quality checking by using human inspection method is varied from person to person according to the inspector’s physical circumstances such as working stress, persuasion and loyalty for traders. Also the knowledge and experience of inspectors are required to accurately perform this evaluation process.

Substantial work for classifying and identifying varieties of grains has been reported. B.S. Anami et al. [1] described a method for gradation and classification of different grains such as wheat, Bengal gram, groundnut etc. An artificial neural network approach is used in the Identification and classification of the bulk grain samples by N.S. Visen et.al. [2]. Harlick, et. al. [3] has presented a paper on classification of image using textural features. This work is done based on gray-tone spatial dependencies for easily computable textural features. LIU zhao-yan et al. [4] projected his ideas on Identification of different varieties of rice grains using neural network and image processing. They used an algorithm of digital imaging based on morphological and color features of different rice varieties. By using image analysis techniques M.A. Shahin and S.J. Symons [5] automated the manual sieving procedure. Using flatbed scanner, J.Paliwal et al. [6] performed a research for both bulk and single seed images. N.S. Visen et al. [2] developed and optimized a technique by extracting the morphological, texture, and color features using images of single grains for discriminating various types of grains. Identifying the food grains and evaluating its quality using pattern classification is done by Sanjivani Shantaiyai, et al. [7]. H.Rautio and O.Silvn [8] carried out experiment to determine the average grain size and classified using morphology and texture features.

Burges et al. 1998 reported that the Support Vector Machine (SVM) is a new pattern classifier set of supervised generalized linear classifiers that have often been found to provide higher classification accuracies than other widely used pattern classification techniques, such as multilayer perceptron

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neural networks [12]. S Noble, 2006 reported that Support Vector Machine (SVM) is a computer algorithm that learns by example to assign labels to objects [13]. M. Galar et al. 2011 suggested the ensemble methods for binary classifiers in multi-class problems, one-vs.-one and one-vs.-all schemes. These researches provided some new ideas and image processing methods for evaluating rice appearance quality. The effectiveness and accuracy of inspection have been improved through these methods. This paper presents classification of grades of Basmati rice granules using the novel technique Image Processing and SVM.

II. Material And Methedology

The samples of Basmati rice grains were collected from stores and a CCD camera is used to acquire and record the images for rice granules of different sizes. The camera is mounted on a stand which provides vertical movement. When the camera is fixed distance between the lens and the sample table with uniform background is 30 cm. The back ground is black. The uniform intensity lighting on the sample table is provided. Inside the field of view the grains were arranged in random orientation and position. Images were stored in jpg format and different parameters of rice were extracted from the image for further analysis. With the parameters interpreted we establish a SVM algorithm for grading of rice granule.

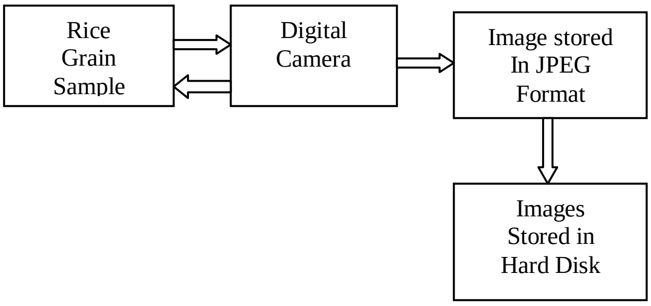

Fig. 1 Basic Building block for image capturing

III. Image Analysis

A. *Image Acquisition and Smoothing:*

The first step in image processing is image acquisition. Acquisition of an image is done by using CCD camera under uniform lighting setup which is shown in Fig. 2.

Fig. 2 Acquired Image

Standard procedures are applied for improving the quality of an image through Pre-processing techniques. Averaging, Gaussian filters are the filtering types used in noise reducing techniques in which their operation causes the image smoothing. In this paper smoothing is done using Median Filters. Median filtering is very widely used in digital imaging because it preserves the edges of the image during noise removal [9]. Salt and pepper noise are which with median filters are particularly effective. Using median filter the noise in the input gray color image is removed. Fig. 3 shows the smoothened image.

Fig. 3 Smoothing Image

B. *Histogram Equalization:*

Graphical display of distribution of tones in a digital image is called image histogram. The variation of tones is represented by the horizontal axis while the number of pixels corresponding to that particular tone is represented by vertical axis. In the field of computer vision, histogram images are used to determine threshold value which is used for thresholding and edge detection. Equalizing Histogram is to adjust the contrast using histogram image. It gives better information about the objects in the acquired image.

C. *Segmentation:*

The next step is to segment an image which is one of the important stages in image analysis techniques. The accuracy of this operation is highly dependent on subsequently extracted data. Sonka et al. [10], Sun [11] proposed that Segmentation is attained by three techniques such as Edge segmentation, Region segmentation and Thresholding. In this paper we perform segmentation through adaptive thresholding and detection of edges through canny and sobel edge detection.

D. *Thresholding:*

Thresholding is a technique based on absorption of light in their surfaces to characterize the regions of the image. Threshold is to separate the regions in an image with respect to the objects which is to be analyzed. This separation is based on the variation of intensity between the object pixels and the background pixels. In our work to perform thresholding, adaptive thresholding technique is implemented. Once we have properly separated the necessary pixels, we can set them with a determined value to identify them (i.e. we can assign them a value of 0 (black), 255 (white) or any value that suits our needs). Fig. 4 shows the result from Adaptive thresholding.

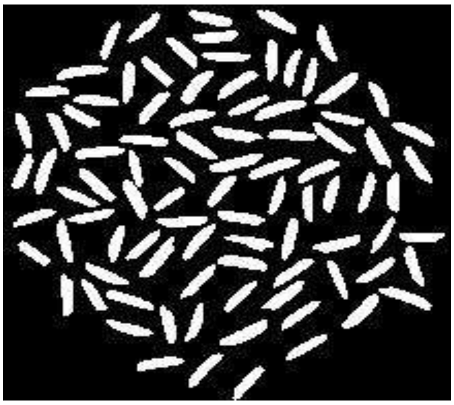

Fig. 4 Threshold Image

E. Edge Detection Techniques:

Edge detection is based on detection of edges by different edge operators. Discontinuities in color, grey level, texture, etc. are detected by edge operators. For comparison of performance two different edge detection techniques namely Sobel edge detector and Canny edge detector are used.

1) Sobel Edge Detection:

In Sobel edge detection, for each position of the pixel in the image the gradient is calculated. Series of gradient magnitudes are created using a simple convolution kernel. Convolution K is applied to the pixel group for those which are mathematically inclined is:

$$N(x,y) = \sum_{k=-1}^{1} \sum_{j=-1}^{1} K(j,k)p(x-j, y-k) \quad (1)$$

Two convolution kernels are used for those that are not mathematically inclined in which one is to detect the changes in vertical contrast (gx) and another to detect the changes in horizontal contrast (gy). Regarding the x and y components of the vector the two gradients are computed using gx and gy

$$\mathbf{g} = \begin{bmatrix} g_x \\ g_y \end{bmatrix} \quad (2)$$

$$g = \sqrt{g_x^2 + g_y^2} \quad (3)$$

$$\theta = \tan^{-1}\left[\frac{g_y}{g_x}\right] \quad (4)$$

Where **'g'** is the vector gradient, 'g' is the magnitude gradient and 'Ө' is the direction gradient. Fig. 5 shows the result of Sobel Edge Detection.

Fig. 5 Sobel Edge Detection

2) Canny Edge Detection:

Canny edge detector is an optimal detector which gives optimal filtered image. The gray scale image edges are detected by this optimal detection technique. The edges in the image are marked only once and false edges are not created due to the noise in the image because Canny's method has good detection and localization with minimal response. This detector has the ability to detect weak edges and is considerably strong. Canny edge detector distinguishes the edges by locating the local maxima and minima of the gradient of the intensity function. The advantage of Canny edge detection over sobel edge detection is that the detected edges are thick. This occurs if the edge is with one pixel thick the Sobel detector thickens it as there are two changes taking place consecutively with the intensity. The Canny edge detector gives a solution to the problem first by blurring the images slightly and then applies an algorithm that thins the edges to one-pixel effectively. The output of canny Edge Detection is shown in the Fig. 6.

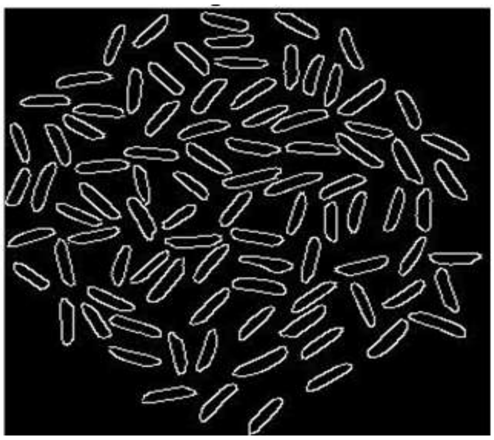

Fig. 6 Canny Edge Detection

F. Feature Extraction:

Extraction of quantitative information from segmented images is dealt with Feature Extraction. Object recognition and classifications are performed based on various algorithms of morphological features. Some of the morphological features for classification purposes contain redundant noisy and irrelevant information. The features which were extracted from images of rice kernels are Perimeter, Area, Minor-axis Length and Major-axis Length using Contour detection which is shown in Fig. 7.

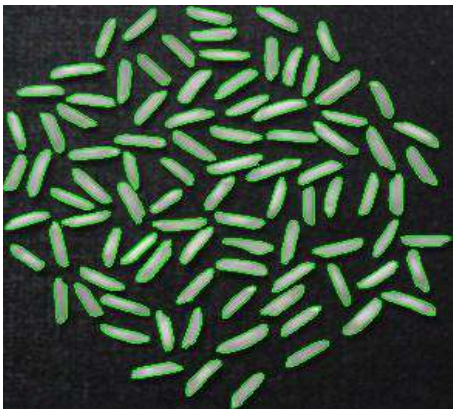

Fig. 7 Contour Image

The collected data were then used in SVM system for grading of rice kernels. Fig. 8 shows the flow chart of the Grading process.

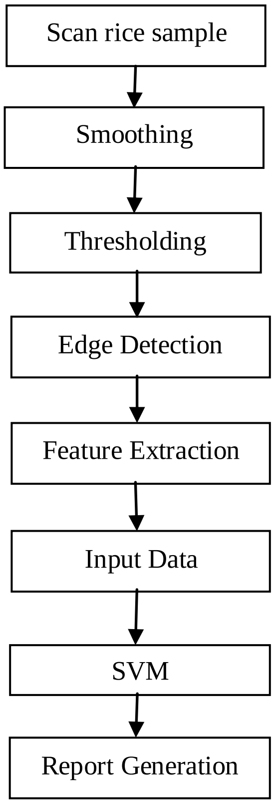

Fig. 8 Flow Diagram of Classification and Grading Techniques

IV. Grading Using SVM

To standardize the grading process manual method needs to be replaced with an approach which is used to stabilize the process. The grading is determined in this paper using SVM.

A. Support Vector Machines:

A support vector machine (SVM) a new pattern classifier was trained for classification of the samples into the grades (Premium, Grade A, Grade B and Grade C).

A support vector machine (SVM) performs classification by mapping input vectors into a higher-dimensional space and constructing a hyper-plane that optimally separates the data in the higher-dimensional space. SVM models are closely related Using a kernel function, SVMs are alternative training methods for polynomial, radial basis function, and multi-layer perceptron classifiers in which the weights of the network are found by solving a quadratic programming problem with linear constraints rather than by solving a non-convex unconstrained minimization problem as in standard neural network training. Given a training set of instance-label pairs x_i, y_i, i =1, 2,3…..l, $x_i \in R^n$, $y_i \in \{-1,1\}$, the SVM require the solution of the following optimization problem:

$$\min_{w,b,\xi} \left\langle \frac{1}{2} w^T w + C \sum_{i=1}^{l} \xi_i \right\rangle \quad (5)$$

Subject to $y_i (w^T \phi(x_i) + b) \geq 1 - \xi_i$, $\xi_i \geq 0$

Here, training vectors x_i (i=1, 2, 3…….l) are mapped into a higher-dimensional space by the function f. Then the SVM finds a linear separating hyperplane (w, b) with the maximal margin in this higher-dimensional space. $C > 0$ is the penalty parameter of the error term. The slack variables, y_i (i=1,2, 3……….l) measure the degree of misclassification of x_i. The SVM does not require an estimation of the statistical distributions of classes to carry out the classification task but it defines the classification model by exploiting the concept of margin maximization.

Furthermore,

$$K(x_i, x_j) = \phi(x_i)^T \phi(x_j)$$

is called the kernel function, with which the computational problem of many dimensions is solved. Although new kernels are being proposed by researchers the radial basis function (RBF) is a reasonable first choice. This kernel nonlinearly maps samples into a higher dimensional space so it unlike the linear kernel can handle the case when the relation between class labels and attributes is nonlinear.

$$K(x_i, x_j) = \exp(-\gamma \| x_i - x_j \|^2),\ \gamma > 0 \quad (6)$$

The RBF kernel nonlinearly maps samples into a higher dimensional space so it can handle nonlinear classification issues. With certain parameters (C, γ) the RBF kernel has the same performance as the linear kernel or the sigmoid kernel. There are two parameters while using RBF kernels: C and γ. It is not known beforehand which C and γ are the best for one problem consequently some kind of parameter search must be done. Cross-validation is commonly utilized to identify good (C, γ) so that the classifier can accurately predict unknown (independent) data. A common strategy is to separate the data set into two parts of which one is considered unknown. The prediction accuracy obtained from the “unknown" set more precisely reflects the performance on classifying an independent data set. An improved version of this procedure is known as cross-validation. In n-fold cross-validation, we first divide the training set into n subsets of equal size. Sequentially one subset is tested using the classifier trained on the remaining n-1 subsets. Thus each instance of the whole training set is predicted once so the cross-validation accuracy is the percentage of data which are correctly classified.

The training set was used to train the SVM model while the independent test set was used to test the model performance. Ten order statistical characteristics (length, area, perimeter, etc.) provided effective classification features. A one-against-one multi-class support vector machine with kernel of RBF was trained by the transformed training pattern vectors and tested by the transformed independent test feature vectors. The image processing methods were implemented in Matlab R2011a and the SVM algorithms in LIBSVM.

V. Proposed Output

The processing of images and the careful selection of the species considered in this work for extracting features from rice granules considerably reduced the complexity of the grading problem.

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