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Rice grain classification using image processing technique

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***Abstract*---**Rice is one of the most widely consumed staple foods, especially in the Asian subcontinent. The quality and varieties of rice grains identification is necessary to avoid mislabeling of rice grain varieties. Mostly it has done by visually. In manual classifications features like Major Axis, Minor Axis, Perimeter, Area, Aspect Ratio, Eccentricity, and Shape Factor are measured by using the specialized tools like calipers and other specialized tools. These features are feed into the machine learning techniques. It is a time consuming process and also there is a chance for measurement errors. In this proposed work the rice images are captured by camera and some preprocessing is done on the image to enhance the image quality. Feature extraction is performed on the collected image using image processing method through MATLAB. The extracted features are given to the Support Vector Machine for classification. The proposed work provides an improved classification accuracy up to 96% with minimum process time.

***Keywords*---**Image Processing Technique, Geometrical Features, Support Vector Machine (SVM), Matlab, Rice classification.

Introduction

Food is one of the elementary necessities of every living being on earth. Rice is grown in many region across India. For about 65% of the people living in India, rice is a staple food for them. There are more than 40,000 different varieties of rice which is cultivated in over 100 countries and on every continent except Antarctica. The food grain types and their quality are speedily measured through visual inspection by human inspectors. In the present grain-handling system,

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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 and also to recognize the growing low quality defining characteristics for identification is desirable as fraudulent mislabeling of rice grain varieties. The farmers are affected by this manual activity and a new scientific era has emerged with great grain quality image processing instruments which can help in the categorization of grain samples and get an attractive price from consumers for the food industry, especially in Asia. Machine vision and image processing are widely used in biological and agricultural research with the improvement of computer technology and significant reduction of the cost of hardware and software of digital imaging. Many researches applied machine vision to estimate rice appearance quality inspection. There are various food varieties like rice, wheat, potato, soya bean and maze. The rice and wheat being commodity crops are important among all the grains. Grain shape is evaluated with length, width and the ratio of length and width of rice grains. Manually, the length and width of rice grains are usually measured by an inspector using a ruler or a micro-meter. For measuring length and width of even few seeds, by placing them in one grain tray and measure the length and width of each seed one by one, is very tedious task and takes lots of time. Outcomes from different inspectors or inexperienced inspectors may vary at an unacceptable range. So it is a neither objective nor efficient way in evaluating rice appearance quality relying upon manual method.

Literature Review

Kaur and Verma, have proposed computer vision techniques for grading of rice kernels based on their sizes (full, medium, half) [1]. The images are acquired using a digital camera having high pixel resolution. The camera is located at a position normal to the object. This algorithm is tested on images placed under different illumination & background color characteristics. The poor illumination effects were removed from the background and the image is converted to binary image, then successive erosion and dilation operations are performed to separate the touching kernels. By labeling the connected components the grains were counted and area of each connected components is found using region props, the maximum grain length found is used as a structuring element and morphological operations were performed to extract the grains which have length less than the structuring element. Then finally grading formulae is applied which gives the percentage of full length grains in the given sample. The grading formula & standards were acquired from the analysis procedure for grading rice followed in India. A.D.M. Hobson et al., proposed image processing techniques for identifying the different varieties of rice based on their size, shape and color [2]. They successfully identified eight different Japanese varieties of rice grains. A commonly used static imaging approach is adopted here to capture images of rice grains; Rice grains were positioned beneath the focus of a camera against a contrasting matte background. The image analysis was centered on the shape and texture features of grains. The following parameters were determined for the presented work. Average Length (La) is the simplest feature considered. This per pixel area and length were determined through calibration. Shape features using diameter lengths are devised from the recorded chain code of each shape. Here, using pixels on opposing halves of the chain code as opposing diameter distances provided a reasonable standard of internal diameter, Aspect Ratio (Ra) feature is defined as the ratio between the shortest (dmin) to the longest (dmax) diameters, Compactness Ratio (Rj) returns values from 0 to 1 for shapes that are elongated to perfectly compact (spherical). Using these features they successfully identified eight different Japanese verities of rice grains. R. Kiruthika et al., presented a work in which a digital imaging approach has been devised in order to investigate different types of characteristics to identify the rice varieties [3]. Two different common rice varieties were used in tests for defining. These include existing standards for rice length, area and aspect ratio features of rice. It successfully showed the effectiveness of compactness as its features. A.I.Pabamalie, H.L.Premaratne focused on providing a better approach for identification of rice quality by using neural network and image processing concepts [4]. This research has been done to identify the relevant quality category for a given rice sample and it was based on texture and color feature extraction are used to measure the quality of a rice sample. Mrutyunjay M S, Lakshmikant T M, et al. proposed, solution for quality evaluation and grading of rice grains using image processing techniques [5]. According to the size of the grain (full, half or broken) the grading of rice is done. Quality of food grains are rapidly assessed through visual inspection by human inspectors. The decision making quality of human inspector are subjected to external influence such as fatigue, vengeance, bias etc., Through the help of image processing technique the proposed work can overcome the above problem also it is a non-destructive and cost effective technique.

Proposed Methodology

The proposed system for identifying different varieties of rice grains is shown in figure 1.This constitutes of following steps, collecting input image, preprocess the input image, segmenting the input image, extract the features from the segmented image, classify the rice varieties based on extracted features by SVM classifier and also classify single image by manual algorithm.

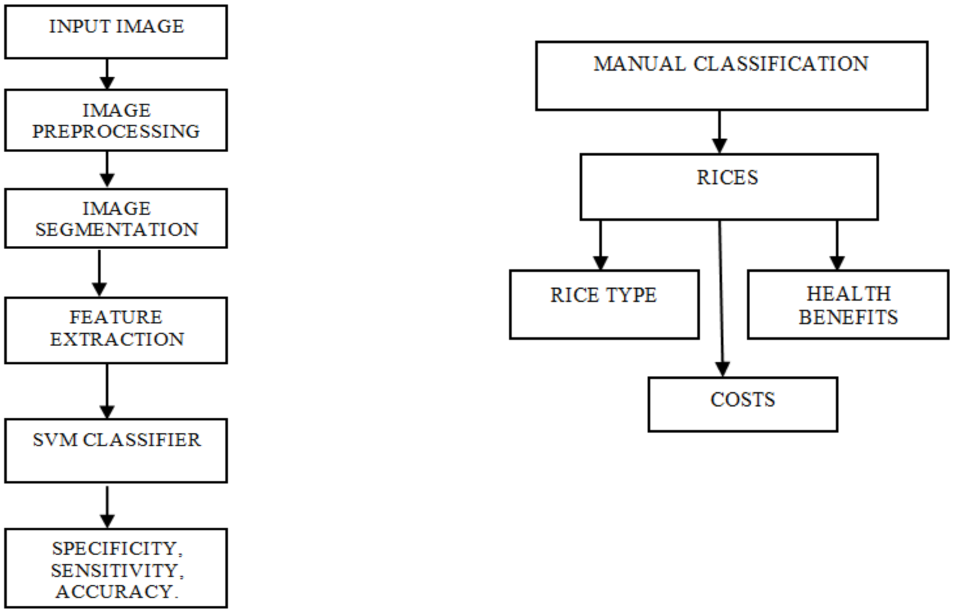

Figure 1. Proposed method

Input Image:
Rice grain images acquisition is considered as the most critical step of the grain recognition system, as it determines the final grain image quality, which has drastic effects on overall system performance. The images are acquired with a Smart Phone (Oppo). was used to capture images of rice grain samples .To collect data rice grain has been placed on a black background and image was captured at correct lighting. Figure 2 shows an acquired image.

Image Pre-processing:
Pre-Processing is done to improve the image data that suppresses unwanted distortions or enhances some image features, which is important for further processing. Median filter is used to remove noise from an image. Thresholding is done to separate the regions in an image with respect to the object, which is to be analysed .The separation of regions is based on the variation of intensity between the object pixels and the background pixels. Here to perform thresholding, Otsu's thresholding technique is implemented .The pre-processed image is shown in Figure 3.

Image Segmentation
Image segmentation is the process of partitioning a digital image into multiple segments. The goal of segmentation is to simplify and change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries in images. It is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics. Before segmenting Dilation-Erosion plays a major role in separating touching element. Dilation process follows erosion process, the goal of dilation is grow the eroded features to their original shape without rejoining the separated features. Erosion is applied to separate the

touching features of rice grain without losing the integrity of single feature. The segmented image is shown in Figure 4.

Feature Extraction:

Extraction of quantitative information from segmented images is deal with feature extraction. Object recognition and classifications is done based on various algorithms of morphological features some of the morphological features for classification purposes contains redundant, noisy and irrelevant information. The features which extracted from images of rice granules is Perimeter, Area, MinorAxis Length, MajorAxis Length, Eccentricity, and AspectRatio, using contour detection. The collected data is given to SVM for classification.

Area: Total number of pixels in rice grain image

$$Area = \Pi R_1 R_2 \quad (1)$$

(a) Perimeter:
Total number of pixels which makes the boundary of rice grains.

$$perimeter = 2\Pi\sqrt{(R_1^2 + R_2^2)/2} \quad (2)$$

(b) Eccentricity:

The eccentricity is calculated by fraction of the number of pixels between the major axis length and foci of the ellipse. The value of eccentricity is between 0 and 1.

$$\text{Eccentricity} = C/A \quad (3)$$

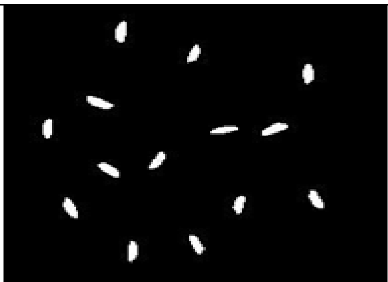

Figure2. Input Image

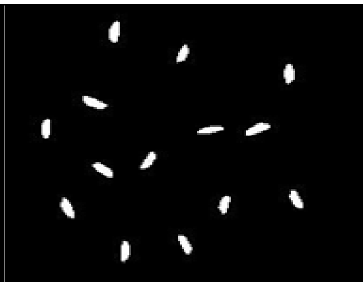

Figure3. Preprocessed Image

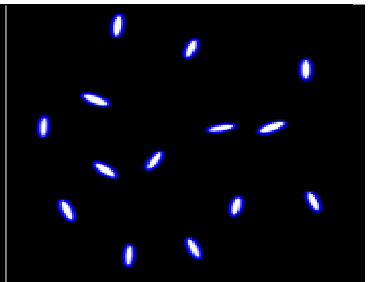

Figure4. Segmented Image

(c) Major Axis Length
It is defined as the length (in pixels) of the major axis of the ellipse.

(d) MinorAxis Length
It is defined as the ratio between the shortest (dmin) to the longest (dmax) diameters.

$$Ra = (2*R2)/(2*R1) \quad (4)$$

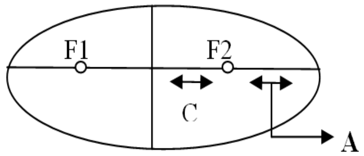

Figure 5. Eccentricity of the ellipse

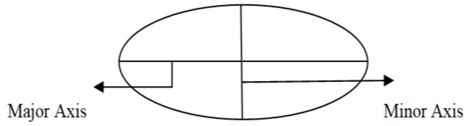

Figure 6. Major and Minor Axis

SVM Classifier

SVM are supervised learning models with associated learning algorithms that analyze data used for classification and regression analysis. An SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible. New examples are then mapped into the same space and predicted to belong to a category based on the side of the gap on which they fall. It can solve linear and non-linear problems and work well for many practical problems.

The objective of the support vector machine algorithm is to find a hyper plane in an N-dimension space (N-number of features)that distinctly classifies the data points. To separate the different classes of data points, there are many possible hyper-planes that could be chosen. The objective is to find a plane that has maximum margin, i.e. the maximum distance between data points of different classes. Maximizing the margin distance provides sum reinforcement so that the future data points can be classified with more confidence. It takes data as an input and outputs a line that separates those classes. Hyper planes are decision boundaries that help to classify the data points .Data points falling on either side of the hyper plane can be attributed to different classes. Also, the dimension of the hyper planes depends upon the number of features. The hyper plane for which the margin is maximum is the optimal hyper plane. SVM classifier is shown in Figure 8.

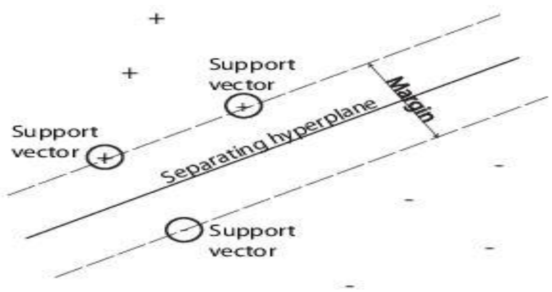

Figure: 8 SVM classifier

A confusion matrix is a summary of prediction results on a classification problem. The number of correct and incorrect predictions are summarized with count values and broken down by each class. This is the key to the confusion matrix. The confusion matrix is shown below. Accuracy, Sensitivity and Specificity are calculated from the confusion matrix**.**

$$CM = \begin{pmatrix} TP & FN \\ FP & TN \end{pmatrix}$$

$$Accuracy = \left(\frac{TP+TN}{TP+TN+FP+FN} \right)$$

$$Sensitivity = \left(\frac{TP}{TP+FN} \right)$$

$$Specificity = \left(\frac{TN}{TN+FP} \right)$$

SVM algorithms use set of mathematical functions known as kernel functions. The function of kernel is to take data as input and transform it into required form. Different SVM algorithms use different types of kernel functions. This function can be of different types. For example, Linear, Polynomial, Radial Basis Function (RBF), Sigmoid and non-linear. In this proposed work, Polynomial has been used as a kernel function.
Polynomial Kernel is popular in image processing. The equation is given below:

$$\mathbf{K(X_i, X_j) = (X_i \cdot X_j + 1)^d} \qquad (5)$$

where **d** is the degree of the polynomial

Manual Classification

In Manual Classification Algorithm, given a set of training examples and additional input image has been given and after processing the input image and feature of Rice Grain been detected. Detected result is compared with trained set of examples. Classifying data and detect the input rice type. Here, in single image which type of rice is present in an image is detected and also the number of rice grain is counted.

Results and Discussion

The confusion matrix of different training and testing images are shown below which shows the performance of the classification model.

	1	2	3	4	5	6
1	10	0	0	0	0	0
2	0	10	0	0	0	0
3	0	0	8	0	2	0
4	0	0	0	10	0	0
5	0	0	0	0	10	0
6	0	0	0	0	0	10

Figure. 9 Train image-80% and Test image-20%

	1	2	3	4	5	6
1	22	0	3	0	0	0
2	0	24	0	0	1	0
3	1	0	24	0	0	0
4	1	0	0	22	2	0
5	0	0	0	4	21	0
6	0	0	1	0	0	24

Figure 10 Train image-50%and Test image-50%

	1	2	3	4	5	6
1	25	0	10	5	0	0
2	0	28	3	7	2	0
3	0	4	28	1	0	7
4	0	0	1	36	3	0
5	0	3	1	13	23	0
6	0	1	10	0	0	29

Figure 11 Train image-20% and Test image-80%

In this paper, out of 6 varieties 5 varieties are classified correctly and the result is shown in table 1.The six varieties are, Basmati, Ponni, Pachaarisi, Sona mansuri, Sannalu, broken rice from this Pachaarisi is misclassified. The final result of the SVM is shown in the table given below.

Table 1
Results for SVM Classifier

Train (%)	Test (%)	No.of. Train images	No.of Test images	Sensitivity (%)	Specificity (%)	Accuracy (%)
80	20	40	10	100	96	96.8
50	50	25	25	100	96	96.7
20	80	10	40	62.5	72	70.4

It clearly shows that increasing number of training images increases the accuracy rate. Result of manual classification algorithm is shown in Figure.12. It gives the type of rice, cost, and health benefits of that particular type.

Figure 12. Classification Result

Table 2
Results Comparision

Year and ref. No.	datasets (Rice varieties)	No. of Features used.	Classifier	Accuracy (%)
2013 [9]	9	3	Neural Networks	92.00
2013 [10]	5	3	Multi-Class SVM	86.00
2014 [11]	5	3	Multilayer Perceptron	96.00
2015 [12]	5	3	Multilayer feed forward artificial neural network	92.23
2017[13]	9	5	k-Nearest Neighbor classifier.	89.23
Proposed work	9	8	SVM	96.63

Conclusion and Future Work

The Proposed image processing technique is developed to analyze the variety of rice. From, the obtained results ,it is proved that image processing technique is an efficient way to classify the rice types based on the extracted features and thus overcoming the disadvantages like time and cost and also reduce the manual errors. And also shows that SVM classifier gives higher accuracy when compare with other existing methods. In Future, the work can be extended by finding other quality features of rice grains and working on moving image

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