Grading of Rice Grain Samples Based on their Added Morphological Features Using Image Processing Technique

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Abstract

Rice is one of the most common food grain found all over the world. It is rich in carbohydrates and is a high nutritional supplement in food. Hence, it is referred as the staple food. Due to its high nutritional content, it is used for food. Its husk is used for feeding cattle. Its bran is used to extract oil in oil milling industries called as rice bran oil. Hence it is essential to ensure its quality before consumption. In the proposed methodology, the morphological features such as area, major axis length, minor axis length, perimeter and chalkiness of rice grain samples are extracted and then they are graded using Support Vector Machine (SVM) classifier for finding the quality of rice grain samples. The proposed method gives best qualitative analysis of rice grain samples. The performance of proposed method is evaluated using different test rice grain samples.

Keywords: *Support Vector Machine, Chalkiness.*

1. Introduction

The rice is the major crop found all over the world. It acts as the staple food for human beings. Its production is high in India compared to other countries in Asia. It is harvested after nearly 6 months. It is rich in carbohydrates and is found to have high nutritional value compared to other food grains [1], [2], [3].

In the field of trade and commerce, it has to be analysed for various parameters to maintain its quality. This is must to fix the value of the product. This is a challenging task to the merchants to sale as well as for farmers to have good profit for their production. The rice grains should have acceptable dimensional as well as morphological features. This includes its area, perimeter, chalkiness, nutritional value and moisture content it holds within it [4], [5], [6]. All these value added features are taken into consideration so that the food crop can be stored for a long time before transportation and consumption.

However, the rice grains have to undergo a variety of hard processes before its entry into the market. These activities have lead to the deployment for rice grain quality. It becomes broken during the process of milling and grinding. It becomes dirty while mingling with other objects. It loses its chalkiness as it passes through metals in milling machines. Due to rapid vibrations in grain filters, they become weakened and lose their solidity become powdery. Sometimes it gets adulterated with other unwanted particles. These adulterants may include other grains, dust, sand and small stone particles [7], [8], [9].

It is to be processed by an automatic machine vision system that ensures the filtration of good quality of rice grains that are acceptable in all aspects for trade and consumption by users.

The main objectives of this research are,

- To extract the rice kernels from background by using maximum variance method.
- To extract the geometrical features such as dimension (length, breadth), chalkiness, color from the rice kernels.
- To create database from the extracted parameters in a spreadsheet.
- To classify the rice kernels using multiclass Support Vector Machine (SVM).
- To grade the rice kernels into good or bad from the compared parameter values.

2. Morphological Parameters of Rice Grains

The Quality of rice is based upon many parameters such as color, size, shape and number of broken kernels. **Rice**

Quality inspection by humans is neither objective nor efficient. In view of this, automated rice quality inspection using machine vision is desirable. Recently, machine vision and image processing are widely used in biological and agricultural research. Many studies have applied in image processing for grain quality inspection. Machine vision (MV) is a rapid, economic, consistent and objective inspection and evaluation technique. A rice grain kernel has numerous and multi-dimensional morphological parameters. These parameters define the appearance, quality, taste and grading aspects that determine their existence in trading and consumption by humans [10], [11]**.** The various morphological parameters of rice grain samples are listed as follows:

AREA

The algorithm calculates the actual number of pixels inside and including the seed boundary.

MAJOR AXIS LENGTH

It is 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 is the distance between the endpoints of the longest line that could be drawn through the seed while maintaining perpendicularity with the major axis.

ECCENTRICITY

Specifies the eccentricity of the ellipse that has the same second-moments as the region. The eccentricity is the ratio of the distance between the foci of the ellipse and its major axis length. The value is between 0 and 1.

PERIMETER

It was the total pixel that constitutes the edge of object. It helps to locate the object & provide information about the shape of the object i.e. counting the number of ‘1’ pixel that have ‘0’ pixel of neighbor.

SOLIDITY

It describes the extent to which the shape is convex or concave.

CHALKINESS

Chalk is white opaque parts of rice grain. Chalkiness is a major concern in rice breeding because it affects the appearance quality of milled rice and is one of the key factors determining grain price. The formation of grain chalkiness is controlled by multiple factors, including starch synthesis, starch granule structure and arrangement and various external stresses during the grain-filling stage.

Chalky grains mean the grains at least half of which are milky white in color and brittle in nature.

3. Support Vector Machine (SVM)

SVM is related to statistical learning theory. SVM was first introduced in 1992. A support vector machine (SVM) is a new pattern classifier and it is a supervised machine learning algorithm which can be used for both classification and regression challenges. However, it is mostly used in classification problems. In this algorithm, we plot each data item as a point in n-dimensional space (where n is number of features you have) with the value of each feature being the value of a particular coordinate. Then, we perform classification by finding the hyper-plane that differentiates the two classes very well.

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 [12], [13], [14]. 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 [15].

The **support vector machine** (**SVM**) is then introduced as a robust and principled way to choose a hypothesis. The **SVM** for two-class classification is deals with in detail and some practical issues discussed. Finally, related algorithms for regression, novelty detection and other **data mining** tasks are discussed.

Linear SVM is the newest extremely fast machine learning (data mining) algorithm for solving multiclass classification problems from ultra large data sets that implements an original proprietary version of a cutting plane algorithm for designing a **linear support vector**

machine.

4. Proposed Methodology

4.1 Image Acquisition

The first stage of any vision system is the image acquisition stage. After the image has been obtained, various methods of processing can be applied to the image to perform the many different vision tasks. Performing image acquisition in image processing is always the first step in the workflow sequence because, without an image, no processing is possible. There are various ways to acquire image such as with the help of camera or scanner. Acquired image should retain all the features.

Image acquisition is the creation of digital image, typically from a physical scene. The co-ordinates of the pixels of the digital image in 2D form is given by 1st and 2nd index of an array and the 3rd index stores the RGB intensities for each co-ordinate. Each element of array then stores an unsigned 8-bit integer. Once the images are obtained, they were further processed using programs to extract whatever information is desired. Image is acquired by digital camera by applying a dark background without the interference of external light rays so that the attributes are able to appear on the image of the rice grain.

4.2 Image Smoothening

The original source input image may be added with external noises during image capture or else further image storage process. This may add salt and pepper noises to the image that results in the loss of information in the image. This causes image fading and blurring. The image components may not be clear enough to analyze the complete informative part of the image. Hence, median filtering is used to remove the salt and pepper noises as well as preserve the edges of the image compared to other filters.

4.3 Image Segmentation

Image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). The goal of segmentation is to simplify and/or 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 (lines, curves, etc.) in images. Essentially, in image partitions are different objects which have the same texture or color.

The image segmentation results are a set of regions that cover the entire image together and a set of contours extracted from the image. All of the pixels in a region are similar with respect to some characteristics such as color, intensity or texture. Adjacent regions are considerably different with respect to the same individuality. The different approaches are,

- By finding boundaries between regions based on discontinuities in intensity levels.
- Thresholds based on the distribution of pixel properties, such as intensity values.
- Based on finding the regions directly.

Thus the choice of image segmentation technique depends on the problem being considered. Based on different technologies, image segmentation approaches are currently divided into following categories, based on two properties of image.

Detecting Discontinuities

It means to partition an image based on abrupt changes in intensity, this includes image segmentation algorithms like edge detection.

Detecting Similarities

It means to partition an image into regions that are similar according to a set of predefined criteria; this includes image segmentation algorithms like thresholding, region growing, region splitting and merging.

4.4 Image Binarization

Image binarization is the process of converting RGB image to gray scale image. The image required is in RGB color. It is converted into gray scale image because it carries only the intensity information which is easy to process instead of processing three components R (Red), G (Green), B (Blue) to value reflecting the brightness of that pixel. One such approach is to take the average of the contribution from each channel: (R+G+B)/3. However, since the perceived brightness is often dominated by the green component, a different, more human oriented and the method is to take a weighted average. Ex: 0.3R + 0.59G + 0.11B.

4.4 Feature Extraction

Feature extraction is a special form of dimensional reduction. When the input data to an algorithm is too large to be processed and it is suspected to be very redundant then the input data will be transformed into a reduced representation set of features. Transforming the input data into the set of features is called feature extraction. If the features extracted are carefully chosen it is expected that the features set will extract the relevant information from the input data in order to perform the desired task using this reduced representation instead of the full size input.

Feature extraction is a challenging work in digital image processing. The feature extraction includes the extraction of features of grain numbers of rice grain samples. During this process, the dimensionality of data was reduced. Feature extraction or selection was a pivotal procedure considerably for grain recognition, which effects on design and performance of the classifier intensively. If the differences of selected features were assumed to be too large, a classifier with good recognition performance could have been easily constructed.

In pattern recognition and in image processing, feature extraction is the special form of dimensionality reduction. It is the method of capturing the visual content of images for indexing and retrieval. When the input data to an algorithm is too large to be processed and it is suspected to be notoriously redundant (much data but not much information) the input data will be transformed into a reduced representation set of features (also named feature vector).

If the attributes extracted are carefully chosen, it is expected that the attributes set will extract the relevant information from the input data in order to perform the desired task using this reduced representation instead of the full size image input. Feature extraction involves simplifying the amount of resources required to describe the large set of data. Visual attributes of images are of 4 types.

- Domain specific attributes which include chalkiness, neutrinos value.
- General attributes which include color, texture and shape. There are two types of attributes categorized under the shape attribute extraction
- Global attributes include moment invariant, aspect ratio and solidity.
- Local attributes include boundary segments.

In this approach the general attributes of the rice grains is extracted and that is shape including area, perimeter and chalkiness. These features are extracted by estimating the gradient of the image at every point to generate a gradient image and thresholding the gradient image to accomplish image segmentation. In this proposed method the three important features such as Area, Perimeter and Chalkiness is extracted.

4.5 SVM Classification

Lastly the extracted features of test grain samples are compared with extracted features of original rice grains by using SVM classifier tool. The compared features of the test image and the original image are tabulated for reference. The error difference (e) is tabulated for each and every feature of the note. The final decision depends on the error (e). If the error is less than threshold value, it is of good quality. If the error is above the threshold value, then it is found to be of poor quality.

Orange data mining tool

Description

Orange is a component-based visual programming software package for data visualization, machine learning, data mining and data analysis.
Orange components are called widgets and they range from simple data visualization, subset selection and preprocessing, to empirical evaluation of learning algorithms and predictive modeling.

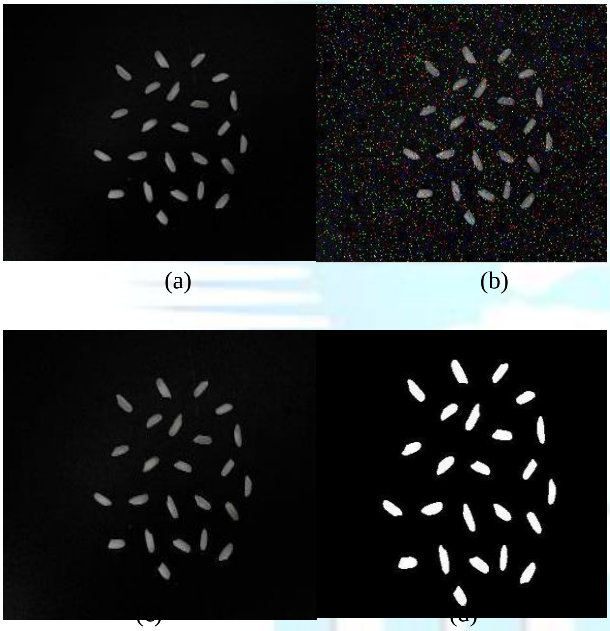
Visual programming is implemented through an interface in which work flows are created by linking predefined or user-designed widgets, while advanced users can use Orange as a Python library for data manipulation and widget alteration.

Features

Orange consists of a canvas interface onto the user places widgets and creates a data analysis workflow. Widgets offer basic functionalities such as reading the data, showing a data table, selecting features, training predictors, comparing learning algorithms, visualizing data elements, etc. The user can interactively explore visualizations or feed the selected subset into other widgets.

5. Results and Discussions

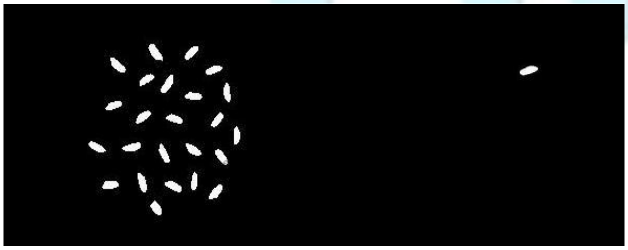
For testing, the rice sample images are acquired by the digital camera. The size of test input sample image is 3264*2448. The results are shown in Figure 1 and in Figure 2.



(a) (b)

(c) (d)

Figure 1. Resultant Images. (a) Input Rice grains Image (b) Noisy Image (c) Median Filtered Image (d) Segmented Image (Otsu Method)



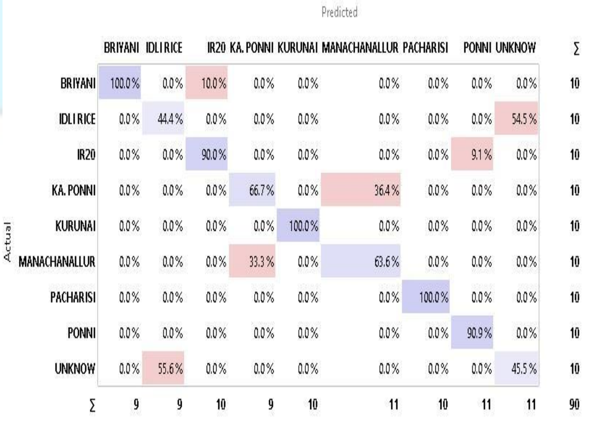
(a) **(b)**

Figure 2. Resultant Images. (a) Binary Image (b) Feature Extracted Image

After the feature extraction, the parametric values are found and then tabulated. The error is calculated between reference grain and the test grain sample for each feature. The conclusion is made based on the error value. If error value is less than 20 and is less than 300, then the grain is of good quality. Otherwise it refers to bad quality. Figure 5 (a) and (b) depicts the Classification of rice grain samples based on their extracted morphological features. Here, the input grain sample is compared with reference rice grain sample varieties. The category with greater percentage of classification is considered to be the best fit. Then, the grain samples are belong to that variety. The two figures Figure 3 (a) and Figure 3 (b) can be interpreted as follows.

Figure 3 (a) – Here, the matching percentage of input rice grain sample taken into account for classification. The rice grain variety that shows the maximum percentage determines the variety Classification. It displays both the actual and predicted percentage values.

Figure 3 (b) – Here, the number of instances(grains) of input rice grain sample that matches with the reference grain sample is taken into account for Classification and is displayed along with actual and predicted grain values.

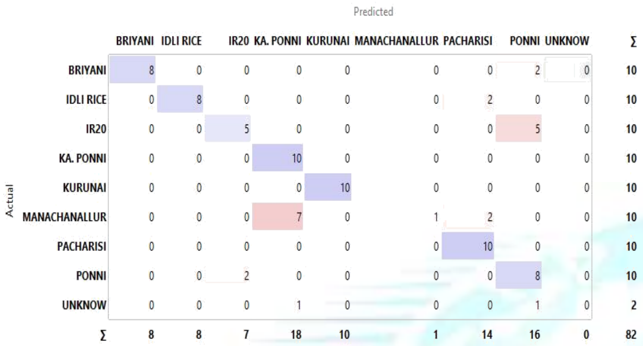


Predicted

Actual

	BRIYANI	IDLI RICE	IR20	KA. PONNI	KURUNAI	MANACHANALLUR	PACHARISI	PONNI	UNKNOW	∑
BRIYANI	100.0%	0.0%	10.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	10
IDLI RICE	0.0%	44.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	54.5%	10
IR20	0.0%	0.0%	90.0%	0.0%	0.0%	0.0%	0.0%	9.1%	0.0%	10
KA. PONNI	0.0%	0.0%	0.0%	66.7%	0.0%	36.4%	0.0%	0.0%	0.0%	10
KURUNAI	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	10
MANACHANALLUR	0.0%	0.0%	0.0%	33.3%	0.0%	63.6%	0.0%	0.0%	0.0%	10
PACHARISI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	10
PONNI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	90.9%	0.0%	10
UNKNOW	0.0%	55.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	45.5%	10
∑	9	9	10	9	10	11	10	11	11	90

Figure 3 (a) SVM Classified confusion matrix output for given samples



Predicted

Actual

	BRIYANI	IDLI RICE	IR20	KA. PONNI	KURUNAI	MANACHANALLUR	PACHARISI	PONNI	UNKNOW	Σ
BRIYANI	8	0	0	0	0	0	0	2	0	10
IDLI RICE	0	8	0	0	0	0	2	0	0	10
IR20	0	0	5	0	0	0	0	5	0	10
KA. PONNI	0	0	0	10	0	0	0	0	0	10
KURUNAI	0	0	0	0	10	0	0	0	0	10
MANACHANALLUR	0	0	0	7	0	1	2	0	0	10
PACHARISI	0	0	0	0	0	0	10	0	0	10
PONNI	0	0	2	0	0	0	0	8	0	10
UNKNOW	0	0	0	1	0	0	0	1	0	2
Σ	8	8	7	18	10	1	14	16	0	82

Figure 3 (b) SVM Classified confusion matrix output for given samples

Table 1 shows the classification of rice grain samples.

Table 1. Classification of Rice Grain samples

Input Sample	Area	Perimeter	Chalkiness	Sample Detected
1	10867	468.4163	0.9787	Briyani
2	9722	428.8011	0.9677	Ponni
3	4589	269.9066	0.9780	Idli
4	5245	308.6346	0.9738	Pacharisi
5	6949	374.3503	0.9621	Manachanallur
6	8456	312.7256	0.9345	Kurunai
7	6735	289.2983	0.9478	KA.Ponni
8	9678	456.2389	0.9613	IR20
9	7856	423.9468	0.9346	Manachanallur
10	8957	467.3875	0.9467	Briyani
11	3756	424.2947	0.9867	Kurunai

6. Conclusions

In this paper, rice grain sample quality analysis is proposed using image processing technique. The input test images are converted into gray scale images. After the gray scale conversion, the edges are detected by using segmentation. The earlier works have been implemented only with dimensional values. But this proposed work has taken into account three parameters-Area, Perimeter and Chalkiness where Chalkiness is considered to be the visual perception attributes of the rice grain samples.

Then, the features are extracted from the segmented output images. Extracted features of test images are compared with reference images to find the rice grain type. Based on the simulation results the classification of rice grain samples is done using SVM Classification tool.

References

[1] Bhavesh Prajapati.B,Sachin Patel, (2013)

"AlgorithmicApproach to Quality Analysis of Indian Basmati Rice Using Digital Image Processing", International Journal of Emerging Technology and Advanced Engineering, vol. 3, pp. 503-504.

[2] Dhara Desai,Prof.Nikunj Gamit,Prof.kinjal Mistree, (2015) "Grading of Rice Grains Quality using Image Processing", International Journal of Modern Trends in Engineering and Research, vol. 2, pp. 395-400.

[3] Harpreet Kaur,Baljit Singh, (2013) "Classification and Grading Rice Using Multi-Class SVM", International Journal of Scientific and Research Publications, vol. 3, pp. 1-5.

[4] Jagdeep Singh Aulakh,Banga.V.K, (2012) "Percentage Purity of Rice Samples by Image Processing", International Conference on Trends in Electrical, Electronics and Power Engineering, vol. 2, pp. 102-104.

[5] Jayanthi.A,Yamini Devi.B, (2015) "Percentage Purity of Rice Samples by Image Processing", Indian Journal of Engineering, vol. 2, pp. 90-94.

[6] Kiruthiga.R,Muruganand.S,Azha Periasamy, (2013) "Matching of Different Rice Grains using Digital Image Processing", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, vol. 2, pp. 2937-2941.

[7] MousaviRad.S.J,Akhlaghian Tab.F,Mollazade.K, (2012) "Design of an Expert System for Rice Kernel Identification using Optimal Morphological Features and Back Propagation Neural Network", International Journal of Applied Information Systems, vol. 3, pp. 33-37.

[8] Mrutjaya.M.S,Lakshmikanth.T.M,Raghavendra.T.K,Praveen Naik.P, (2014) "Quality Analysis of Rice Grains Using Image Processing Techniques", International Journal of Combined Research & Development, vol. 2, pp. 16-18.

[9] Neelagam.p,Abirami.S,VishnuPriya.K,RubalyaValantina.S, (2013) "Analysis of Rice Granules using Image Processing and Neural Network", IEEE Conference on Information and Communication Technologies, vol.2, pp. 879-884.

[10] Pazoki.A.R,Farokhi.F,Pazoki.Z, (2014) "Classification of Rice Grain Varieties using Two Artificial Neural Networks(MLP and NEURO-FUZZY), vol. 1, pp. 336-343.

[11] Rahul Birla, Ajay Pal Singh Chauhan, (2015) "An Efficient Method for Quality Analysis of Rice Using Machine Vision System", Journal of Advances in Information Technology, vol. 6, pp. 140-145.

[12] Rajlakshmi Ghatkamble, (2016) "Matching and Grading of Different Varieties of Rice Grains through Digital Image Processing", International Journal of Computer Science Trends and Technology, vol. 4, pp. 95-99.

[13] Rubi Kambo,Amit Yerpude, (2014) "Classification of Basmati Rice Grain Variety Using Image Processing and Principal Component Analysis", International Journal of Computer Trends and Technology, vol. 11, pp. 80-85.

[14] Veena.H,Latharani.T.R, (2014) "An efficient method for classification of rice grains using morphological process", International Journal of Innovative Research in Advanced Engineering, vol. 1, pp. 218-221.

[15] Vidya Patil, Malemath.V.S, (2015) "Quality Analysis and Grading of Rice Grain Images", International Journal of Innovative Research in Computer and Communication Engineering, vol. 3, pp. 5672-5678.