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# A REVIEW ON ANALYSIS AND GRADING OF RICE USING IMAGE PROCESSING

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**ABSTRACT**

This review paper presents the recent developments of image processing and machine vision system in an automated rice grading system. In agricultural field, the efficiency and accuracy in grading process is very essential to increase the productivity of the yield. Rice is cultivated in many regions across India. Rice is a staple food for about 65% of the Indians. There are more than 40,000 different varieties of rice which is cultivated in all continents except Antarctica. The food quality is becoming a major issue in health care. It is tedious for people to analyze the grades and quality in the market. The rice varieties and their quality are assessed through visual inspection by food quality Managers. The decision making capabilities of food quality Managers are subjected to an external influences. In this paper, image processing techniques are implemented to automate the process which overcomes the drawbacks of manual process. Here, various procedures are reviewed to obtain the percentage, quality of rice grains based on its size.

**Keywords:** rice classification, machine vision, feature extraction, morphological features, quality analysis, neural networks.

## INTRODUCTION

Rice is a source of vitamins and minerals. It is good in nutrition values, low in fat and has no additives. It is the staple food for the 80% of the population around the world. It provides energy and is rich in nutrients and has a low glycemic index (Bernas, 2011). India is the second largest producer of rice in the world, therefore enforcing the use of rice grain standards to ensure that producers get paid maximum value for their grain according to the quality of the grain. The analysis of grain type, grading and their quality attributes are performed manually by skilled personnel. These methods are prone to many problems such as, it is highly subjective, influenced by human factors and working conditions that results in inconsistent results. Also, the rate of cleaning and recovery of salvages is limited (Kaur Gl., *et al*. 2013). Non-destructive quality evaluation of food products is an important vital factor in food/agricultural industry. Non-destructive quality evaluation of food products for various parameters defines quality of these product (e.g. size, shape, color, texture, external defects, etc.) and calculated with the help of image processing without affecting physical structure of food products (Jain K R., *et al*. 2009). Rapid advances in hardware and software for digital image processing have motivated several studies on the development of computer vision systems to evaluate quality of diverse raw and processed foods (Abdullah M Z., *et al*. 2000). Advancement in computer technology leads to use these in the domain of food processing like grading, sorting and quality inspection (Parmar R R., *et al*. 2011).

When both colour and morphological features are combined, results are much more accurate. In addition, texture features can be added to improve the classification accuracies. Classification accuracies are very high when different features of the tested varieties are used (Paliwal J., *et al*. 2001). Artificial neural networks have many advantages over fuzzy classifiers and statistical classifiers (Mazumdar S., *et al*. 2000). Back-propagation neural network is the most popular choice for classification of agricultural products (Jayas D S., *et al*. 2007).

## RICE GRADING

Rice grading is a process of sorting rice and assign into its classes or grade. The grading of rice plays important role in the determination of rice quality method applied in the rice production industry and its subsequent price in the market. The grade and price of rice is largely determined by its quality, genetic, agronomic and commercial value. The manual and visual methods are still employed by the rice industry today. The trained human classifiers can perform quality inspection, this method is highly subjective, susceptible to fatigue, and is affected by human psychological limitations leading to erroneous judgment.

As a result from research carried out, most of the researchers such as (Verma B., *et al*. 2010) have used image processing and Neural Network method in their work. In their work, image processing have been used to extract the features in rice and based on these features extracted, rice is classified. Other researchers such as by Guangrong (2011), uses the image processing method to study the chalk feature which is an important feature for rice classification and grading. Zhong *et al*., (2011) used the Wavelet packet and support vector machine to differentiate rice kernels.

While Yao.Q *et al*., (2009), used several methods in analyzing rice grains length and width such as contacting angle analysis method to separate contacting rice grain, Multi-threshold method based on maximum entropy for chalkiness features, Minimum enclosing rectangle (MER). Shiddiq. D.M *et al*., (2011) used image processing and ANFIS for degree milling. Yao.M *et al*., (2010), used the Computer Vision for capturing image and principle component analysis (PCA) and regression analysis is used to detect head rice, while Wee. C.Y. *et al*.,

(2007), used Neural Networks with trained Multilayer Perceptron (MLP) Zernike moment and feature extractor used by Line sensor for Capturing Image.

Neural Networks or neural net (NN) or known as Artificial Neural Networks (ANN) is a technique that inspired by the way biological nervous system works to simulate the learning process. Normally NN is configured for a specific application such as clustering, grading or pattern recognition, prediction system and function approximation through a learning process. In NN, there are four architectural forms that are feed-forward networks, feedback networks, network layer and perceptrons (R C Chakraborthy, 2010). Another definition for NN is a processor of information consisting of simple processing elements connected together [JM Bishop., *et al*. 1991]. Uhrig, R.E., (1995) stated that NN model represents a human brain. Nodes in NN represent the neurons and a link represents a synapse.

According to Paliwal.J, *et al.,* (2001) if the relationship between the inputs and outputs is difficult to translate into the mathematical function but if some input and corresponding output values are known, it is suitable to use NN to solve the problem. Based on the previous works, NN is the most popular method used in rice grading. (Wee C Y., *et al*. 2007) used the same method to classify rice but for capturing the image.

**METHODOLOGIES**

Guzman. J.D *et al*., (2008) proposed the use of a machine vision system and multilayer neural networks for automatic identification of the sizes, shapes, and variety of samples of 52 rice grains belonging to five varietal groups of rice in the Philippines. Thirteen grain features extracted from each sample image using multilayer neural networks. The Artificial Neural Networks classifiers developed were able to identify the grain sample sizes and shapes at overall average accuracies of 98.76 per cent and 96.67 percent, respectively. The individual rice varietal types of the lowland irrigated, lowland rainfed, saline prone, cool elevated, and upland rice groups were classified at average overall accuracy of 85.81, 94.58, 96.16, and 97.39 percent respectively. An average accuracy of about 70 percent was obtained when the sample images of the 52 varieties were included in the group classification.

Verma, B., (2010) proposed relatively faster computer vision system to analyze and sort rice kernels. A series of measurements were done using image processing techniques namely smoothing, binarization, etc. on three varieties of Indian rice namely Markfed Supreme, Markfed Golden (export quality),Hafed Basmati. The extracted parameters area, perimeter, maximum length, maximum width, compactness and elongation from processed images were measured. The rice varieties are classified based on shape difference, cracked, chalky, broken and damaged kernels with an accuracy ranging from 90-95%.

Rad.S.J.M, *et al.,* (2011), proposed an algorithm for classifying five different Iranian varieties of rice, using the color and texture features. The proposed algorithm consists of several steps: image acquisition, segmentation, feature extraction, feature selection, and classification. Sixty color and texture features were extracted from rice kernels. The set of features contains redundant, noisy or even irrelevant information, so features were examined by four different algorithms. Finally twenty-two features were selected as the superior ones. A back propagation neural network-based classifier was developed to classify rice varieties. The overall classification accuracy was achieved as 96.67%.

MousaviRad. S.J. *et al.,* (2012), proposed an algorithm for identifying five different varieties of rice, using the morphological features. The proposed algorithm consists of several steps: image acquisition, segmentation, feature extraction, feature selection, and classification. Eighteen morphological features were extracted from rice kernels. The set of features contains redundant, noisy or even irrelevant information, so features were examined by four different algorithms. Finally six features were selected as the superior ones. A back propagation neural network-based classifier was developed to classify rice varieties. The overall classification accuracy was achieved as 98.4%.

Aulakh. J.S. *et al.,* (2012), have proposed image processing techniques for grading of rice samples based on their sizes. The images were captured using a Flat Bed Scanner (FBS) and then converted to binary image to which they apply morphological operations and by the objects features were extracted by finding the properties of the connected components and get the information regarding connectivity, image size, numobjects, pixelidxlist. The stem graphs were plotted and the grain kernels which have lesser values than a threshold were discarded.

Ajay.G *et al.,* (2013), have proposed a quality evaluation of rice grains using morphological methods. Among the milled rice samples, the quantity of broken kernels are determined with the help of shape descriptors like length, width, and perimeter are considered. Once the geometric features are extracted, the lengths of the grains are obtained using a threshold value for the length. The grains whose values are less than 75% of the normal grain size are considered as broken.

Silva.C.S *et al.,* (2013), proposed a classification of rice seeds obtained through a machine vision combined with neural network architecture. A total of 9 different rice verities were considered for the study. Algorithms were developed to extract thirteen morphological features, six color features and fifteen texture features from color images of individual seed samples. A different neural network models were developed for individual and combined feature set. High classification accuracy was given by textural features than morphological and colour features. Out of these feature sets, texture features produced high classification accuracy. Especially texture features obtained from red colour band produced better predictions. Improved classification accuracies were obtained when the network trained with optimal data set. The combined feature model produced the overall classification accuracy of 92%.

Kaur, H. *et al.,* (2013), have proposed a technique for classification and grading of rice kernels using multi-class SVM. The images were captured and pre-processed to remove noise. The images subdivided into its parts by using segmentation methods to convert into binary images. The percentage of Head rice, broken rice and brewers in rice samples are determined using geometric features. Multi-class SVM classified rice kernels by analyzing the shape, chalkiness and percentage of broken kernels accurately more than 86%. Based on the results, grains were classified as grade A, grade B, grade C.

Maheshwari, C.V. *et al.,* (2014), proposed image processing techniques for identifying varieties of rice based on their shape and size. Images of a sample grains were captured using a digital camera, the edge detection operation were performed to calculate the Geometric parameters like calculating area, major axis length, minor axis length and eccentricity for counting normal seed and foreign element for a given sample. The method proposed in the paper is based on non-destructive machine vision based technique for certification of quality of rice seeds. Based on these parameters, rice seeds are graded into three parts namely normal, long and small rice seed.

The Scaled Conjugate Gradient Training based Neural Network is proposed for grading rice granules with the accuracy of 98.7%. is proposed by Abirami, S. *et al.*, (2014). The developed Neural Network can be adapted for grading added grains and foodstuffs as well. Grading of Basmati rice seeds is performed by means of image processing. Calculations of perimeter, minor axis length, area, major axis length are calculated. The rice granules are graded depending on the dimension of grains present in the sample. Number of images taken for training and testing has been restricted due to time constrained. From the overall 22 samples were classified as grade 1, 20 samples were graded as grade 2 and 34 samples were graded as grade 3. When there is no overlap of grains, it is able to classify well for all the grains and the accuracy is found to be 98.7%. If there is overlap of grains, the Neural Network is not able to classify correctly and in this case the accuracy is found to be 91.3%.

Chaugule. A. *et al.,* (2014), proposed algorithm for classification of grains based on texture, shape, and texture-*n*-shape features. The resulted accuracy achieved is 82.61%, 88.00%, and 87.27% with texture, shape, and texture-*n*-shape features, respectively. The most satisfactory results were delivered by the shape feature set. Texture feature set gave lower accuracy than all the other sets because the difference between the features (contrast, energy, and homogeneity) of different varieties is negligible. It can be concluded that invariant moments, standard moments, and central moments of shape have a significant role in discriminating the paddy varieties.

Siddagangappa. *et al.,* (2014), An automated system is introduced which is used for grain type identification and analysis of rice quality (i.e. Basmati, Boiled and Delhi) and grade (i.e. grade 1, grade 2, and grade3) using Probabilistic Neural Network. This paper proposes a model that uses color and geometrical features as attributes for classification. The grading of rice sample is done according to the size of the grain kernel and presence of impurities. Good classification accuracy is achieved using only 6 features, i.e. mean of RGB colors and 3 geometrical features. The total success rate of type identification is 98% and total success rate of quality analysis and grading of rice is 90% and 92% respectively.

Pazoki, A.R. *et al.,* (2014), proposed classification of 5 main rice grain varieties grown in different environments in Iran. Classification was made in terms of 24 color features, 11 morphological features and 4 shape factors that were extracted from color images of each grain of rice. The rice grains were then classified according to variety by multi-layer perceptron (MLP) and neuro-fuzzy neural networks. The average accuracy amounts for classification of rice grain varieties computed 99.46% and 99.73% by MLP and neuro-fuzzy classifiers alternatively.

A digital system for Agmark Standardization of Rice has been proposed by Tanck. P. *et al.,* (2014), on the basis of machine vision. The paper illustrates a new method, which helps in extracting the morphological features of grains like area, perimeter and length etc. of an object. The designed system was found to classify the grains with an accuracy of over 90% at a nominal cost.

Mahajan. S. *et al.,* (2014), have proposed the problem of Non-Uniform Illumination in an image which show their effects in the process of extracting objects from the background and also cause segmentation errors due to non-uniform illumination of the image to analyze the quality of rice grains in rice industry and also highlighted the related work of researchers to eradicate the problem related to quality analysis of rice grains. The effects of the Non-Uniform Illumination are corrected by applying Top-Hat Transformation on rice grain images and the various parameters are calculated for the quality analysis of Indian Basmati rice grains so as to classify them into Normal, Small and Long rice seeds.

B.S. Anami. *et al.,* (2015), proposed a method for recognition of paddy varieties from bulk paddy grain image samples based on color texture features extracted from color co-occurrence matrices. The color texture features are extracted from H, S and I color planes and their combinations. The color texture features are used for recognition of 15 paddy varieties. The reduced feature set of the HS plane includes Energy, Entropy and Correlation features from Hue plane and Energy, Entropy, Contrast, and Correlation features from Saturation plane. The paddy grain images are recognized using a multilayer feed-forward artificial neural network. The considered fifteen paddy varieties have given the recognition accuracy of 92.33%.

Neelam *et al.,* (2015), proposed the computer vision system, designed for identification and classification purpose. In this, training algorithm was based on using Levenberg Marquardt and performance is based on the mean square error. The network was trained, validated, tested on given parameters with accuracy approximately 89.7%.

Vidya *et al.,* (2015), proposed grading of rice grains based on morphological techniques using image

processing. The images are initially subjected to preprocessing and the individual grains are segmented. The geometric features of the grain such as area, major axis length and the minor axis length are extracted and classified as grade 1, grade 2 and grade 3with an average accuracy of 93%.

Wanputri *et al.,* (2015), proposed the methods used for rice grading using image processing. Various approaches have been applied by previous researchers have classified rice based on special features such as shape, length, chalkiness, color and internal damage of rice. The system is tested using testing image to measure the accuracy of the system. The result gain is 46.6 percent when the image is trained with 285 items of rice images.

## COMPARISON BETWEEN EXISTING METHODS

This paper presents recent advancements of using computer-vision based systems for classification of rice varieties. A computer-vision application using image processing techniques involves five basic processes such as image acquisition, preprocessing, segmentation, object detection and classification. This survey highlights these approaches in context of rice grading practices and summarizes their relevancy to precision farming. Table-1 summarizes research that has been reported on methods developed using image processing techniques and provides an assessment of techniques used in terms of accuracy for practical usability in an agricultural context.

**Table-1.** Comparison with existing rice grading classification methods.

| References | Data set | Pre-Processing techniques | Extracted features | Color spaces | Training | Criteria | Average accuracy |
|---|---|---|---|---|---|---|---|
| Guzman. J.D *et al.,* (2008) | 52 rice grains | Nil | Morphological | RGB | Multi-Layer Perceptron | Accuracy | 70% |
| Verma, B., (2010) | 15 to 20 samples | Smoothing | Watershed segmentation | Grayscale | Multi-Layer Perceptron | Accuracy | 90%-95% |
| Rad.S.J.M, *et al.,* (2011) | 5 rice varieties | Threshold | Color and texture | Grayscale, RGB,HSV, and L*a*b* | feed-forward neural network | Accuracy | 96.67%. |
| MousaviRad.S.J. *et al.,* (2012) | 5 rice varieties | Threshold | morphological features | grayscale | feed-forward neural network | Accuracy | 98.40% |
| Ajay.G *et al.,* (2013) | Mixed rice samples | Threshold | morphological features | grayscale | Nil | Recognition rate | 75% |
| Silva.C.S *et al.,* (2013) | 9 rice varieties | Filter, dilation, erosion | Morphological, colour and texture | RGB | Multi-Layer Perceptron | Accuracy | 92% |
| Kaur, H. *et al.,* (2013) | 4 to 5 samples | Maximum variance method | Chalky volume, shape, purity | RGB | Multi-Class SVM | Accuracy | 86% |
| Abirami, S. *et al.,* (2014) | 53 samples | Thresholding, Edge detection | morphological features | grayscale | LScaled Conjugate Gradient Training | Accuracy | 98.70% |
| Chaugule.A. *et al.,* (2014) | 4 paddy varieties | Image segmentation | texture, shape, and texture-*n*-shape | RGB | Levenberg-Marquardt | Accuracy | 86% |
| Iman Golpour, *et al.,* (2014) | 5 rice varieties | Image segmentation and noise reduction | Color | RGB, HSI, HSV | Levenberg-Marquardt | Accuracy | 98.80% |
| Siddagangappa. *et al.,* (2014) | 3 rice varieties | Image segmentation | Morphological | RGB | Nil | Accuracy | 92% |
| Pazoki, A.R. *et al.,* (2014) | 5 rice varieties | Image segmentation | Morphological, shape | RGB, HSV, YCbCr and I1,I2,I3 | Multi-Layer Perceptron | Accuracy | 98% |
| Tanck.P. *et al.,* (2014) | 5 samples | Background removal, contrast | Morphological | Grayscale | Nil | Accuracy | 90% |
| B.S.Anami. *et al.,* (2015) | 15 paddy varieties | color co-occurrence matrices | Color, Texture | HIS | multilayer feed-forward artificial neural network | Accuracy | 92.33% |
| Neelam *et al.,* (2015) | 4 rice varieties | Image segmentation | Morphological, color | RGB | Levenberg-Marquardt | Accuracy | 89.70% |
| Vidya *et al.,* (2015) | 3 rice varieties | Image segmentation | Geometric | RGB | Nil | Accuracy | 93% |
| Wanputri *et al.,* (2015) | 285 rice images | Image segmentation | Color, shape | RGB | supervised learning | Accuracy | 46.60% |

## CONCLUSIONS

This paper presented a survey on using image processing techniques used in an automated rice grading systems in an agricultural context. Most of the work in this field uses image processing methods like background subtraction, feature extraction and training and classification. An image processing based solution is also explored from the published literature for automatic rice recognition, classification and recognition of foreign particles from images using color and texture features. There is a necessity to select the most appropriate techniques to assist decision-making. The image processing techniques have been used widely across agricultural contexts. It can be an effective tool in food quality assessment. There are number of applications and methods to select for implementation to real time needs. While the existing rice classification methods sustaining the needs of today, there are more and more new methods are evolving to assist and ease the rice classification. It is evident that these approaches will all contribute to the wider goal of optimizing global food production.

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