Assessment of Quality of Rice Grain using Optical and Image Processing Technique

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***Abstract*— Rice is the most favorable and most consuming food for human being in all over the world and researchers are working to improve the quality of rice. The quality measurement of rice is also important because it is consumed as food as well as it is used for milling process in the national and international market. Many researchers have already worked on the quality of grain and proposed different techniques to characterize the quality of rice. Chalky is whiteness part in the rice grain and it is one of the most important parameter that is used to evaluate the quality of rice grain. We proposed an image processing technique using extended maxima operator to detect the chalky area in the rice. We also calculated the dimensions and color to classify rice grains. The experiment was performed on 22 sample images of rice grain to test the proposed method and was validated using visual inspection.**

Keywords—Extended maxima Operator; Chalky; Quality assassment; optical; image processing

I. INTRODUCTION

Rice is the most consumed and most favorite food in the world. It is easily available in all over the world. The rice grains are also ideal for the long term storage. It is used to produce number of value-added products for human beings for examples cereals, flour and kheer etc. The main rice producing countries are China, India, Indonesia and Vietnam as well as Pakistan is also largest producer of rice in all over the world [1]. The rice producing countries are competing among themselves mainly on the basis of rice quality. Many countries are trying to improve the quality of rice. Thus the measurement of rice quality is equally essential as well as quality of rice is an important requirement for today's market to protect the consumers from substandard product [2]. This research work is related to the quality measurements of rice grain.

As new technology growing, people are adopting new technology as compare to using old technology [3]. In the previous research, researcher proposed different technologies in order to find the best quality of rice grain. The inspection of quality rice using naked eye is in efficient, so therefore for analyzing the quality and grading of rice proposed many algorithms and technologies. The classification of rice can be obtained by using computer vision and machine vision techniques.

In this article, we have analyzed the quality of rice grain using image processing technique based on their physical properties including length, width, area, aspect ratio, color features and chalky in the rice grain.

II. RELATED WORK

Many researcher worked to find out the quality of rice grain. Leng Yan et al (2004) [4], worked on the rice grain and found out the best quality to measuring the length, width as well as chalky of the grain. In their work, they used Vernier caliper to measure the length and width of rice with the precision of 0.02mm and calculated the weight of rice using LA114 type analytical balance (0.0001 g). Once the data of rice was calculated the data was analyzed using Excel software. This method is very complicated and time consuming method. Changming Sun et al (2007) [5], used wheat grain for quality assessment. They used stereo vision technique to find out the size (length, width and thickness) of grain and detect the presence or absence of crease in the sample of the wheat grain. Crease is basically a line or black spot that are present in the grain. Stereo vision is basically extracting of 3D information from digital images. Jagdeep Sing & Banga (2012) [6], have proposed a method in order to find the quality of rice grain. They graded rice based on their size. Images of rice grain were captured by using flatbed scanner (FBS) and high resolution camera was also used. The images were captured by using outside source then the RGB image was converted into binary to which the morphological operations were applied. Finally by finding the properties of the connected components in the image, the object features were extracted. Neelamegam. P et al (2013) [7], analyzed the quality of Rice based on image processing technique. They proposed a method based on neural network in order to classify the Rice. Vinita Shah et al (2103) [8], proposed a methodology based on image processing and multi-layer feed forward neural network technique which achieved high degree accuracy. The count large seed as well as small and also find out the features of the Rice grain by using this methodology. Nandini Sidnal et al (2013) [9], proposed a model of quality grade testing and built an identification model which is based on appearance features such as the morphological and color using image processing and neural network. The morphological and color features are presented to the neural network for training purposes. The trained network is then used to identify the unknown

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grain types, impurities and its quality. Sheetal Mahajan, Sukhvir Kaur (2014) [10], proposed a method to find out the quality of Rice grain by using top-Hat transformation. In this method, they analyzed different features of Rice grain. Top-Hat transformation was used to correct the information of Non-uniform illumination.

III. MATERIAL AND METHODOLOGY

MATLAB software was used to write the programming code. The block diagram in fig. 1 explains the work flow.

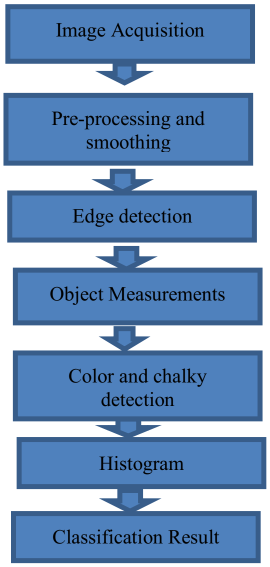

Fig. 1. Work Flow Block diagram

A. *Image Analysis and Processing*

We have acquired rice grain images from HP Scan jet G2410 with black background under best illumination scenario. The saved images in Jpeg format are then used for image processing. The scanned image are show in fig. 2 (a).

B. *Pre-processing and Smoothing*

Preprocessing and smoothing means image is filtered from external factors (such as noise, dust etc.) In this paper we are using Gaussian filter for removing noise. The mathematical equation of Gaussian filter is given in equation 1.

$$G(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{x^2}{2\sigma^2}} \tag{1}$$

Where,

$\sigma = \text{sigma}$ (Increasing the value of sigma the result will be more blurred). It is assumed that mean distribution value x is centered (x=0).

C. *Edge Detection*

The canny edge detector is applied on gray scale images. It is a good approach for detecting the edges and has the ability to minimize the localization error. It can detect the weak edges as well. However, in this research work sobel edge detector is also used to find out area and other features of an object that are shown in fig. 2(c).

D. *Morphological Features*

Following features were extracted from rice sample images:

Area: The total number of pixel covered by grain.

Major axis Length (L): The longest line that can be drawn through an object is called major axis length.

Minor axis Length (l): The longest line that can be drawn through an object, perpendicular to the major axis.

Length (l): Rice grain is enclosed in rectangular bounding and the length of this rectangle bounding box gives the length.

Width (W): Width of rectangle bounding box is known as width

E. *Chalky*

Chalky is basically the whiteness part in the rice grain. Chalky does not effect on the taste of food but it does effect on the milling process in the nation and international market.

Percentage of Chalky: Percentage of chalky is calculated using following formula.

$$\text{percentage of chalky} = \left(\frac{\text{Actual area of grain - area of chalky portion}}{\text{Actual area of grain}} \right) * 100$$

1) *Detection of Chalky in the Rice Grain*

Chalky is the most important parameter for identifying the best quality in the rice grain. For quality parameter, rice grain with minimum chalky is considered the best quality. In order to detect the chalky in the rice grain, we used extended maxima operator along with other morphological operators.

2) *Extended Maxima Operator*

Extended maxima operator is used in our image processing technique. By using this operator we can close all minimum values in the image and highlight the high values. We separated the chalky portion in the grain images by applying this operator

3) *Algorithm for Chalky Calculation*

The major steps that are involved in detection of the chalky in rice are described below:

a) *Step 1: Apply Morphology Opening:*

Creates a square shaped structuring element with the specified length and width. Then perform the morphological opening operation on the image. Morphological opening is basically the dilation of erosion of set f by structuring element b. The mathematical equation is given in equation 2. The opening process is shown in fig. 2(d).

$$f \circ b = (f \ominus b) \oplus b \tag{2}$$

b) Step 2: Apply Morphology Erosion and Reconstruction:

Erosion is one of the fundamental operation in morphological image processing. The mathematical form of erosion is given equation 3.

Fig. 2(a). Original Image

Fig. 2(b). Apply Canny Edge Detector

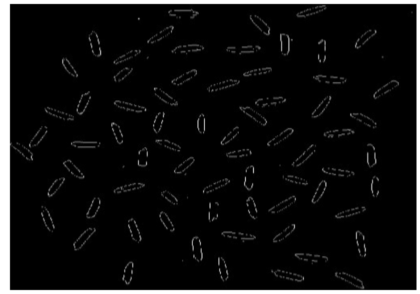

Fig. 2(c). Apply Sobel Edge Detector

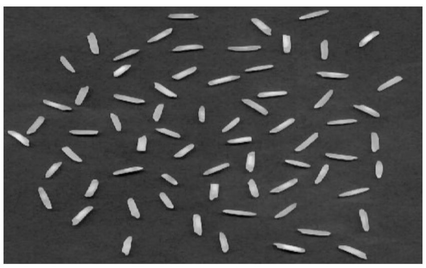

Fig.2 (d). Apply Opening Process

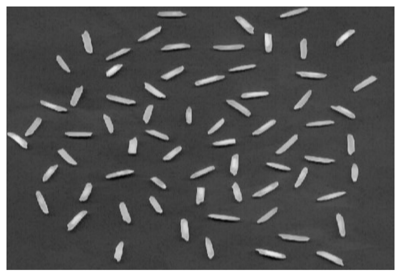

Fig. 2(e). Apply Reconstruction

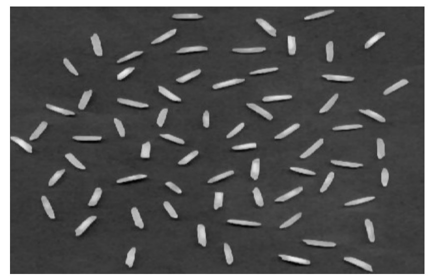

Fig. 2(f). Apply Closing Process

Fig. 2(g). Separated Chalky from the Original

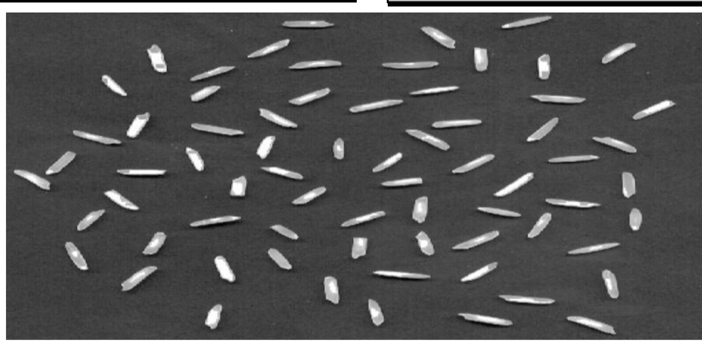

Fig. 2(h). Superimpose Chalky on the Original Image

.Fig. 2. Process on the Image to Identifying Chalky in the Grain

$$A \Theta B = \{(z/(B)z \subseteq A)\} \quad (3)$$

The erosion of A by B is donated as $A \Theta B$, and is defined in equation 2. It indicates that the erosion of A by B is the set of all points z such that B, translated by z, is contained in A. The purpose of erosion is to remove smallest particles in the image. The morphology reconstruction is shown in fig. 2(e).

c) Step 3: Apply Morphology Closing Operation:

In image processing closing is, combine with opening the basic concept of morphological noise removal. Opening removes small objects, while closing removes small holes. In mathematical morphology, the closing of a set (binary image) f by a structuring element b is the erosion of the dilation of that set, and the closing process is shown in fig. 2(f).

$$f \yen b = (f \oplus b)\Theta b \quad (4)$$

d) Step 4: Apply Extended-Maxima-Transform:

The extended-maxima-transform is applied to identify the chalky in rice grain. This transform is the regional maximum of the H-maxima transform where H is a nonnegative scalar. The H-maxima transform suppresses all maxima in the intensity image whose height is less than H, where H is a scalar. In our work value of H is 15.The regional maxima are connected components of pixels with a constant intensity value, and whose external boundary pixels all have a lower value. By default, this operator used 8-connected neighborhoods for 2-D images. By using regional maxima operator we have separated the whiteness part from the rice grains in the image.

e) Step 5: Superimposed Regional Maxima on the Original Image

Next we superimposed the chalky on the original image.

f) Step 6: Compute the Area of Chalky:

After performing step 4, we extracted the chalky portion in the rice grain and calculated the area of this chalky by the properties of region props .Finally we compared this value with the original area of rice. The extracted chalky from original image is shown is fig. 2(g).

F. Color Detection in the Rice Grain

For color detection in the rice grain, we are used two types of rice named as, yellow color rice and white color rice. These two colors of rice are shown in fig.3.We calculated color features using RGB and HSV color model.

1) RGB Color Model:

RGB stands for red, green and blue. We have taken yellow color rice and white color rice, then apply RGB model for color detection as shown in fig 4 and fig 5. We have to calculate the ranges and set the threshold in order to select color of rice in computer vision.

Although the peaks of the red channel, blue channel and green channel of both color of rice are same but the ranges of the channels are also same as given below. Hence this model is not suitable for detecting the color of rice.

2) HSV Color Model:

HSV stands for Hue (H), Saturation (S) and Value (V). Now we have to apply HSV model on the both colors of rice grain as shown in the fig. 6 and fig. 7. We calculated the minimum and maximum ranges of hue, saturation and value. By comparing these values we differentiated the color in the rice grain.

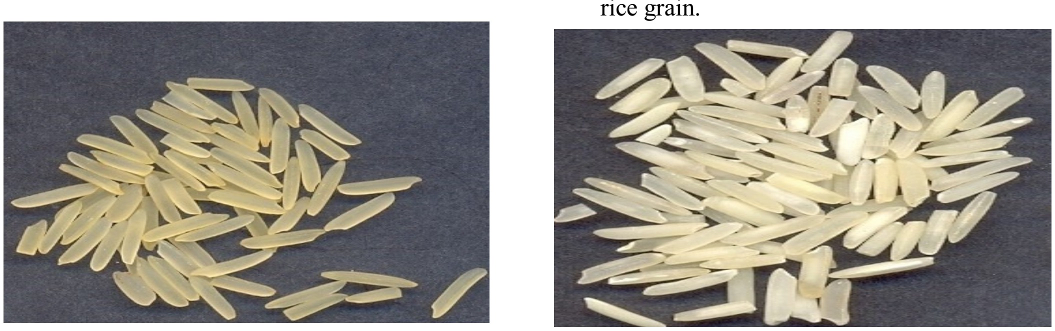

Fig. 3. Yellow and White Color of Rice

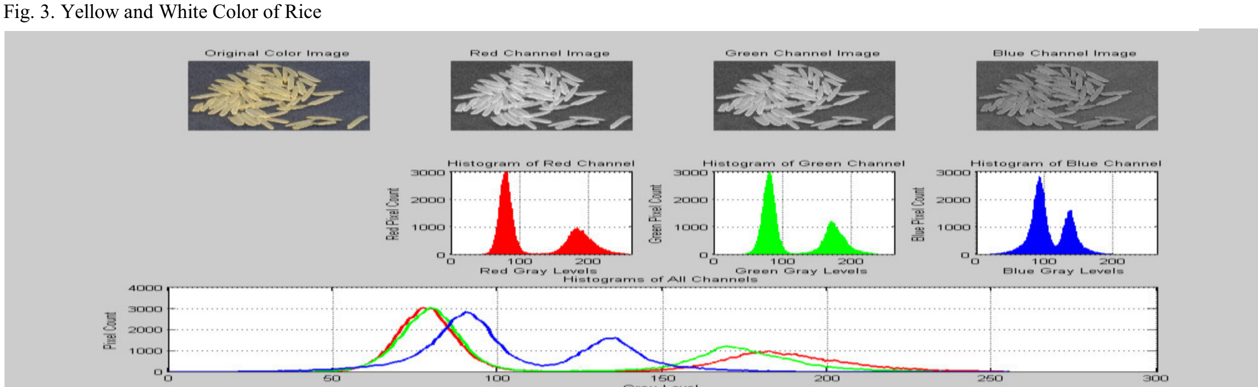

Fig. 4. Yellow Rice and its Red Color image, Green Color Image, Blue Color Image and their Histograms

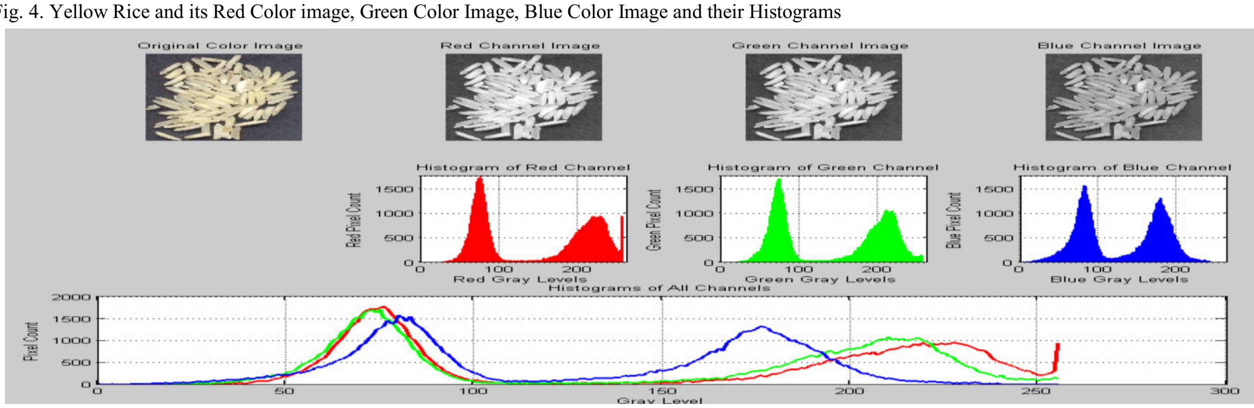

Fig. 5. White Rice and its Red Color image, Green Color Image, Blue Color Image and their Histograms

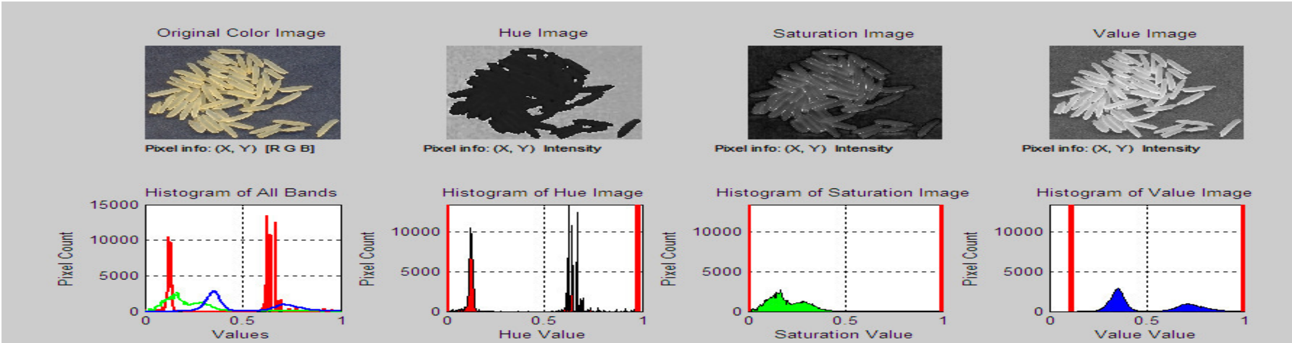

Fig. 6. Yellow Rice and its Hue image, Saturation Image, Value Image and their Histograms

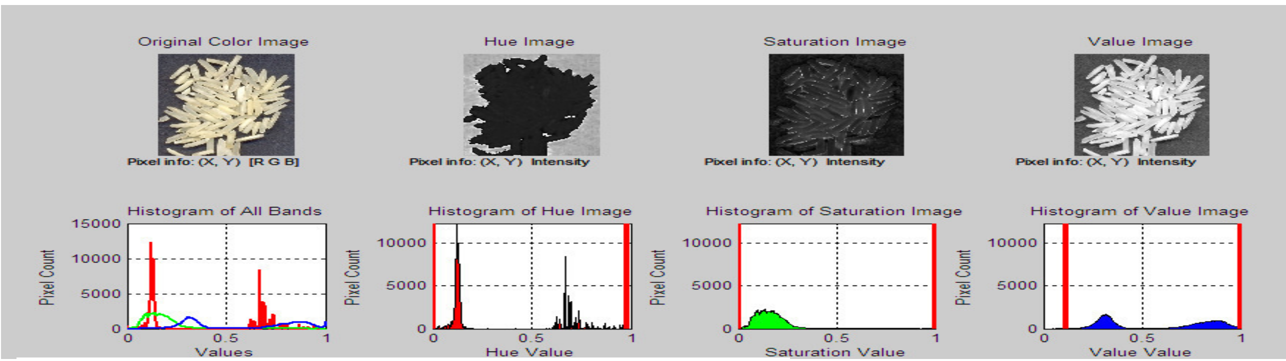

Fig. 7. White Rice and its Hue Image, Saturation Image, Value Image and their Histogram

It is clear in the Table I and Table II that value of hue and saturation are same in both color of rice but the difference occurs in Value ranges so, our rule to detect the color is as follows:

If range of Value is in between 0.1 to 1, then the color of rice is yellow and if range of Value is in between 0.05 to 1 then the color of rice is white. We tested this method on 22 samples of rice grain.

TABLE I. HSV RANGES FOR YELLOW RICE

HSV	min Ranges	max Ranges
Hue	0	0.9815
Saturation	0	1
Value	0.1176	1

TABLE II. HSV RANGES FOR WHITE RICE

HSV	min Ranges	max Ranges
Hue	0	0.9896
Saturation	0	1
Value	0.051	1

IV. RESULT AND DISCUSSIONS

We calculated the chalky area, and different dimensions of the rice grain in 22 rice image samples and their respective results are plotted in Table III respectively.

The graphical representation is given in fig. 8, fig. 9 and fig. 10. On the basis of our measurement the grading of the rice grain in the samples in performed and shown in Table III, I V, V, VI and VII. The results show that the best rating of all features cannot be found in one sample image .Therefore the rice grading needs to be done on the basis of different features individually and need not to incorporate all the features at the same time.

TABLE III. AVERAGE VALUES OF AREA, LENGTH, WIDTH AND CHALKY OF EVERY SAMPLE

Rice Samples	Mean Area	Mean Length	Mean Width	Chalky Area	% of Chalky
Sample 1	427	4.5936	1.9407	201	53%
Sample 2	532	5.8466	1.896	222	58.00%
Sample 3	579	6.7708	1.7279	304	47%
Sample 4	758	8.386	1.8782	259	65%
Sample 5	625	7.1676	1.8004	340	45%
Sample 6	604	6.4185	1.8404	384	36%
Sample 7	572	6.4667	1.7842	279	51%
Sample 8	643	7.035	1.7635	239	62%
Sample 9	359	4.5356	1.7184	270	24%
Sample 10Y	730	8.06	1.7	359	50%
Sample 11W	766	8.2	1.7	599	21%

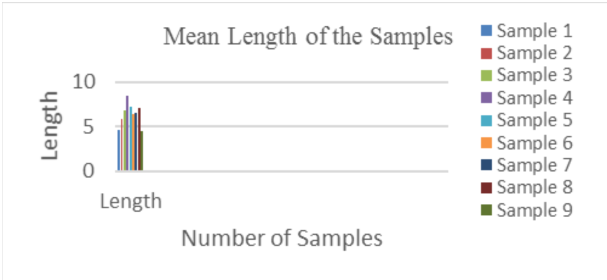

Fig. 8. Mean Length of the Samples

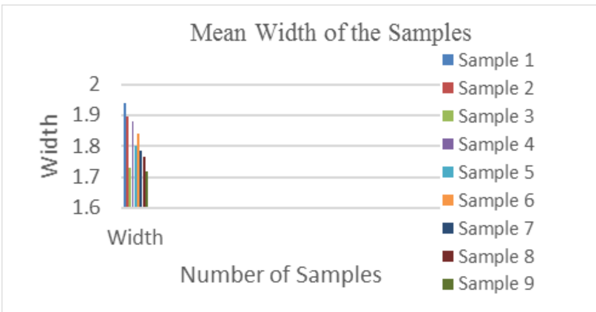

Fig. 9. Mean Width of the Samples

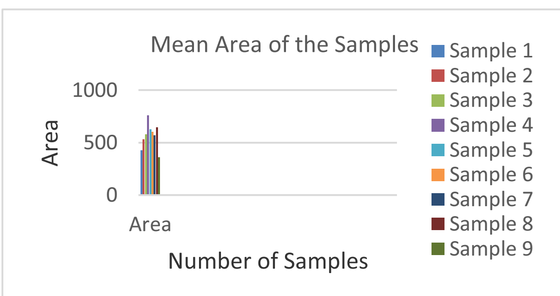

Fig. 10. Mean Area of the Samples

Samples are compared on the basis of Area, Length, width and chalky. Largest area grains are placed in Grade A, average in Grade B and smallest area of rice are placed in Grade C. Similarly, this grading is also applied for length, width and chalky, which are shown in Table IV, V and VI.

TABLE IV. GRADING ON THE BASIS OF AREA

GRADES	SAMPLES
Grade A	Sample 4
Grade B	Sample 5
Grade C	Sample 9

TABLE V. GRADING ON THE BASIS OF WIDTH

GRADES	SAMPLES
Grade A	Sample 1
Grade B	Sample 4
Grade C	Sample 10

TABLE VI. GRADING ON THE BASIS OF LENGTH

GRADES	SAMPLES
Grade A	Sample 4
Grade B	Sample 7
Grade C	Sample 9

TABLE VII. GRADING ON THE BASIS OF CHALKY

GRADES	SAMPLES
Grade A	Sample 11
Grade B	Sample 6
Grade C	Sample 4

V. CONCLUSION

In this research article, we developed an image processing algorithm to grade the rice on the basis of length, width, area and area of chalky and also worked on the color detection on the rice grain. From the results obtained, it is concluded that some rice are better on the basis of their length, some are better on the basis of their width while some can be termed good in quality on the basis of their area and area of the chalky. However it is not essential that all features can be present in the rice grain .More data can be acquired for further validation of our techniques .For further research, the moisture content in the rice grain can also be added to grade the overall quality of the rice grain.

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