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FEATURE EXTRACTION OF A CEREAL GRAINS BY USING IMAGE PROCESSING TECHNIQUE

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Abstract: Rice grains quality estimation is important in fulfilling customer requirements. Geometric features of grains are used to check the quality of rice grains. Mechanical classification methods are being used largely by local industry to grade different size of food grains on basis of geometric parameters. Image processing techniques can be applied to extract various features of rice grains and classifies the grains based on geometric features. This study proposed a method that processes the captured still digital image of rice grains. The program has been developed using MATLAB technology. The compiler of this technology was used to convert the program into standalone application. Application was embedded with MATLAB compiler runtime that enables the execution of compiled application on computers that do not have this technology installed. In this method seven geometric features of individual rice grain were extracted from digital images and then grains of particular varieties were classified into three different classes. Calibration factor was calculated to make the method independent of camera position. The method was tested on five varieties of rice grains and compared to experimental results by measuring the geometric features of rice grains using digital vernier caliper.

Key words: Rice grains, Classification, Feature Extraction, Image Processing.

1. INTRODUCTION

Rice is produced in several areas throughout the world. Preceded by China, India is at second position in yield of rice in the whole world. Rice is main food of 80% of the people in South East Asia [6]. Good quality rice grains are demanded by the customer because every country now becomes self-sustaining in rice production. Many parameters are required to be judged for finding the rice grains quality. Techniques need to be developed for processing of rice grain images and require automation of system to find the quality of rice grains.

Basically, quality of the rice grains is based on geometric features. Grains obtained after performing mechanical operations by machines varies in size approximately 37.5%. These require finding geometric feature of rice grains and classification.

Computer vision basically involves image analysis and image processing which are the important aspects. To improve the quality of an image, a large number of operations are performed. Such operations involve removal of various defects as improper focus, repetitive noise, geometric distortion, camera motion and non-uniform lighting. For taking decisions in system to control application the image analysis is used to differentiate the interested area from background region [11].

Brosnan gives review of system for online automatic grain inspection using machine vision which was developed by Wan, Lin and Chiou [1]. Related to rice kernel sixteen attributes were identified which were based on defects and kernel colour for rice quality estimation in three different classes. Cracked, sound, broken, chalky, dead, immature, offtype, paddy broken and destroyed brown kernels of rice were identified and system classified these with a low error rate than by manual work. The inner blemish of rice grain can be estimated by various techniques in image processing as modified dark field illumination method. Liu proposed a method based on morphological and color in digital image processing for identification of rice seeds of the six varieties which are available in Zhejiang Province [7]. Guzman investigated the usage of a computer vision techniques and multilayer neural networks for efficiently finding the sizes, variety and shapes of 52 samples of rice grains related to five groups of varieties of rice grain in the Philippines [4].Shantaiya performed the work by using Image analysis and image warping approach [10]. To find the unknown grain varieties, a network was trained. Patil presents the study on distinct color models which involve L*a*b, HSI, HSV, and YCbCr were used for finding and categorizing the food grains by taking color and basic

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texture attributes in consideration [9]. Maheshwari presents a quality analysis of Gujarat-17 rice seeds via image analysis [8]. They identify normal seed and foreign elements present in a given sample using a proper image acquisition system. Gujjar provides a method to accomplish morphological and texture-based retrieval on a rice grain images of Basmati [3]. To find the unknown grain varieties, a network was used, which was trained to analyze features. Percentage purity of rice grain sample of basmati which was hulled was determined by various images processing method. Kaur trains the SVM model by training set, whereas model working was tested on independent test [6]. The transformed training pattern vectors were used to train the kernel of the RBF along with support vector machine and then tested by using specific methods. Nine rice varieties were classified based on different sides of grain and other parameters [2].

This paper is organized as follows: Section 2 describes the Literature survey. Section 3 proposed system. Section 4 Result and discussion. Section 5 gives the conclusion.

2. LITERATURE SURVEY

Cereal grains play an important role in meeting the nutrient needs of the human population. They are good excellent sources of nutrients. Pulses are nutrient-rich foods; containing dietary fiber, protein, carbohydrates, b-group vitamins and minerals such as iron, zinc, calcium and magnesium. The quality of cereal products is determined by a variety of characteristics which may be assigned different significance depending on the desired end use or type of product.

The quality of grain is defined in context of its content elements such as protein, carbohydrate, etc. as well as in context of its physical features. This work is focused on the physical aspects involved in the grain analysis and therefore this chapter presents the research carried out in the area of physical feature analysis, and issues are to be addressed.

This chapter first presents different kind of grain analyser techniques used in physical analysis of grains found in literature. It mainly includes manual and machine-based techniques. Both techniques are further classified into different categories. All techniques have their own limitation and advantages which are discussed in subsequent sections.With this research prime focus is made on rice quality analysis. This analysis technique is also useful for quality analysis of other types of grain by configuring various parameters.

Grain Analysis Standards

This section describes importance of various standards provided by standard organisations.

Importance of standards

For any grain, quality is a very important factor. The food product which is made from grain is having direct relation with human health. Good quality food can be prepared from good quality grains. Therefore, any progress made for grain quality measurement techniques, is directly beneficial for society. Moreover, it will also help in getting higher selling price from consumer.

It is required to define some measurement criteria for categorisation of good quality grain sample. Many organisations are working for defining standards for different kind of grains and food products. All organisations defined their own standards based on their geographical location; consumer needs, nutrition factors and other environmental parameters. Standards are defined for size, color, appearance, cooking and packaging techniques and for sampling. Based on that standardisation, sorting and categorisation is done for different types of grain samples. There is also possibility that an organisation is following more than one standard for categorisation. It might be varying with different varieties, different group of consumers and exporting norms.

Organisations provide measuring quality data that can be used for decision making in identifying better quality grains. Rice and wheat are most consumed cereal grain in India. It provides more than one fifth of the calories consumed worldwide by humans. India is ranked 1 in largest rice producing companies in the world for exporting Basamati rice (Exporters India 2017). So, we have considered rice quality measurement as a base.

With this research various rice standards are studied, and based on that the techniques are developed which can be configured for meeting those rice standards. Various standards are defined by various organisations for physical feature analysis of grain is discussed next.

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Rice standard organisations

The most commonly accepted standards for rice are provided by Bureau of Indian Standards (BIS), Directorate of Marketing & Inspection (DMI), Department of Food & Public Distribution (DFPD), ARSO (African Rice Standard Organisation), CODEX Standards, Cambodia milled rice standards and "Food and Agriculture Organisation of United Nations".

Bureau of Indian Standards (BIS)

Bureau of Indian Standards, Manak Bhavan, New Delhi, India (FAD16 10730_12092016 2016) has provided method of analysis food grain part I FAD 16 (10730) C. Standards are provided for the wheat, maize, paddy, rice, barley, gram and other pulses. The seeds refractions as other food grain, damage, discolored, insect damaged, broken and slightly damaged are considered for 20gm grains. Percentage of each category is considered as given below equation:

X category seed percentage = (no. of X category seed *100) / Total no. of seeds

For wheat shape analysis the parameters are mostly used as area, parameter, compactness, major axis and minor axis length (Shouche, et al. 2001).

Directorate of Marketing & Inspection (DMI)

Directorate of Marketing & Inspection, Ministry of Agriculture and Farmers Welfare, Government of India (DMI 2016) which provides standards for all agricultural foods. It has considered CODEX 192-1995 (adopted in 1995 and revised yearly till last 2016) standard as a base for universally adoption. The Codex Alimentarius or "Food Code" is a collection of standards, guidelines and codes of practice adopted by the Codex Alimentarius Commission. The Commission, also known as CAC, is the central part of the Joint FAO (Food and Agriculture Organisation) / WHO (World Health Organisation) Food Standards Program and was established by FAO and WHO to protect consumer health and promote fair practices in food. It provides standards for different pulses, fruits, vegetables, tobacco, tea, amala, cocoa, fiber crop and all edible nuts.

It has provided *maize* standards (Agmarknet-Maize 2016)**,** which includes foreign matter (organic and inorganic), damaged grains, immature/shriveled grains, weevilled grains, other edible grains, admixture of different varieties and Moisture content in sample. Based on percentage existence of different types of grain kernel in sample the maize quality is categorised in Grade –I, II, III and IV.

It has also provided standards for *rice and wheat* (Agmark-Wheat 2016), which is based on consideration of wholesomeness, appearance, colour, foreign matter (organic and inorganic), damaged grains, broken grains, immature / shriveled grains, weevilled grains, wheat of other variety, other food grains and moisture content. Based on percentage existence of different types of grain kernel in sample the wheat quality is categorised in Grade –I, II, III and IV.

Department of Food & Public Distribution (DFPD)

Department of Food & Public Distribution, govt. of India, Krishi Bhawan, New Delhi (DFPD 2014)specifies standards for all varieties of paddy, rice, bajra, jowar, maize and ragi which includes foreign matter, damaged, discolored grains, chalky grains, red grains, admixture of lower class and moisture content percentage in grain sample For every types of grain analysis it is required to measure same kind of parameters. Common analyser can be developed which can measure all parameters, and based on percentage value of all parameters the overall sample quality can be determined. Percentage of different type of seed in the sample is described in *[ref. sec. 2.8.2.1]*.

CODEX Standards

The first recorded universal instance of food additives standardization is, CODEX STAN 192-1995, adopted in 1995 and revised yearly till last 2016 (Codex Alimentarius 2016). These grain standards and inspection procedures are designed to ensure a uniform product and to facilitate the trading and marketing of universal grain. It is universally accepted standards. With CODEX standard for rice 198-1995 (CODEX STAN 198-1995 2016) standards the grain seed is classified in mainly three categories long seed, medium seed and small seed. Classification of seeds depends on the selected option i.e. based on seed length / width ratio, based on seed length, based on a combination of the seed length and the length/width ratio.

CODEX STAN 198-1995 classifies seed based on dimension criteria as given below:

1.Kernel length / width ratio: (*Long grain* – length width ratio of 3.1 or more, *medium grain*

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length / width ratio 2.1-3.0, *short grain* – length /width ration 2.0 or less)

2.Kernel length: (*long grain* – kernel length 6.6 or more, *medium grain* – kernel length of 6.2 mm or more but less than 6.6 mm, *short grain* – kernel length less than 6.2 mm)

1. ***Combination of kernel length and length / width aspect ratio***: (*long grain* – a kernel length of more than 6.0 mm and with a length / width ratio of more than 2 but less than 3, or; a kernel length of more than 6.0 mm and with a length/width ratio of 3 or more. *Medium grain* - kernel length of more than 5.2 mm but not more than 6.0 mm and a length/width ratio of less than 3, *Short grain* - has a kernel length of 5.2 mm or less and a length/width ratio of less than 2 mm.)

Moreover, these standards would be based on milling degree (Milled rice, under milled rice, well-milled rice and extra-well-milled rice).

It gives definitions for paddy, husked, milled, parboiled and glutinous rice. This standard defines maximum percentage of allowable other organic extraneous matter. It also specifies the contaminants, hygiene, ingredients, packaging and labeling standards for rice.

Trading Market Specification Worldwide

Different standards are followed by traders, which is mainly to satisfy the market need. It becomes essential while exporting. The all quality-based specifications can be measured based on appearance except aroma and milling degree. Image processing techniques is excellent solution for appearance-based quality parameters.

All India Rice Exporters Association, New Delhi, India (All India Rice Exporters Association 2017) is an association of rice exporters with the prime mission of influencing export policy of rice. It includes min l/b ratio, moisture content, damaged, chalky, broken, foreign, red stripped grain, paddy, elongation ratio, and green grain. **Department of Food & Public Distribution, govt. of India** specifies standards for rice based on foreign matter, damaged, discolored grains, chalky grains, red grains, admixture of lower class and moisture content (sra-010914.pdf 2014). **KAYAVLON Impex Private Limited, Gujarat, India** (Kayavlon 2017) is ISO 9001:2008 certified millers / exporters rice in India. For different rice varieties specification includes the parameters average grain length (pre - cooked), moisture content, broken, chalky kernels, damaged / discolor and paddy / black grains and foreign matter. **Rice Authority** (Rice Authority 2016), largest Vietnam rice exporters includes broken, whole grains, moisture, color sorting, length, discolored, damaged, admixture, red streak, black, yellow, foreign matter, paddy and milling. **Vaigai** World wide's Basamati rice specification includes length, broken, damaged, discolored, paddy, foreign matter, taste, moisture and aroma (Vaigai Worldwide 2016). For other pulses specifications, also mainly foreign matter, size, damaged and broken grains are considered (Valency International Trading Pte Ltd. 2016). **LE GROUP** considers long, broken, moisture, damaged, yellow, foreign, chalky, red and milling degree for rice specifications (LE Group Industries 2016).

3. PROPOSED WORK

MATERIAL AND METHODOLOGY

Material

For determining physical dimensions five varieties of rice grains were used - grain 1, grain 2, grain 3, grain 4, grain 5 by using MATLAB. The images of rice grains were acquired on black background with a Sony Digital Camera. The grains were not overlapped with each other. The image of known region length was captured on white background for calculating calibration factor. A digital vernier caliper 1112-150 of 0.01 mm least count was used for manual determination of length and width of rice grains.

Methodology

Figure (1) describe the various steps in program development and Figure (2) describe the various steps in overall application development. 2.2.1 Image Acquisition The images of five rice grain i.e. grain 1, grain 2, grain 3, grain 4, grain 5 were taken for processing and stored in different formats. MATLAB technology is used for performing operations on image.

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Fig1: Steps in Program Development.

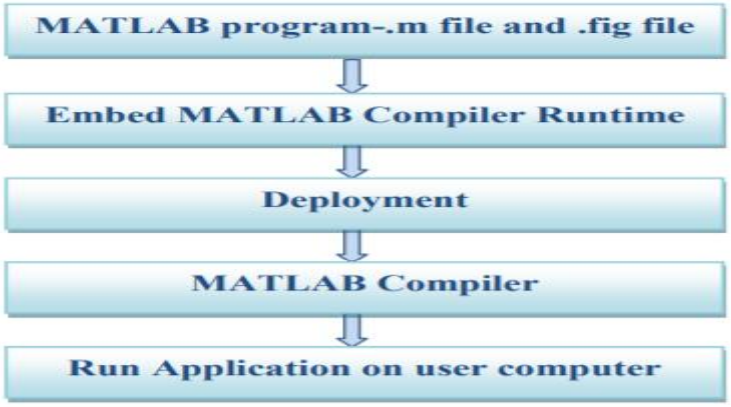

Fig 2: Steps in Application Development

Image Processing

Image processing is one of the important steps for the enhancement of quality of the captured image. To improve the performance various operations involves such as removal of various defects as improper focus, repetitive noise, geometric distortion, camera motion and non-uniform lighting. The Median filtering is applied for image smoothing. Then the grayscale image is binaries. Once the image is binaries morphological operations are performed.

RGB to Gray:

Imread function provides RGB image of values of colour intensity ranging within 0-255.Colour information is not required to extract geometric features. As binary image is needed to perform operations on image. The image requires conversion into binary. RGB image is first converted into gray scale image. rgb2gray function is used to convert RGB image into gray scale image.

Binary Image:

The image is converted into binary image which contains pixel intensity values 0 and 1. The image contains noise which can be removed by filtering. On binary image, filtering method is applied

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to get information regarding desired area of interest accurately.im2bw function is used to convert image into binary.

Image Filtering:

Images cannot be used directly due to disruption made by the poor contrast and variation in intensity. In this, certain image characteristics are explained by transforming pixel intensity values: - 1) Enhancement: helps to improve the contrast of the image 2) Smoothing: Smoothing removes the noise from the image. Different types of filtering technique are used for smoothing purpose. This proposed work uses median filter to remove noise by function medfilt2 (). Pre-processing steps include filtering to improve the image for later processing. While removing noise it also preserves the edge information.

Feature Extraction

First, the number of pixels was calculated in 1cm*1cm for calibration. Number of components was calculated from binary image. Then, the features extracted from image of rice grains are as follows:

1. Major Axis Length: Number of pixels between the extreme points of longest line along the length of the rice grain.

2. Minor Axis Length: Number of pixels between the extreme points of longest line along the width of the rice grain.

3. 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.

4. Perimeter: Total number of pixels which makes the boundary of rice grains.

5. Area: Total number of pixels in rice grain image.

6. Orientation: The angle between horizontal axis and major axis.

7. Aspect Ratio: It was the major axis length divided by minor axis length.

Classification

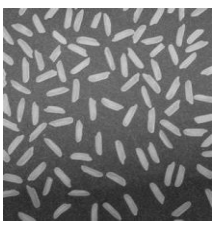
Based on the major axis length the grains percentage of long, medium and small was calculated. Largest value of major axis length was stored to extract the particular rice grains. The percentage of largest value above which grain was extracted taken from dialog box. The grains of greater value of major axis length than the percentage of largest grain was displayed.

Application

Development MATLAB .m and .fig file was embedded with MATLAB compiler runtime by deploy tool. This application enables the execution of compiled application on computers that do not have MATLAB installed.

4. RESULTS AND DISCUSSION

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.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Grain1 Grain -2 Grain-3

Grain-4 Grain-5

Fig: 3 different grains Grain 1, Grain 2, Grain 3, Grain 4 and Grain 5

Grain 1 image Geometric values

Table 1: Geometric Features of rice grains 1

S.NO	Area (mm^ 2)	Major Axis Length (mm)	Minor Axis Length (mm)	Eccentricity (mm)	Orientation (degree)	Aspect Ratio	Perimeter (mm)
Grain 1	193	30.198	8.2889	0.96159	79.123	0.94146	62.696
Grain 2	227	30.346	9.7914	0.94652	48.605	0.94583	65.592
Grain 3	210	28.782	9.0566 4	0.94315	-51.223	0.94595	61.928
Grain 4	132	22.041	8.2833	0.9267	-18.281	0.94286	49.869
Grain 5	237	32.51	9.5497	0.95588	-87.681	0.97131	67.327
Grain 6	232	31.436	9.8481	0.94966	-64.989	0.9093	67.162
Grain 7	246	31.736	10.054	0.94849	45.69	0.98795	66.436
Grain 8	206	32.066	8.4096	0.965	46.498	0.93636	65.493
Grain 9	201	29.706	8.812	0.95499	-89.349	0.93488	61.819
Grain 10	198	27.632	9.4539	0.93965	-62.506	0.94286	58.462

GRAIN 2: Geometric values

Table 2: Geometric Features of rice grains 2

S.NO	Area (mm^2)	Major Axis Length (mm)	Minor Axis Length (mm)	Eccentricity (mm)	Orientation (degree)	Aspect Ratio	Perimeter (mm)
Grain 1	115	20.558	7.7433	0.92635	-62.63	0.94262	46.065
Grain 2	106	15.964	8.7885	0.83483	-52.927	0.96364	38.382
Grain 3	141	29.445	6.8287	0.97274	-81.587	0.91558	59.925
Grain 4	145	21.818	8.9091	0.91284	-32.569	0.90625	49.836
Grain 5	64	14.084	6.2533	0.89604	-80.555	0.95522	31.989
Grain 6	188	24.573	10.014	0.91319	-15.171	0.92611	54.649
Grain 7	123	19.319	8.5064	0.89785	56.422	0.91791	43.112
Grain 8	204	30.514	8.8479	0.95704	50.467	0.95775	63.235
Grain 9	188	30.129	8.2374	0.9619	-31.303	0.91262	62.796
Grain 10	220	29.264	9.8109	0.94213	-27.742	0.94828	62.672

GRAIN 3 Geometric values

Table 3: Geometric Features of rice grains 3

S.NO	Area (mm^2)	Major Axis Length (mm)	Minor Axis Length (mm)	Eccentricity (mm)	Orientation (degree)	Aspect Ratio	Perimeter (mm)

Grain 1	156	23.252	8.7537	0.92643	-41.725	0.93413	50.027
Grain 2	234	31.563	9.6975	0..95163	-49.081	0.96296	66.618
Grain 3	196	27.839	9.6056	0.93859	38.796	0.92891	59.844
Grain 4	203	29.285	9.0934	0.95057	-74.986	0.93981	61.05
Grain 5	165	22.903	9.5823	0.90827	78.243	0.92697	51.713
Grain 6	199	28.06	9.3359	0.94303	-26.683	0.95215	60.265
Grain 7	160	27.267	7.6217	0.96014	-0.85573	0.93023	56.485
Grain 8	206	31.517	8.5849	0.96219	37.533	0.94495	64.649
Grain 9	200	28.181	9.4994	0.94147	-6.6219	0.92593	59.859
Grain 10	223	31.033	9.468	0.95232	84.758	0.94093	63.68

GRAIN 4 Geometric values

Table 4: Geometric Features of rice grains 4

S.NO	Area (mm^2)	Major Axis Length (mm)	Minor axis Length (mm)	Eccentricity (mm)	Orientation (degree)	Aspect Ratio	Perimeter (mm)
Grain 1	187	27.775	8.9466	0.9467	-72.695	0.90777	58.9
Grain 2	210	30.075	9.1084	0.95304	22.981	0.94595	61.902
Grain 3	157	25.44	8.1329	0.94752	70.838	0.92899	53.293
Grain 4	76	14.581	7.0133	0.87673	26.489	0.96203	33.238
Grain 5	175	26.834	807261	0.94565	-6.9783	0.91623	57.072
Grain 6	207	31.166	8.6645	0.96058	-46.051	0.95392	64.087
Grain 7	197	29.712	8.6028	0.95717	13.816	0.92056	62.357
Grain 8	228	32.01	9.2953	0.95691	11.066	0.93827	66.831
Grain 9	157	21.344	9.7538	0.88948	60.539	0.95152	49.564
Grain 10	156	23.252	8.7537	0.92643	-41.725	0.93413	50.027

GRAIN 5 Geometric values

Table 5: Geometric Features of rice grains 5

S.NO	Area (mm^2)	Major Axis Length (mm)	Minor Axis Length (mm)	Eccentricity (mm)	Orientation (degree)	Aspect Ratio	Perimeter (mm)
Grain 1	186	26.775	8.9466	0.9467	-71.695	0.90777	58.9
Grain 2	208	29.075	9.1084	0.95304	21.981	0.94595	61.902
Grain 3	154	25.44	8.1329	0.94752	69.838	0.92899	53.293
Grain 4	72	12.581	7.0133	0.87673	25.489	0.96203	33.238
Grain 5	173	22.834	8.7261	0.94565	-5.9783	0.91623	57.072
Grain 6	204	29.166	8.6645	0.96038	-45.051	0.95392	64.087
Grain 7	192	28.712	8.6028	0.95717	13.816	0.92056	62.357
Grain 8	222	31.01	9.2953	0.95691	11.066	0.93827	66.831
Grain 9	152	20.344	9.7538	0.88948	60.539	0.95152	49.564
Grain 10	156	22.252	8.7537	0.92643	-41.725	0.95313	50.027

Average output for Grain 1, Grain 2, Grain 3, Grain 4, Grain 5 shown in table -6

Average values of Different Grains Geometric features values:

Table 6: Geometric Features of rice grains

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S.NO	Area (mm^2)	Major Axis Length (mm)	Minor Axis Length (mm)	Eccentricity (mm)	Orientation (degree)	Aspect Ratio	Perimeter (mm)
Grain 1	208	29.6	9.2	0.94	-15.4	0.94	62.6
Grain 2	149	33.5	8.3	0.92	-32.8	0.93	107.1
Grain 3	194	28.09	9.12	0.94	12.2	0.93	46.4
Grain 4	175	26.2	8.6	0.93	38.2	0.93	55.7
Grain 5	171	24.8	8.6	0.93	60.5	0.93	55.7

5. CONCLUSION

Here we conclude that grading of rice can effectively be done by using the image processing techniques. With our coding we can calculate that how pure is our sample. The setup used is also very common and easily available. This is also more accurate than the human visual inspection. All this leads to better quality in food processing by image processing in this research paper, 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 is 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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