

Automatic Detection & Classification of Rice using Computer Vision- A Survey

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ABSTRACT: Human being for the quality inspection of various food articles are being used for so long. Human being was assigned a duty to recognize fruits, grains, flowers and many other agriculture and products. Even Face recognition of a person, birds and animal identification and classification based on their shape, size, color and patterns was being done manually by human being. However manual evaluation is very difficult and tiring, there is a lot of wastage of time as well. The decision-making power of human inspectors are subjected to be influenced by various factors such as tiredness, bias, loss of interest etc. So these jobs need automation, in this context Machine Vision System is used successfully for automated identification and classification of images of various Rice Grains

KEYWORDS : Rice grain classification, Neural Networks, Machine vision System, Automatic Quality Checking of rice grain

I. INTRODUCTION

There are five main constituents of an automatic machine vision system which include illumination, camera, an image acquisition board, computer hardware and software. Illumination system has a great effect on the quality of image and has a significant role in performance and precision of the system. A good illumination system can improve image processing by highlighting various image features like contrast and brightness. Proper lighting can reduce reflection and shadow. Important things to be taken care of while designing a illumination setup to be used in food industry includes location of the camera, type of lamp and color quality [2].

The procedure used to change images into mathematical form is called digitization. To do this an image is divided into a 2D space of very small portions known as pixels by using a digitizer or frame grabber. There are many analogue to digital converters (ADC) available but for real time applications a different type is needed, this is called as a flash ADC [3]

Low level image processing is responsible for capturing of the image and its pre-processing. Image acquisition is basically capturing the image by using the sensing device and converting it into the mathematical form. Pre-processing is done to improve image quality either by filtering out the unwanted data i.e noise or by highlighting the important portions of the region of interest. [4].

Segmentation is commonly done by different methods like thresholding, edge-based segmentation and region-based segmentation [5]. Thresholding is a very simple and fast method for characterizing portions of an image based on constant. Edge-based segmentation is based on edge detection by edge operators. Edge operators detect discontinuities in grey level, color and texture etc. In region segmentation same type of pixels are combined to each other in a single class to represent a single portion or object in the picture. High level processing uses classifiers or multilayer neural networks for the area of interest. The advantages of this automated system are that now human involvement is not required in this labourious processes, consistency has been increased, efficiency and cost effectiveness have also been increased. [6]

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II. METHODS USED FOR DETECTION AND CLASSIFICATION

Y.N.Wanet al [12] used 16 parameters which are classified into 3 basic groups: (1) Morphological characteristics are rice area, perimeter, compactness, L/B ratio; (2) Color characteristics of a rice grain includes average gray-levels of red, green, and blue color (3) Characteristics of image illuminated from below: maximum gray-level difference (MGLD) between adjacent blocks on a rice grain, to categories 1200 samples of brown rice into 13 categories such as sound kernels, green mature kernels, chalky kernels (white, green), cracked kernels, broken kernel, immature kernels (green, white), dead kernels (white, green), damaged kernels (including rusty, discolored, abnormal, and insect-damaged kernels), off-type kernels and paddy.

Firstly rice grains were placed and then scattered on matrix sheet which is placed on a conveyor belt of the machine. Two CCD (charge-coupled device) cameras connected to the image processing unit of the system were used to capture the image of the rice grains moving on the conveyor belt. Histogram and threshold methods were used to separate each rice grain from its background.

The neural network with three-layer error back-propagation (EBP) model using normalized input parameters, sigmoid activation function, and learning method with initial learning constant 0.5 and fixed moment constant 0.4. The learning cycle was 50,000 iterations. The advantage of using neural network method was that it did not require time-consuming tests and modifications to increase the inspection accuracy.

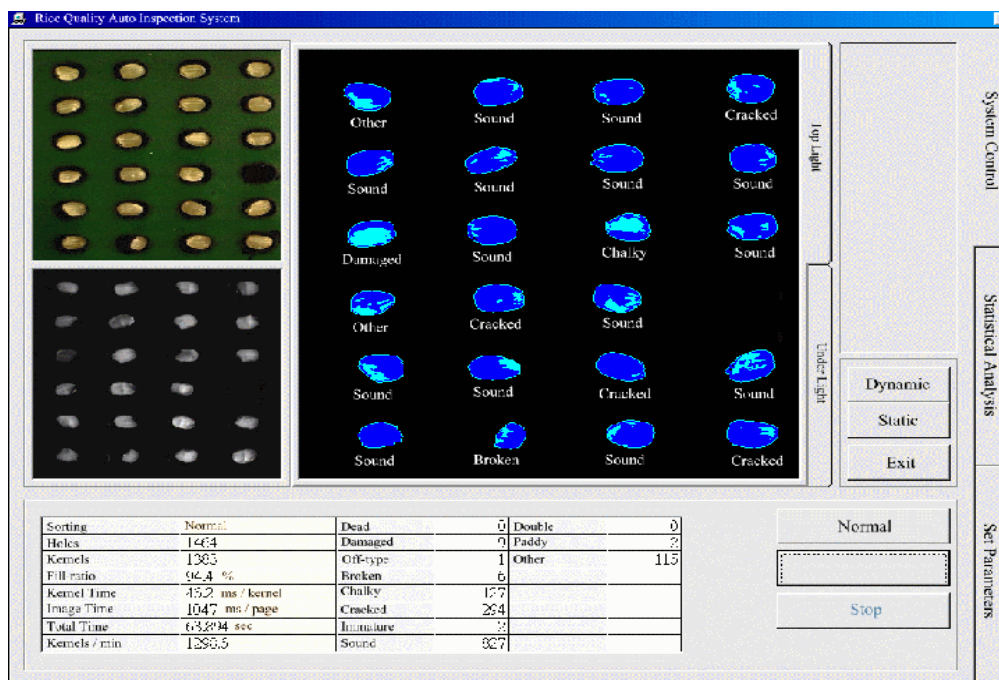


Fig. 1 Grain quality inspection windows

However, several rice categories had many similar characteristics, such as white immature, chalky, and dead kernels; green immature, chalky, and dead kernels; damaged and off-type kernels; sound and cracked kernels. The similar group showed little difference in inspection parameters, making them difficult to be distinguished by the neural network method. Therefore, the hybrid method was used to increase the classification accuracy by combining appearance-alike categories together. The appearance-alike kernels were classified in the second step using reduced range selection method with only one or two parameters.

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The recognition accuracy was about 75.9%. Combining appearance-alike rice categories such as white dead, immature and chalky kernels; green dead, immature, and chalky kernels; damaged and off-type kernels; cracked and sound kernels, could increase the recognition accuracy to 92.7%. The hybrid method continued the process using the range selection method to separate the appearance-alike rice kernels. The average inspection accuracy of the hybrid method was 86.4%.

Shuso Kawamura et al [9] used a near-infrared (NIR) transmission Instrument and a visible light segregator (VIS) to determine sound whole kernel of brown rice. The NIR instrument and the VIS segregator were found to be very good to determine moisture content, protein content and sound whole kernel ratio due to their high precision and accuracy. The major chemical ingredients of milled rice are moisture (15%), protein (7%) and starch (77%). The major quality aspect of the milled rice (the rice grain ready to be cooked) is protein content. Protein content decides the extent up to which the rice can absorb water when rice is cooked and it also affects the quality of cooked rice. Rice which has fairly good amount of protein is considered good from health point of view and tasty as well because they are less sticky. The objective was to make an automatic rice-quality detection system using a near-infrared (NIR) instrument and a visible light (VIS) segregator. The instrument scanned 33 wavelengths between 825 and 1075 nm. Rice were poured into the hopper of the instrument. A silicon detector captured the NIR light that was passed through the rice grains and converted that into the electrical signals. The value of SDD is measured for the moisture content and protein content and is given in Table 1.

Table No1. Precision of chemical analysis

Chemical analysis	Measured Sample	Number of samples	Range (%)	SDD (%)
Moisture content	Damp rough rice	134	15.4 – 34.8	0.32
Moisture content	Damp brown rice	136	15.9 – 32.1	0.29
Protein Content	Brown Rice	150	7.3 – 9.4	0.07
Protein Content	Milled rice	150	6.7 – 8.9	0.05

G.van Dalen et al [10] presents an image analysis (IA) method using flatbed scanner (FBS) for the classification of the rice grain after its size determination. A flatbed scanner, also known as desktop scanner was used to take the images of the rice grains. The rice is placed on the glass plate of the FBS scanner and covered with a black sheet of paper. Because of its cost effectiveness, robustness and it does not depend on the external light conditions so FBS scanners are the most commonly used scanners. The scanner was used with the resolution of 200 dpi. Analysis was made using the Scion Image software.

The FBS scanner was used with a black aluminium sample matrix with holes to facilitate the separation of touching rice kernels. The image was processed using macros in Scion Image and Excel with Visual Basic (2.1). The morphological parameters like area, length, breadth and perimeter of each rice grain was calculated with the software and also with the sliding caliper for 100 rice grains. Thresholding is used to separate the rice kernel from its background.

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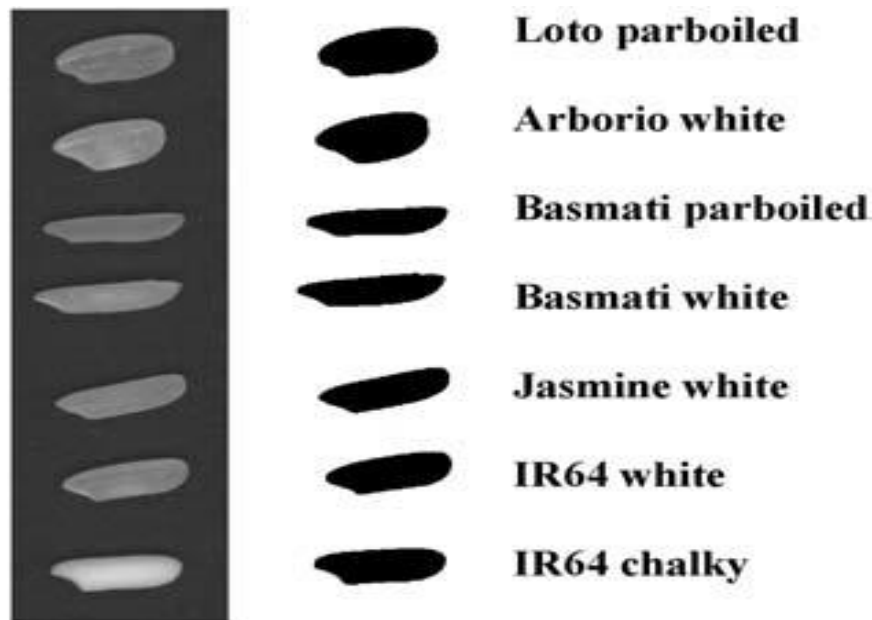


Fig. 2 Various types of rice grains

Image processing has various methods to distinguish connected objects. In these the layer of pixels are removed one by one from the outer surface of the image. The purpose of this process is to separate the touching objects without the loss of any information. Dilation is done after erosion. Here two different software's Scion and Qwin were used and whose results were compared at the end to check the classification accuracy. None of the software gave a satisfactory result to separate the connected objects. The accuracy of software for calculating the parameters of rice was tested by comparing the results obtained by manual analysis using a sliding caliper which resulted in an error. The length of the rice grain observed with the two software and the manual determination was under acceptable level of only 3%. However, the widths were quite larger than manual analysis.

D. M. Hobson, R.M Caetwr, Y. Yan et al [11] To identify the features eight most widely used type of rice were used. The features were length and aspect of the rice. Compactness and texture feature were also identified and played very important role here in classification. Features are extracted by applying unsupervised clustering techniques for the appropriate identification. Image of the rice grains is taken through a CCD camera. The next step is to remove noise from the image then thresholding the original image leaving us with binary form of the image. Minor problems are removed by using various morphological functions, then filtering is done after that. Edge detection is done on the perimeter of the of the rice grains.

Daljeet Kaur et al. [15] Flatbed scanner of 200dpi has been used to acquire the image of rice because it is robust and does not depend upon the external light conditions and one more thing is that flat bed scanner is an economical approach to take the image of an object. Because the rice do not have any defined geometry so no direct formula can be applied to calculate Perimeter, Length, Breadth, L/B ratio. Therefore the algorithms to calculate the Perimeter, Length, Breadth, L/B ratio have been developed and the program has been written using MATLAB Software to classify rice based on these features as well as on the color features. The analysis of rice for color feature has been done using HSI model. Rice has been classified on the bases of color first in three categories i.e Good rice, Discolored rice, Chalky rice and further morphology of the rice has been calculated and rice has been classified on the bases of morphology as Full Size rice, Big broken rice, Small broken rice and organic (powder like). The block diagram work done is shown in Fig. 3 and images of the rice grain with the detection of various morphological parameters like perimeter and centroid of the rice is calculated in Fig.4 so that the actual parameters responsible for the classification of rice like length, breadth, L/B ratio can be calculated.

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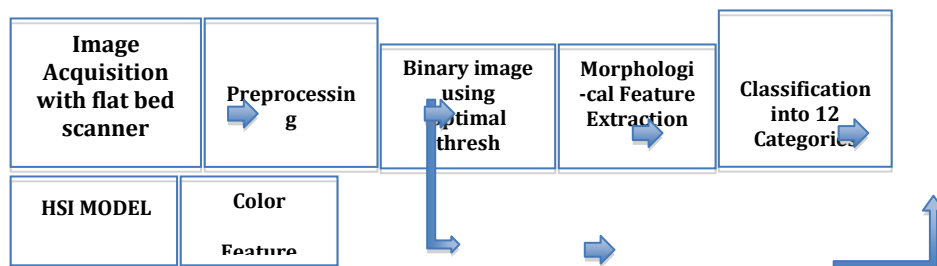


Fig. 3 Block Diagram of Purposed work

Original Image

Placement of centroid



Binary Image

Perimeter



Fig. 4 Placement of centroid in the perimeter image

Table No.2 Classification of rice grains based on L/B ratio

Rice No.	Length in Pixels (*0.127mm)	Breadth in Pixels(*0.127mm)	L/B Ratio	Class
1	44 pixels *0.127 =5.5880mm	13 pixels *0.127=1.6510mm	3.38	Full Size
2	27 pixels *0.127 =3.429mm	16 pixels *0.127 =2.032mm	1.68	Small Broken
3	48 pixels *0.127 =6.096mm	15 pixels *0.127=1.4050mm	4.33	Full Size
4	42 pixels *0.127 =5.3340mm	11 pixels *0.127=1.3970mm	3.81	Full size
5	26 pixels *0.127 =3.3020mm	16 pixels *0.127=2.0320mm	1.62	Small Broken
6	36 pixels *0.127 =4.5720mm	13 pixels *0.127=1.6510mm	2.76	Full size
7	40 pixels *0.127 =5.0800mm	14 pixels *0.127=1.7780mm	2.85	Full size
8	41 pixels *0.127 =5.2070mm	13 pixels *0.127=1.6510mm	3.15	Full size
9	12 pixels *0.127 =1.5240mm	7 pixels *0.127 =0.8890mm	1.71	Small Broken
10	30 pixels *0.127 =3.8100mm	13 pixels *0.127=1.6510mm	2.30	Big Broken

Table no.2 shows the Length and breadth calculations of few rice grains. The calculations have been done for 180 grains. Then value of Hue, Saturation and Intensity parameters of each rice which are necessary to classify the rice on the bases of color have been calculated.

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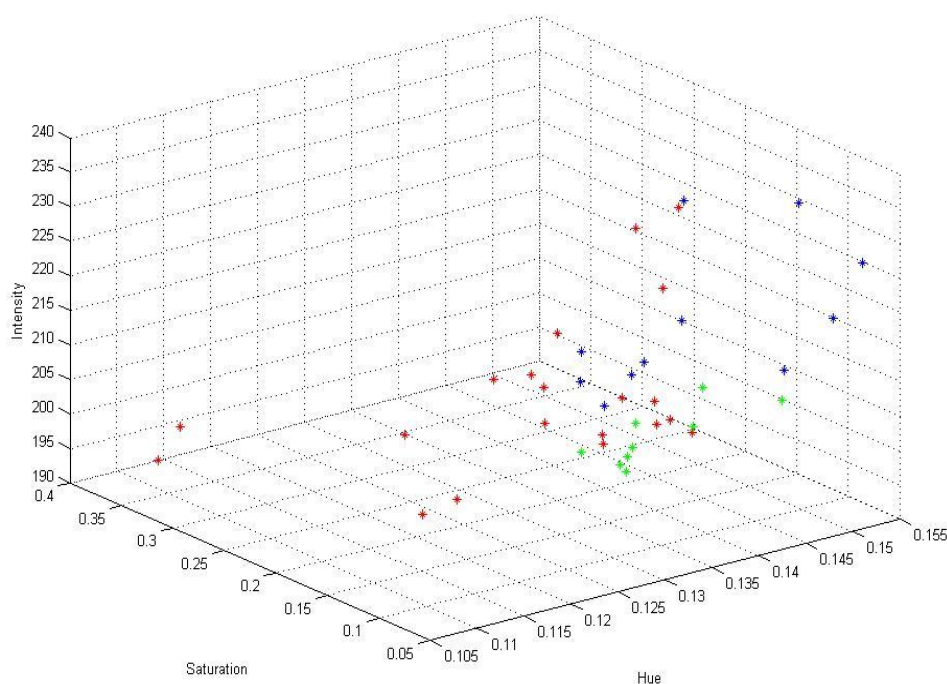


Figure No.5 Three Dimensional Plot for Hue, Saturation and intensity

Table no.3 Color Classification on the bases of Saturation and Intensity

Rice no.	Saturation	Intensity	Hue	Class
1	0.1076	215.48	0.1358	Chalky
2	0.1311	190.02	0.1200	Discolored
3	0.2347	182.17	0.1220	Discolored
4	0.1180	235.49	0.1550	Chalky
5	0.1005	191.52	0.1714	Good
6	0.1025	198.50	0.1480	Good
7	0.1085	190.60	0.1390	Good
8	0.0742	192.12	0.1670	Good
9	0.0994	230.98	0.1530	Chalky
10	0.1060	191.98	0.1480	Good

Classification of rice based on its morphological and color features has been done successfully. Accuracy of classification for morphology is 95% when it is compared to the classification done by the human inspector means out of 180 rice grains 171 were classified correctly into their exact class and 9 were in the wrong class. Color classification is also done by human inspector for 180 rice grains and compared with the classification of program written for this purpose and the accuracy of 94% has been observed and hence the overall accuracy of 94% has been observed.

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III. CONCLUSION

Various methods and techniques of calculating the morphological parameters of rice like Length, Breadth, Area, Perimeter, L/B ratio, Texture features and color features have been discussed on the bases of which rice can be classified into various categories like Full rice, big broken rice, small broken, organic, discolored rice, damaged rice and chalky rice etc. Advantages and disadvantages of image acquisition devices like Flat Bed Scanner and CCD cameras have also been discussed. Accuracy and speed of classification of rice can further be enhanced by using fuzzy logic along with neural network and image processing as a combination.

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