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QUALITY ASSESSMENT OF ORYZA SATIVA SSP INDICA (RICE) USING COMPUTER VISION

Chetna V. Maheshwari

Asst. Professor, Dept. of EC., G. H. Patel College of Engg. and Tech, Vallabh Vidyanagar, Gujarat, India

ABSTRACT: Food quality is complex, being determined by the combination of sensory, nutritive, hygienic-toxicological, and technological properties. The paper presents a solution for the problem of quality evaluation and category of Rice in an agricultural industry via computer vision, image analysis. This paper proposes parametric superiority method for quality assessment which is non-destructive and cost-effective technique. This paper also provides one automated method for counting the number of Oryza sativa L (rice seeds) from the foreign elements with a high degree of quality and then quantify the same by introducing Q-curves for quantification and assessment of the rice seeds. There is a high degree of quality achieved using computer vision as compared to human vision inspection.

Keywords: Computer vision; Quality; Image processing; Oryza sativa L; ISEF edge detection; Combined measurements.

I. INTRODUCTION

In this hi-tech uprising, an agricultural industry has become more intellectual and automatic machinery has replaced the human efforts [1]. In India to overcome the need of ever-increasing population it is necessary to make advancement in agricultural industry. Due to automation need of high quality and safety standards achieved with accurate, fast and cost effective quality determination of agricultural products[15]. Quality control is of major importance in the food industry because after harvesting, based on quality parameter a food product has been sorted and graded in different grades. Traditionally quality of food product is defined from its physical and chemical properties by human sensory panel which is time consuming, may be varying results and costly[14].

Machine vision is one of the important advanced technological field where significant developments have been made[6,10].Machine vision attempts to impersonate sensory perception of human beings viz. vision, touch, smell, taste, hearing etc [1]. Efforts are being geared towards the replacement of traditional human sensory panel with automated systems, as human operations are inconsistent and less efficient [8]. Scientists have successfully endowed computers with machine vision by digital cameras and machines.[4] Extreme research is in progress all over the country on application of electronic eye and nose in food, beverage and agricultural industry [20].Many industries have come up with the same but its quite costly.

Oryza Sativa L(Rice) is a vital worldwide agriculture product. It is one of the leading food crops of the world as more than half of the world's population relies on rice as the major daily source of calories and protein[8]. Rice (Oryza sativa L) is cultivated in several countries such as India, China, Indonesia, Bangladesh and Thailand which are considered as the major producers. India is the world's 2nd largest producer and consumer country of rice for a very long time.

This paper presents a solution to the problem faced by Indian Rice industry. Section 2 discusses the Particular problem of quality evaluation of Masoori Rice seed (Oryza sativa L). Section 3 talks about the materials and methods proposed for calculating parameters for the quality of rice seeds (Oryza sativa L).The proposed system and proposed algorithm for computing Rice seed (Oryza sativa L)with long seed as well as small seed being present in the sample is also discussed in the same section. Section 4 discusses the quantification for the quality of rice seeds based on image processing and analysis. Section 5 discusses results based on quality analysis. Section 6 provides the conclusion of the proposed process.

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II. PROBLEM DEFINITION

In agricultural industry quality assessment of product is main problem. Nowadays, the quality of grain seed has been determined manually through a visual inspection by experienced technicians. So it requires high degree of accuracy to satisfy customer need of high level of quality as well as correctness for a non-destructive quality evaluation method which is proposed based on image processing [4,12].

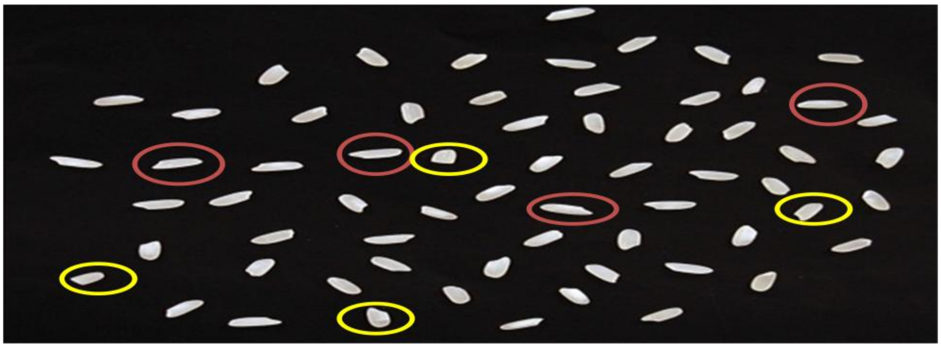

Figure 1. Masoori Rice seed with and without foreign elements

Masoori rice(Oryza sativa L) seed contains foreign elements in terms of long as well as small seed. As shown in Figure 1 the red colored circles are long and yellow colored ones are too small.These seeds are having very much importance in quantifying quality. At the time of processing these seeds are removed. Proper removal of this seed is necessary if it is not so then it creates degradation in quality of rice seed. This paper proposes a new method for counting the number of Masoori rice (Oryza sativa L) seeds with these foreign elements using computer vision non destructive technique based on combined measurement techniques to quantify the quality of Masoori rice(Oryza sativa L) seeds.

III. MATERIALS AND METHODS

In this section we discuss the proposed algorithms. Here we have used different varietal samples of Masoori rice. we define quality based on the combined measurement technique. we use area, major axis length, minor axis length and eccentricity of rice seed for counting the number of Masoori rice (Oryza sativa L) seeds with long seeds, normal seeds as well as small seeds.

i) System Description and Operating Procedure:

A schematic diagram of the proposed system is in Figure 2.In our proposed system there is a camera which is mounted on the top of the box at point 1. The camera is having 12 mega pixels quality with 8X optical zoom. After capturing images of rice seed by camera is stored for further processing. To evade problem of illuminance and for good quality of image, we used two lights at point 2 and 3. We can also use butter paper for uniform distribution of light on the tray. In our system box contains opening which can be seen at point 4. At point 5 which is a tray in which rice seeds will be inserted for capturing an image[16].

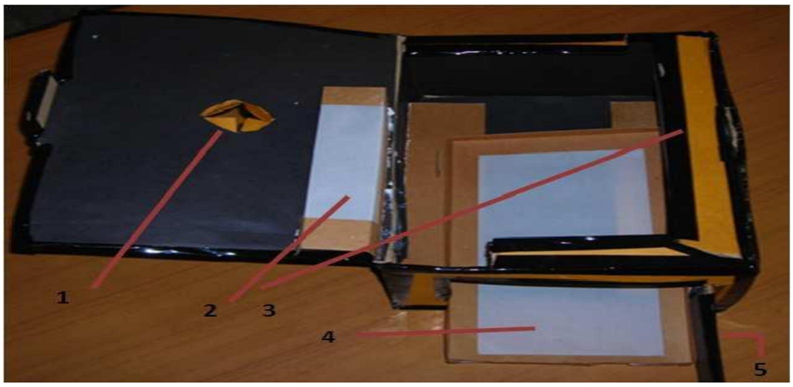

Figure 2. Proposed Machine Vision System For Analysis Of Seed

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The simplicity of operation of system can be concluded from the operating procedure detailed in Table 1.

Table 1 Operating procedure for proposed system

Sr. No	STEPS
1	Spread the samples of seeds uniformly on the tray to avoid overlapping of seeds
2	Capture images
3	Process and analysis of digital image in computer
4	Display number of normal rice seeds, long rice seeds and small seeds.
5	Repeat above steps for 10 to 15 samples

ii)Proposed algorithm to detect rice seeds with long and small seeds:

According to our proposed algorithm as in Table 2, first capture image of sample spread on the black or butter paper using camera. This image is color image so we convert it in to gray scale image as the color information is not of importance. The identification of objects within an image is a very difficult task. One way to make straightforward the problem is to use optimal edge detector, ISEF, for extracting edges of gray scale image. This phase identifies individual object boundaries and marks the centre of each object for further processing. Thresholding is used to convert the segmented image to a binary image. The output binary image has values of 1 (White areas) for all pixels and 0 (black) for all other pixels.

Table 2 Proposed Algorithm

Sr. No.	STEPS
1	Select the region of interest of the rice seeds
2	Convert the RGB image to gray images
3	Apply the edge detection operation
4	Calculate the parameters of the rice seeds
5	Compute the histogram of the parameters of rice seeds and find out the threshold ranges.
6	Display the count of normal, long and small rice seeds on screen.

iii) ISEF Edge Detection:

The edge can be detected by any of template based edge detector but Shen-Castan Infinite symmetric exponential filter based edge detector is an optimal edge detector like canny edge detector which gives optimal filtered image[18]. First the whole image will be filtered by the recursive ISEF filter in X direction and in Y direction. Then the Laplacian image can be approximated by subtracting the filtered image from the original image. For thinning purpose apply non maxima suppression as it is used in canny for false zero crossing. The gradient at the edge pixel is either a maximum or a minimum. Now gradient applied image has been thinned, and the problem of Streaking can be eliminated by thresholding with Hysteresis. Finally thinning is applied to make edge of single pixel. The ISEF algorithm is given inTable3.

Table 3 ISEF algorithm

Sr.No.	Steps
1	Apply ISEF Filter in X & Y direction
2	Apply Binary Laplacian & Non Maxima Suppression Technique
3	Find the Gradient
4	Apply Hysteresis Thresholding
5	Thinning

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(a) (b) (c)
Figure 3. Rice seed with and without foreign elements

(a) (b) (c)
Figure 4. After edge detection operation rice seed without and with foreign elements

In Figure 3(a) normal rice seed of good quality is shown, while Figure 3(b) and Figure 3(c) contains an image of a long seed and small seed. After applying the Edge detection operation, we get images of Figures 4(a) ,(b) and (c) respectively.

iv) Parameter Calculation:

Here we are extracting four parameters area, major axis ,minor axis length and eccentricity for differentiating normal rice seed from long seed as well as small seed.

“The area (A) of any object in an image is defined by the total number of pixels enclosed by the boundary of the object.”

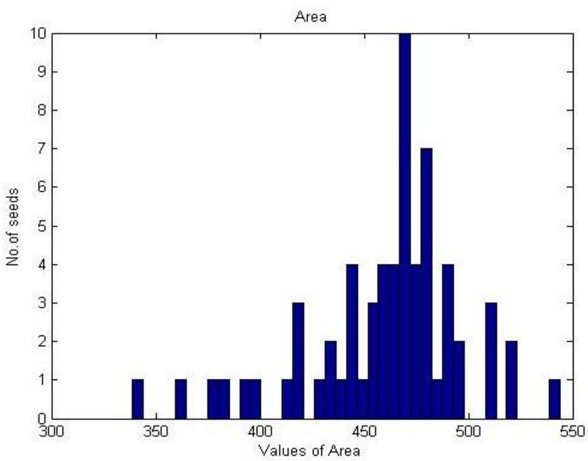
“The major axis length (N) of an image is defined as the length (in pixels) of the major axis of the ellipse that has the same normalized second central moments as the region.”

“ The minor axis length (M) of an image is defined as the length (in pixels) of the minor axis of the ellipse that has the same normalized second central moments as the region.”

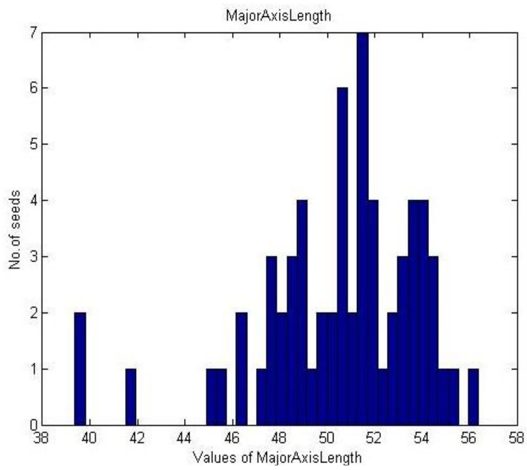
“The eccentricity is the ratio of the distance between the foci of the ellipse and its major axis length. The value is between 0 and 1.”

For Area calculation, we define area of a normal seed is **A**, area of long seed is **B** and area of small seed is **C**. Area **A** is having a normally less value then area B and area **C** is having a less value than area **A**. Use of Vernier caliper for quality evaluation by human inspector can be replaced by Major axis, Minor axis calculation. For eccentricity calculation a long seed is having bigger value than the normal seed and small seed.

Diagram for histogram for area, Major axis length ,Minor axis length and Eccentricity calculation computed from sample is shown in Figure 5 (a) -to-(d).



(a) Area



(b) Major Axis

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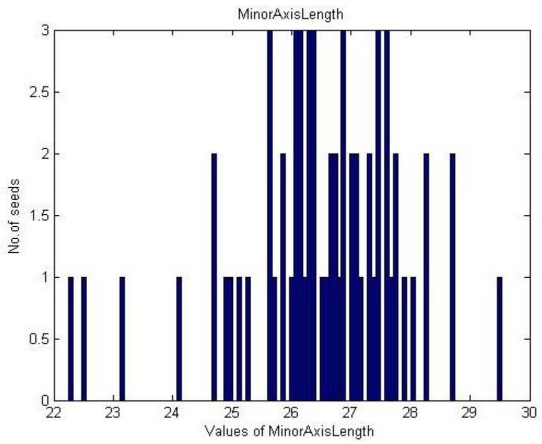
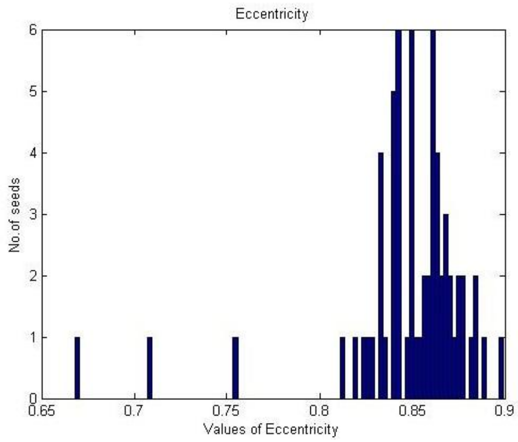


(c) Minor axis



(d) Eccentricity

Figure 5. Histograms of parameters for Masoori rice seeds

IV. RESULT ANALYSIS

Classification of Rice Seeds can be done based on assessment of parameters like Area, Major axis, Minor axis and eccentricity. The original image is shown in figure 6 and gray scale image is shown in figure7.Image after performing edge detection operation is in Figure 8.

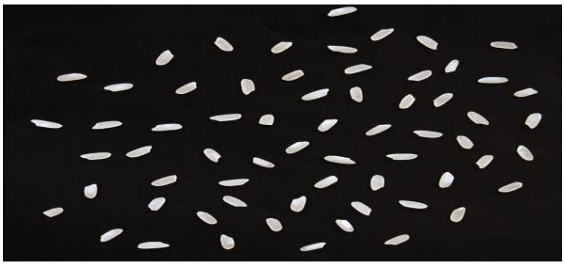


Figure 6. RGB image of one of the sample of Masoori Rice seed

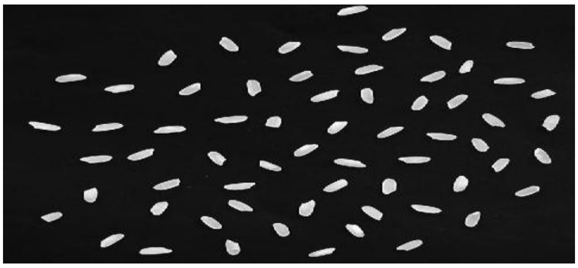


Figure 7 Gray-scale image of one of the sample of Masoori Rice seed

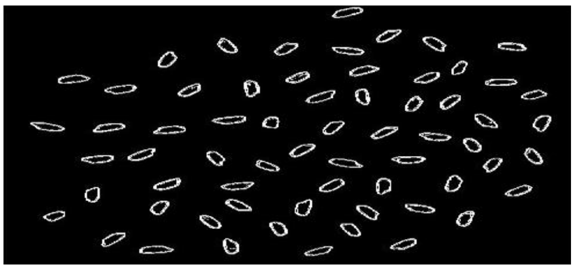


Figure 8. Image after edge detection operation of one of the sample of Masoori Rice seed

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Table 4 shows intended parameters value for twenty seeds of one of the sample of Masoori Rice out of ten samples based on histogram for normal seeds, ling seeds and small seeds respectively. Table 5 and Table 6 shows calculated parameters value and percentagewise calculated parameters value based on histograms.

Table 4 Analysis for Several Seed available in one Sample

Sr.No.	Area	Major Axis Length	Minor Axis Length	Eccentricity
1	339	39.375	27.778	0.7087
2	360	39.679	29.533	0.6678
3	384	46.389	22.244	0.8775
4	391	46.339	24.091	0.8542
5	400	49.117	22.533	0.8885
6	411	48.052	26.112	0.8394
7	421	47.683	25.886	0.8398
8	439	49.059	27.083	0.8338
9	448	51.742	26.349	0.8606
10	459	54.261	27.571	0.8612
11	469	48.831	26.035	0.8460
12	478	51.675	24.974	0.8754
13	488	51.627	24.698	0.8781
14	490	50.786	24.681	0.8739
15	493	53.450	24.927	0.8845
16	495	51.832	26.756	0.8564
17	513	45.683	26.233	0.8186
18	520	50.829	27.642	0.8391
19	521	51.451	25.599	0.8674
20	544	51.616	26.556	0.8574

Table 5 Result analysis of various samples based on algorithm

Sample No.	Normal seed	Long seed	Small seed	Total seed
1	58	1	1	60
2	60	1	3	64
3	52	2	1	55
4	49	1	2	52
5	52	2	1	55
6	48	6	1	55
7	49	3	1	53
8	51	4	1	56
9	47	6	1	54
10	52	2	3	57

Table 6 Result analysis of various samples based on Percentage value

Sample No.	Normal seed	Long seed	Small seed	Total seed
1	56	2	2	60
2	58	4	2	64
3	50	3	2	55
4	49	2	1	52
5	50	3	2	55
6	49	4	3	55
7	48	3	2	53
8	50	4	2	56
9	51	3	1	54
10	50	4	3	57

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We compare the results with ground truth data. Table 7 shows values calculated based on Human Sensory Evaluation Panel for normal seeds, Long seeds and Small seeds of various sample. Table 8 shows the percentagewise calculated value based on Human Sensory Evaluation Panel for the same.

Table 7 Result analysis of various samples based on Human Sensory Evaluation Panel

Sample No.	Total seed	Normal seed%	Long seed%	Small seed %
1	60	96	2	2
2	64	94	2	4
3	55	94	4	2
4	52	94	2	4
5	55	94	4	2
6	55	87	11	2
7	53	92	6	2
8	56	91	7	2
9	54	87	11	2
10	57	91	3	6
	Average	**94**	**4**	**2**

Table 8 Result analysis of various samples based on Percentage value of Human Sensory Evaluation Panel

Sample No.	Total seed	Normal seed%	Long seed%	Small seed %
1	60	93	3	3
2	64	91	6	3
3	55	91	5	4
4	52	94	4	2
5	55	90	5	3
6	55	89	7	5
7	53	90	6	4
8	56	89	7	4
9	54	94	5	2
10	57	88	7	5
	Average	**91**	**6**	**3**

V. CLASSIFICATION OF RICE SEED

For finding out the number of normal rice seeds, long rice seeds and small rice seeds we compute thresholds values using the histograms of Figure 5 (a) -to-(d) for area, minor axis length, major-axis length and eccentricity as mention in Table 7.

Table 7 Computed threshold values

Parameters	Small seed	Normal seed	Long seed
Area	350-400	400-525	525-600
Major Axis Length	35-45	45-55	55-60
Minor Axis Length	18-25	25-33	33-40
Eccentricity	0.7-0.8	0.8-0.89	0.89-0.96

The quality Q, of Rice seeds is not having any particular formula for quantification and assessment. The quality factor Q depends on foreign materials. If these parameters increase percentage wise in the bulk of Rice seeds then as a result the quality Q would decrease. Hence the quality factor Q is inversely proportional to Rice seed with foreign materials. So the Q factor can be defined as

$$Q = \frac{c}{x_1 + x_2}$$

Assuming C to be 100, Q Table can be prepared defining various Q values on the basis of two parameters x1 and x2. For instance if one consider x1 to be 11% and x2 to be 1% the quality factor Q would be 9.09. This particular instance predicts the grade of Rice seeds to be ”A” as seen from the Figure 8. The top most ellipse represents Grade A normal seeds, the red color filled area represents grade B which comprise of higher percentage of long seeds .The bottom most encircled area is grade C for small seeds.

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X1 / X2	1	5	9	13	17	21	25
1	50	16.6666	10	7.1428	5.5555	4.5454	3.8461
5	16.6666	10	7.1428	5.5555	4.5454	3.8461	3.3333
9	10	7.1428	5.5555	4.5454	3.8461	3.3333	2.9411
13	7.1428	5.5555	4.5454	3.8461	3.3333	2.9411	2.6315
17	5.5555	4.5454	3.8461	3.3333	2.9411	2.6315	2.3809
21	4.5454	3.8461	3.3333	2.9411	2.6315	2.3809	2.1739
25	3.8461	3.3333	2.9411	2.6315	2.3809	2.1739	2

Figure 9: Q Curves according to Equation

VI. CONCLUSION AND FUTURE WORK

This paper presents a quality analysis of Masoori rice seeds via image analysis. We are calculating area, major axis length, minor axis length and eccentricity for counting normal seed and foreign element in terms of long as well as small seed for a given sample. This paper illustrates new method which is non-destructive for quality analysis. Traditionally quality evaluation and assessment is done by human sensory panel which is time consuming, may be variation in results and costly. For quality analysis more parameters can be calculated to make more accurate results.

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BIOGRAPHY

Chetna V. Maheshwari
Graduated in Electronics & Communication Engineering from the Government Engineering College, Modasa, North Gujarat University (Patan) , Gujarat, India in 2001. She has done her Master's in Communication Engineering from G H Patel College of Engineering and Technology(GCET), V. V. Nagar Gujarat Technological University(GTU) in 2012. She is working as a Assistant Professor in G H Patel College of Engineering and Technology(GCET), Vallabh Vidyanagar, Gujarat, India. She has published several National & International Conference Papers as well as international Journal papers based on Computer Vision and Image processing.