Parametric quality analysis of Indian Ponia Oryza Sativa ssp Indica (rice)

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Abstract— Quality assessment of grains is a very big challenge in the Agricultural industry.The paper presents a solution for parametric quality analysis and grading of Rice. Machine vision provides one alternative for an automated, non-destructive and cost-effective technique. With the help of proposed method for solution of quality assessment via computer vision, image processing there is a high degree of quality achieved as compared to human vision inspection. This paper proposes a method for counting the number of Oryza sativa L (rice seeds) with long seeds as well as small seeds with a high degree of quality and then quantify the same for the rice seeds based on combined measurements .

Keywords: Machine vision; Quality; Image processing; Image analysis; Oryza sativa L. (rice Seeds); ISEF edge detection; Combined measurements.

I. INTRODUCTION

Food quality is complex, being determined by the combination of sensory, nutritive, hygienic-toxicological, and technological properties.The agricultural industry is probably too oldest and most widespread industry in the world. In this hi-tech uprising, an agricultural industry has become more intellectual and automatic machinery has replaced the human efforts[1]. 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. More than one quality attribute will therefore be considered in most of the manual food quality grading systems.

Based on image processing and analysis, machine vision is a novel technology for recognizing objects and extracting quantitative information (Features) from digital images [2],[6],[10]. Machine vision attempts to impersonate sensory perception of human beings viz. vision, touch, smell, taste, hearing etc [1]. 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].

Oryza Sativa L(Rice) 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 Ponia 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.

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].

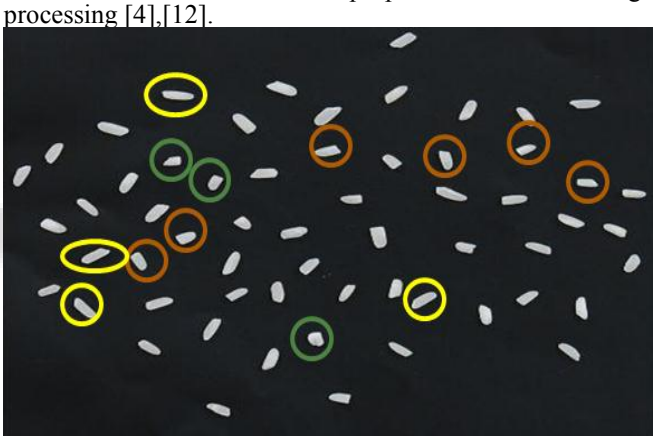

Figure .1: Rice seed with and without foreign elements

Ponia rice(Oryza sativa L) seed contains foreign elements in terms of long as well as small seed as shown in Figure 1.The yellow colored circles are long and green colored ones are too small with red colored circles are normal seed. 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 Ponia rice (Oryza sativa L) seeds with these foreign elements as shown in Figure 2 using computer vision non destructive technique based on combined measurement techniques to quantify the quality of Ponia rice(Oryza sativa L) seeds.

(a) (b)

Figure.2 : Foreign elements in the sample

III. MATERIALS AND METHODS

In this section we discuss the proposed algorithms. Here we have used different varietal samples of Ponia 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 Ponia rice (Oryza sativa L) seeds with long seeds, normal seeds as well as small seeds.

A. *System Description and Operating Procedure:*

A schematic diagram of the proposed system is in Figure 3.In our proposed system there is a camera which is mounted on the top of the box at point 1 in Figure 3. 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 as in the Figure3. 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].

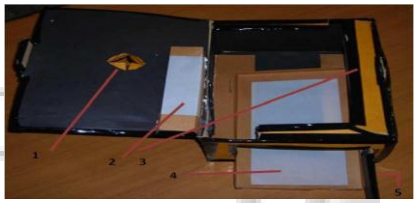

Figure.3: Proposed Machine Vision System For Analysis Of Seed

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

Sr. No	STEPS
1	Spread the samples of seeds uniformly on the tray to avoid overlapping of seeds
2	Capture image of samples
3	Analyze 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

Table-1: Operating procedure for proposed system

B. *Proposed algorithm to detect rice seeds with long and small seeds:*

According to our proposed algorithm first capture image of sample spread on the black or butter paper using camera. This image is color image so we covert 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 straight forward 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.

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.

Table-2 : Proposed Algorithm

C. *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.

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

Table- 3: ISEF algorithm

(a) (b) (c)

Figure .4: Rice seed with and without foreign elements

(a) (b) (c)

Figure .5: After edge detection operation rice seed without and with foreign elements

In Figure 4(a) normal rice seed of good quality is shown, while Figure 4(b) and Figure 4(c) contains an image of a long seed and small seed. After applying the Edge detection operation, we get images of Figures 5(a) ,(b) and (c) respectively.

D. *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, long seed and small seed as **A**, **B** and **C** respectively. Value of **A** is normally less than **B** and **C** is having a less value than **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 of histogram for area, Major axis length, Minor axis length and Eccentricity calculation computed from a sample is shown in Figure 6 –to-9.

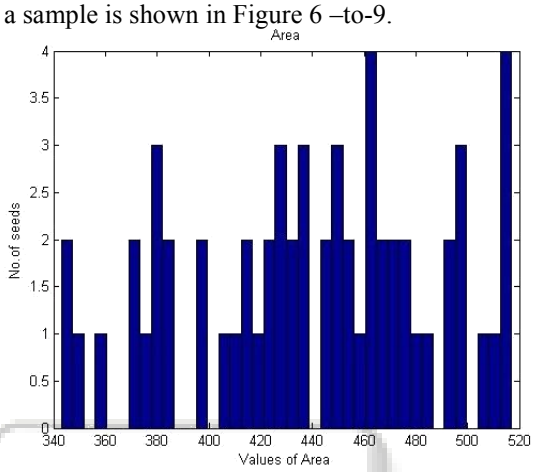

Figure.6: Histogram showing area of Ponia rice seeds

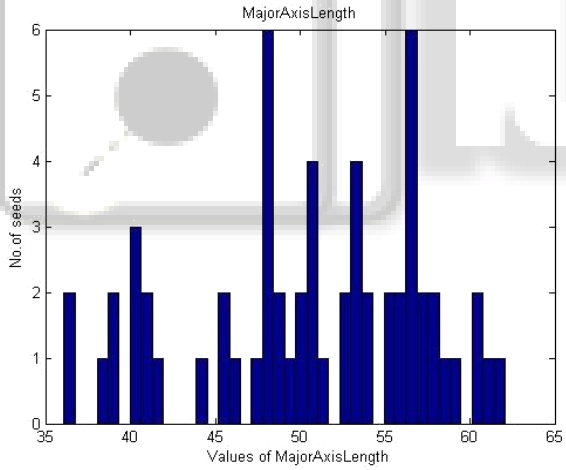

Figure.7: Histogram showing Major Axis of Ponia rice seeds

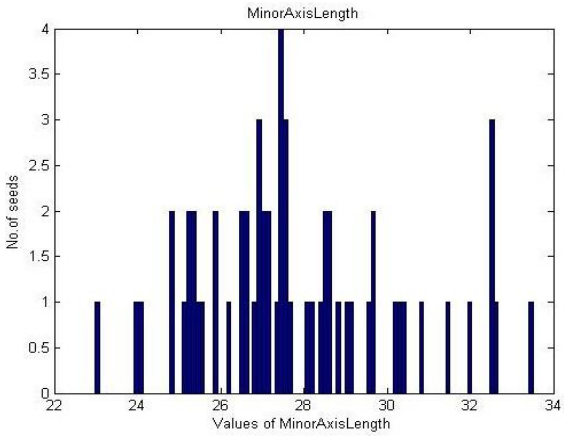

Figure 8: Histogram showing Minor axis of Ponia rice seeds

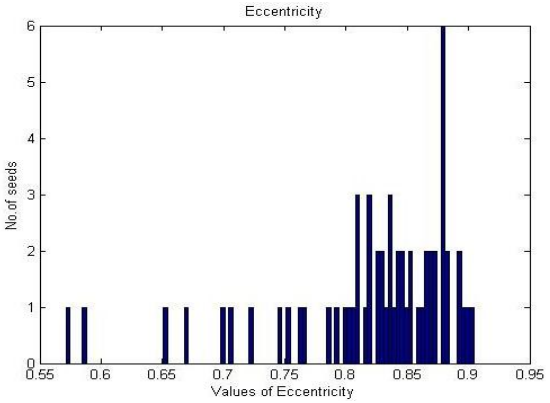

Figure .9 : Histogram showing Eccentricity of Ponia rice seeds

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 10 and gray scale image is shown in figure11.Image after performing edge detection operation is in Figure 12.

Figure .10: RGB image of one of the sample of Ponia Rice seed

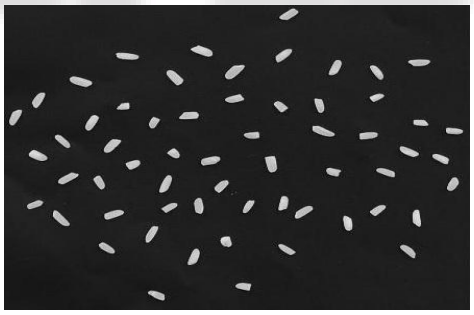

Figure .11: Gray-scale image of one of the sample of Ponia Rice seed

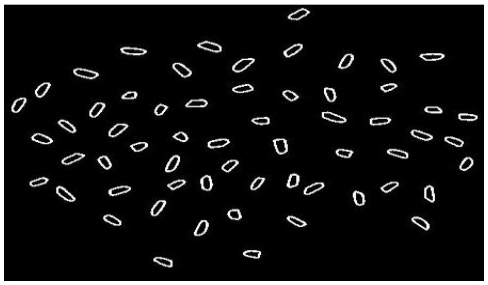

Figure .12: Image after edge detection operation of one of the sample of Ponia Rice seed

Table 4 shows intended parameters value 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.

Sr No.	Area	Major Axis Length	Minor Axis Length	Eccentricity
1	345	36.085	25.576	0.7054
2	360	40.431	26.216	0.7612
3	381	44.333	25.433	0.8190
4	396	40.490	29.004	0.6977
5	409	48.353	22.976	0.8799
6	413	45.637	25.830	0.8243
7	429	47.8701	29.121	0.7937
8	436	52.711	29.598	0.8274
9	438	53.008	24.081	0.8908
10	447	53.019	25.339	0.8784
11	453	53.675	25.367	0.8812
12	461	55.813	27.580	0.8693
13	468	55.417	27.525	0.8679
14	484	56.328	25.277	0.8936
15	491	58.087	27.451	0.8812
16	498	57.220	32.033	0.8286
17	499	56.874	31.587	0.8195
18	506	58.239	32.520	0.8295
19	515	60.608	26.930	0.8958
20	517	56.877	33.516	0.8079
21	355	36.055	25.506	0.7154
22	362	40.401	26.256	0.7712
23	382	44.373	25.453	0.8290
24	336	40.590	29.104	0.6577
25	457	48.368	22.966	0.8499
26	418	45.657	25.840	0.8283
27	435	47.871	29.151	0.7837
28	436	52.721	29.398	0.8374
29	463	53.108	24.021	0.8918
30	454	53.219	25.319	0.8484
31	458	53.685	25.667	0.8612
32	465	55.823	27.540	0.8643
33	478	55.467	26.545	0.8479
34	434	56.358	25.287	0.8636
35	481	58.187	27.455	0.8852
36	469	57.230	32.053	0.8266
37	488	56.854	32.577	0.8165
38	509	58.289	32.554	0.8268
39	525	60.612	26.965	0.8967
40	527	56.875	33.554	0.8067
41	478	57.269	32.038	0.8289
42	486	56.867	32.595	0.8294
43	535	58.259	31.524	0.8295
44	541	60.608	26.930	0.8958
45	524	56.877	33.535	0.8035
46	510	58.259	32.525	0.8237

Table – 4: Analysis for Several Seed available in one Sample

Sample No.	Normal seed	Long seed	Small seed	Total seed
1	50	2	3	55
2	50	8	2	60
3	34	14	3	51
4	43	11	2	56
5	45	2	4	51
6	45	7	1	53
7	47	6	2	55
8	49	2	5	56
9	51	3	4	58
10	49	2	7	58
11	45	2	7	54
12	45	6	5	56
13	41	1	11	53
14	51	3	12	66
15	43	2	10	55

Table-5: Result analysis of various samples based on algorithm

Sample No.	Total seed	Normal seed%	Long seed%	Small seed %
1	55	91	4	5
2	60	84	13	3
3	51	67	27	6
4	56	77	20	3
5	51	88	4	8
6	53	85	13	2
7	55	85	11	4
8	56	88	3	9
9	58	88	5	7
10	58	84	4	12
11	54	83	4	13
12	56	80	11	9
13	53	77	2	21
14	66	77	5	18
15	55	78	4	18
	Average	**82**	**9**	**9**

Table-6:Result analysis of various samples based on Percentage value

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.

Sample No.	Normal seed	Long seed	Small seed	Total seed
1	48	6	1	55
2	49	8	3	60
3	35	3	13	51
4	45	4	7	56
5	47	2	2	51
6	44	5	4	53
7	49	4	2	55
8	48	5	3	56
9	49	4	5	58
10	48	7	3	58
11	45	4	5	54
12	43	6	7	56
13	40	5	8	53
14	48	8	10	66
15	45	4	6	55

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

Sample No.	Total seed	Normal seed %	Long seed %	Small seed %
1	55	87	11	1
2	60	82	13	5
3	51	69	6	25
4	56	80	7	12
5	51	92	4	3
6	53	83	9	7
7	55	89	7	3
8	56	86	9	5
9	58	85	7	8
10	58	83	12	5
11	54	83	7	9
12	56	77	11	12
13	53	76	9	15
14	66	73	12	15
15	55	82	8	10
	Average	**81**	**8**	**11**

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

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 6 to 9 for area, minor axis length, major-axis length and eccentricity as mention in Table 9

Parameters	Small seed	Normal seed	Long seed
Area	**300-360**	**360-500**	**500-580**
Major Axis Length	**35-40**	**40-60**	**60-70**
Minor Axis Length	**15-22**	**22-32**	**32-50**
Eccentricity	**0.4-0.6**	**0.6-0.88**	**0.88-0.94**

Table .9 - Computed threshold values

VI. CONCLUSION AND FUTURE WORK

This paper presents a quality analysis of Ponia 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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