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NON-DESTRUCTIVE QUALITY ANALYSIS OF INDIAN GUJARAT-17 ORYZA SATIVA SSP INDICA(RICE) USING IMAGE PROCESSING

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Abstract : The Agricultural industry on the whole is ancient so far. Quality assessment of grains is a very big challenge since time immemorial. The paper presents a solution for quality evaluation and grading of Rice industry using computer vision and image processing. In this paper basic problem of rice industry for quality assessment is defined which is traditionally done manually by human inspector. 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 analysis and processing there is a high degree of quality achieved as compared to human vision inspection. This paper proposes a new method for counting the number of Oryza sativa L (rice seeds) with long seeds as well as small seeds using image processing with a high degree of quality and then quantify the same for the rice seeds based on combined measurements.

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

1. INTRODUCTION

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]. 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 it is 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 2^{nd} 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 Gujarat-17 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.

2. 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].

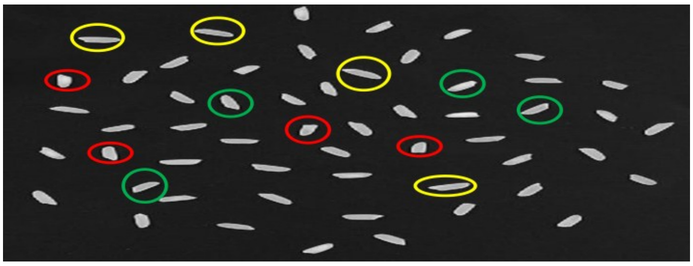


Figure 1. Rice seed with and without foreign elements

Gujarat-17 rice(Oryza sativa L) seed contains foreign elements in terms of long as well as small seed as shown in Figure 1. The yellow coloured circles are long and red coloured ones are too small with green coloured 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 Gujarat-17 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 Gujarat-17 rice(Oryza sativa L) seeds.

Figure 2. Foreign elements (Long seed and Small seed) in the sample.

3. MATERIALS AND METHODS

In this section we discuss the proposed algorithms. Here we have used different varietal samples of Gujarat-17 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 Gujarat-17 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 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].

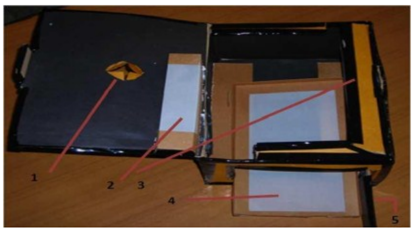


Figure 3. Proposed Machine Vision System For Analysis Of Seed

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

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 image of seeds
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 first capture image of sample spread on the black or butter paper using camera.

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.

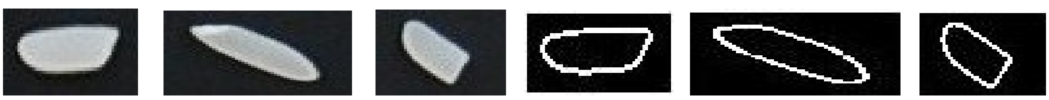
This image is color image so we covert it in to gray scale image as the color information is not of importance. The identification of objects within an image is a very difficult task. One way to make straightforward the problem is to use optimal edge detector, ISEF, for extracting edges of gray scale 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.

ii) 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 in Table3.

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



(a) (b) (c) (d) (e) (f)

Figure 4 Rice seed with and without foreign elements both original and after edge detection operation.

Figure 4(a) shows normal rice seed of good quality (b) & (c) contains an image of a long seed and small seed. After applying the Edge detection operation, we get images as shown in (d), (e) & (f) 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."

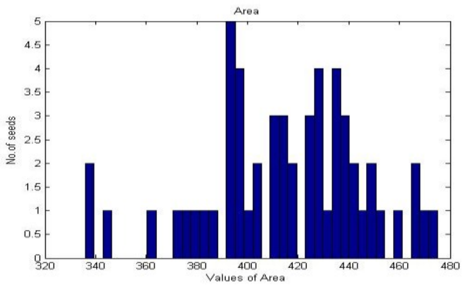
"The major axis length N of an image is defined as the length (in pixels) of the major axis of the ellipse that has the same normalized second central moments as the region."

" 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."

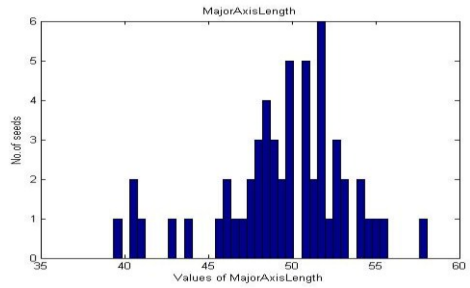
"The eccentricity is the ratio of the distance between the foci of the ellipse and its major axis length. The value is between 0 and 1."

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.

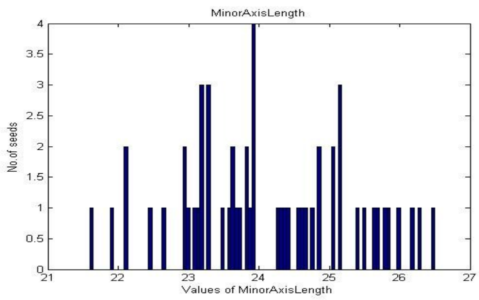
Diagram for histogram for area, Major axis length ,Minor axis length and Eccentricity calculation computed from sample is shown in Figure 5(a) to (d).



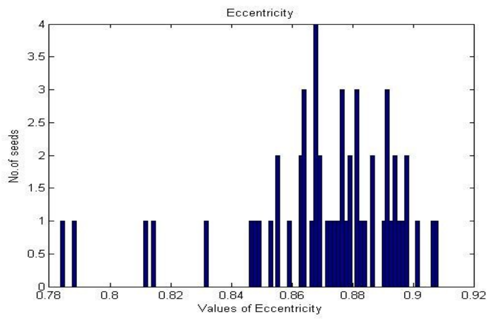
(a)



(b)



(c)



(d)

Figure 5. Histograms for (a)Area (b) Majoraxislength (c) Minoraxislength (d) Eccentricity of Gujarat-17 rice seeds

4. RESULT ANALYSIS

Classification of Rice Seeds can be done based on assessment of parameters like Area, Major axis, Minor axis and eccentricity. The original (RGB) image, gray scale image and image after performing edge detection operation is in Figure 6 (a) to (c).

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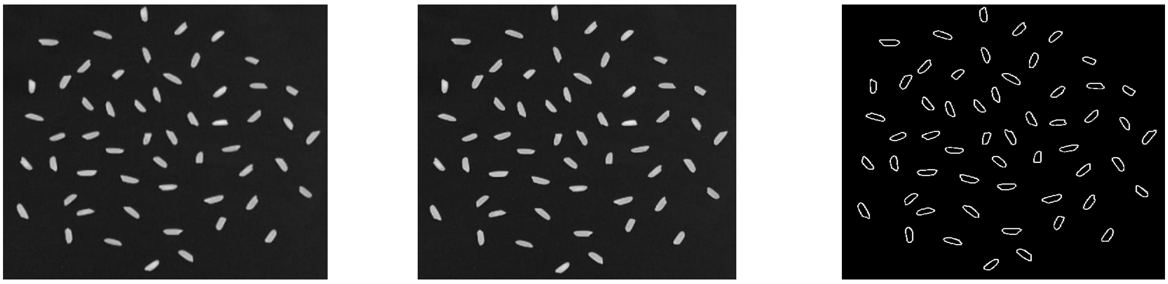

(a) (b) (c)

Figure 6 (a) RGB (b) Gray-scale (c) Edge detected image of one of the sample of Gujarat-17 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.

Table 4 Analysis for Several Seed available in one Sample

Sr.No.	Area	Major Axis Length	Minor Axis Length	Eccentricity
1	336	39.364	22.994	0.8116
2	362	41.154	23.897	0.8141
3	385	46.729	23.481	0.8645
4	398	47.456	25.169	0.8477
5	405	48.739	24.614	0.8633
6	414	51.568	23.289	0.8920
7	416	50.978	24.341	0.8786
8	427	50.993	22.117	0.9010
9	434	51.820	25.669	0.8686
10	440	51.826	25.782	0.8674
11	442	54.094	23.908	0.8970
12	446	50.744	25.501	0.8645
13	449	55.508	24.658	0.8959
14	450	51.950	25.985	0.8659
15	451	53.916	24.420	0.8915
16	460	52.965	25.036	0.8812
17	466	54.335	26.169	0.8763
18	467	53.319	26.501	0.8677
19	470	58.057	24.316	0.9080
20	475	54.801	25.629	0.8839

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.

5. 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) –(d) for area, minor axis length, major-axis length and eccentricity as mention in Table 9.

Table 5 Result analysis of various samples based on Algorithm

Sample No.	**Normal seed**	**Long seed**	**Small seed**	**Total seed**
1	48	1	2	51
2	45	2	7	54
3	48	1	5	54
4	46	1	3	51
5	50	2	3	55
6	44	2	6	52
7	52	1	4	57
8	50	1	3	54
9	52	1	5	58
10	50	1	2	53
11	51	1	6	58
12	47	4	3	54
13	44	2	7	53
14	48	1	7	56
15	43	3	6	52

Table 6 Result analysis of various samples based on Percentage value

Sample No.	Total seed	Normal seed%	Long seed%	Small seed %
1	51	94	2	4
2	54	83	4	13
3	54	89	2	9
4	51	90	2	8
5	55	91	4	5
6	52	85	4	11
7	57	91	2	7
8	54	92	2	6
9	58	90	1	9
10	53	94	2	4
11	58	88	2	10
12	54	87	7	6
13	53	83	4	13
14	56	86	2	12
15	52	83	6	11
	Average	**89**	**2**	**9**

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

Sample No.	**Normal seed**	**Long seed**	**Small seed**	**Total seed**
1	45	3	3	51
2	44	6	4	54
3	47	3	4	54
4	45	2	3	51
5	52	1	2	55
6	46	4	2	52
7	54	1	2	57
8	47	4	3	54
9	51	3	4	58
10	45	3	7	53
11	49	4	5	58
12	44	5	5	54
13	49	2	2	53
14	52	3	1	56
15	40	2	10	52

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	51	88	6	6
2	54	81	11	8
3	54	87	6	7
4	51	88	4	8
5	55	94	2	4
6	52	88	8	4
7	57	95	2	3
8	54	87	7	6
9	58	88	5	7
10	53	85	6	9
11	58	84	7	9
12	54	82	9	9
13	53	92	4	4
14	56	93	5	2
15	52	77	4	19
	Average	**87**	**6**	**7**

Table 9 Computed threshold values

Parameters	**Small seed**	**Normal seed**	**Long seed**
Area	300-360	360-460	460-550
Major Axis Length	25-40	40-55	55-70
Minor Axis Length	20-22	22-26	26-30
Eccentricity	0.7-0.8	0.8-0.9	0.9-0.96

6. CONCLUSION AND FUTURE WORK

This paper presents a quality analysis of Gujarat-17 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. The time taken to obtain such results is also very less which clearly depicts its importance in the world of automation. 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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