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Occlusion Resilient Quality Evaluation of Cuminum cyminum L (Cumin Seeds) Using Machine Vision

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Abstract

Quality evaluation of cumin seeds using machine vision technique suffer from system operational issues like occlusion or overlapping of seeds during test preparation by the operator of system. When due care is not taken by the system operator in spreading the seeds on the test tray, occlusion of the seeds occur. This severely deteriorates the system performance by dramatic change in quality value. The proposed α- trimmed mean filter based outlier rejection technique which makes the system occlusion resilient

KEYWORDS: - Quality control, Machine Vision, Cuminum cyminum L (Cumin Seeds), occlusion resilient, combined measurements.

1. Introduction

Intense research is in progress all over the world on application of electronic eye and nose in food, beverage and spice industry. Since non destructive testing [8], [1] makes it possible to examine the condition or quality of food without damaging it, the use of non destructive analytical techniques is quickly gaining momentum in the food industry. Kavindra Jain [19] ET. al. proposed a system (as shown in figure - 1) for non destructive quality evalution of cuminum cyminum L (cumin seeds).

Cuminum cyminum L (Cumin) is a small and slender annual herb, which grows up to a height ranging from 40-50 cm with many branches and linear, dark green leaves. The stem has 3-5 primary and 2-3 secondary branches. The seeds are mostly used as condiments in the form of an essential ingredient in all mixed spices and in curry powder for favoring vegetables, pickles, soups, sausages, cheese and other preparations and also for seasoning of breads, cakes and biscuits.

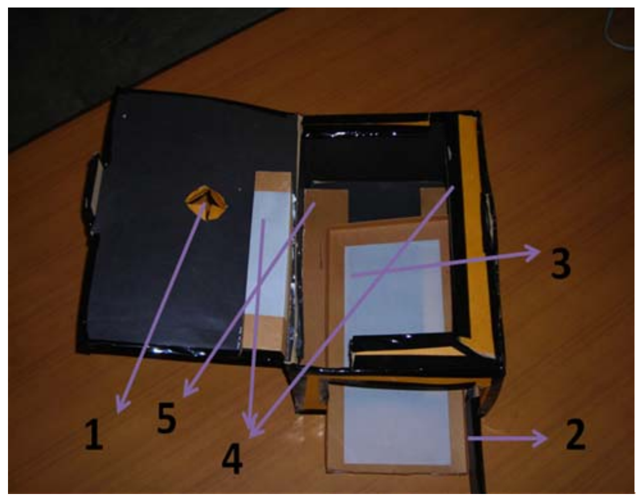


Fig 1: Proposed system for analysis

It is used in many Ayurvedic and veterinary medicines as carminative, stomachic, astringent and is useful against diarrhoea and dyspepsia. A Cuminum cyminum L (cumin) seed contains pedestals as shown in Figure 2. If seen closely to the cumin seeds having pedestals they are of prime importance for quantifying quality. If these pedestals are incorrectly removed then it not only deteriorates the quality but it also increases its pungency. This may lead to microbial growth and blackening of kernel at that particular point. The foreign elements being present are shown in figure 3.

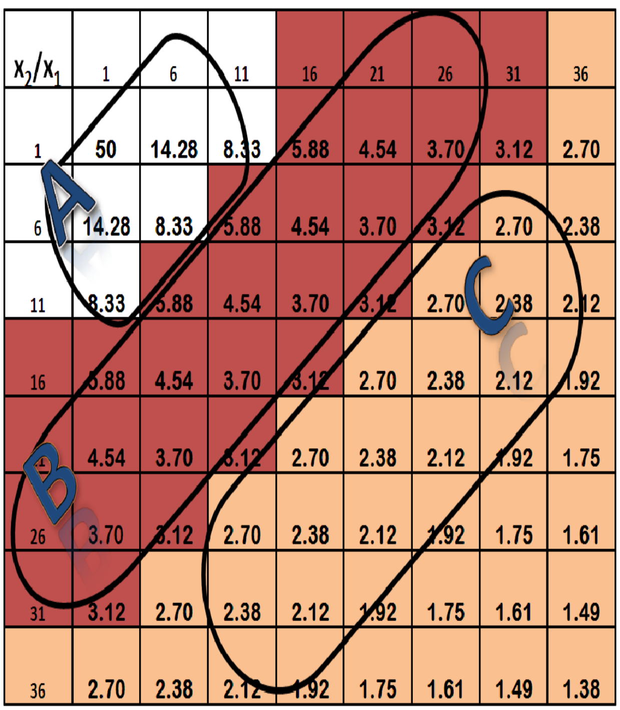

Fig 2: Cumin seeds with & without pedestals

Fig 3: Foreign Elements in the sample

The parameters used to evaluate quality of the cumin seeds are [19] area and minor axis length of each seeds in the sample. Then the quality value Q is computed using the following equation.

$$Q = \frac{c_1 c_2}{X_1 + X_2} \quad \text{........(1)}$$

Where, X_1 is average percentage of cumin seeds with pedestals and X_2 is average percentage of cumin seeds with foreign elements. Based on the Q values, Quality curves were introduced [19] as shown in figure 4. Based on these curves the final grade of the cumin seeds can be concluded.



X_2/X_1	1	6	11	16	21	26	31	36
1	50	14.28	8.33	5.88	4.54	3.70	3.12	2.70
6	14.28	8.33	5.88	4.54	3.70	3.12	2.70	2.38
11	8.33	5.88	4.54	3.70	3.12	2.70	2.38	2.12
16	5.88	4.54	3.70	3.12	2.70	2.38	2.12	1.92
21	4.54	3.70	3.12	2.70	2.38	2.12	1.92	1.75
26	3.70	3.12	2.70	2.38	2.12	1.92	1.75	1.61
31	3.12	2.70	2.38	2.12	1.92	1.75	1.61	1.49
36	2.70	2.38	2.12	1.92	1.75	1.61	1.49	1.38

Fig 4: Q Curves based on Quality Formula

In this paper we dealt with the problem of occlusion of seeds and their effect on quality evaluation. During the operation of the system for quality evaluation, one needs to make sure that the seeds are spread properly on the sheet given for inspection. But by chance, when two seeds came very near, there will be occlusion which will be reflected as a single object in the image. This will affect the final quality and grade evaluation. This problem is discussed in detail in Section 2. Section 3 discusses the proposed algorithm for occlusion resilient quality evaluation. Section 4 discusses the results obtained from the proposed algorithm. Section 6 concludes the paper along with indebted acknowledgment and references failing which research would be a success.

2. Problem Definition

This section is broadly divided into two sub sections. In first sub section the method proposed in [19] is briefly outlined with respect to images without occlusion. In the second sub section we evaluate the method's performance with respect to overlapping of seeds (occlusion). Further we investigate this problem's effect in calculation of Q values and its effect on final conclusion of grade of the seeds.

2.1. Basic algorithm to evaluate quality of cumin seeds [19]:

The basic algorithm to evaluate quality of cumin seeds is described in table. 1. The image captured for a sample of cumin seeds is shown in figure 5. The basic algorithm finds area and minor axis length and using equation (1) of quality the Q values are found out. Then the grade of the sample is decided using the Q curves as shown in figure 4.

For a specific sample shown in figure 5, we get the Q value equal to 3.269; hence it is concluded as Grade B cumin seeds.

Fig 5: RGB image of the sample

Table I

Basic algorithm to compute quality of Cumin Seeds

Sr.No.	Steps
1.	Select the region of interest of the cumin seeds
2.	Convert the RGB image to gray images
3.	Apply the ISEF edge detection.
4.	Calculate the area of cumin seeds.
5.	Calculate the minor axis of the cumin seeds.
6.	Find the histogram of the areas of cumin seeds.
7.	Compute the threshold value based on histogram.
8.	Classify the three different classes of cumin seeds based on the threshold value computed from the histogram
9.	Display on screen a) The total number of cumin seeds in the sample b) Number of cumin seeds with pedestals c) Number of foreign materials in the sample

2.2. Effect of Occlusion of seeds:

When the seeds are uniformly spread on the tray before the image is captured at that particular time there are chances of overlapping of two seeds which is called occlusion. The image so captured by webcam available at point number 1 in the system is shown in figure 6. Now when we apply the basic algorithm of table 1 on this image the value of Q changes.

The change in Q value changes the decision boundaries hence overlapping the grades as shown in figure 7 encircled with red & green colors. To understand the problem in detail we analyzed eleven samples with occlusion. The results obtained are shown in Table 2.

Where, X is total seeds available, X_1 is number of cumin seeds with pedestals, X_2 is number of foreign elements & X_3 is number of normal cumin seeds. We find average percentage of cumin seeds with pedestals and average percentage of cumin seeds as foreign elements to find the Q values for this test on occlusion images, these values are given in Table 3.

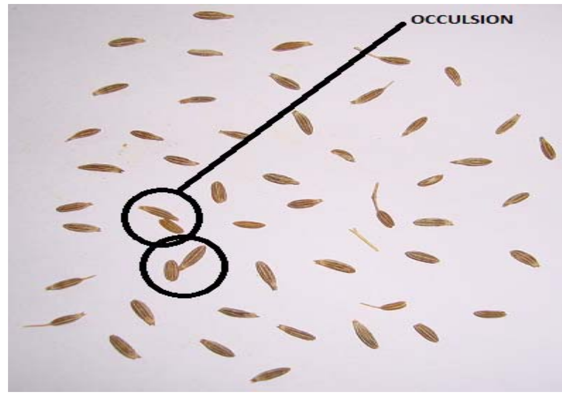


Fig 6: RGB image of the overlapped sample

Using the average percentage of x_1 and average percentage of x_2, if we compute the Q value using equation 1, we get Q equal to 3.9404. The drastic change in value of Q from 3.269 to 3.9404 changes the decision boundaries from B grade to A grade cumin seeds.

Our analysis shows an average change of 6.24 in Q values because of occlusion and a standard deviation of 8.5. Thus there is a demand of an occlusion resilient technique for quality evaluation of cumin seeds using machine vision.

Table 2
Result analysis of various samples due to occlusion

Sr.No.	X	X_1	X_2	X_3
1	51	06	2	43
2	51	10	2	39
3	48	10	3	35
4	50	12	2	35
5	46	8	3	42
6	49	19	0	40
7	53	4	3	46
8	49	16	6	27
9	46	5	1	40
10	49	11	3	35
11	54	10	3	41

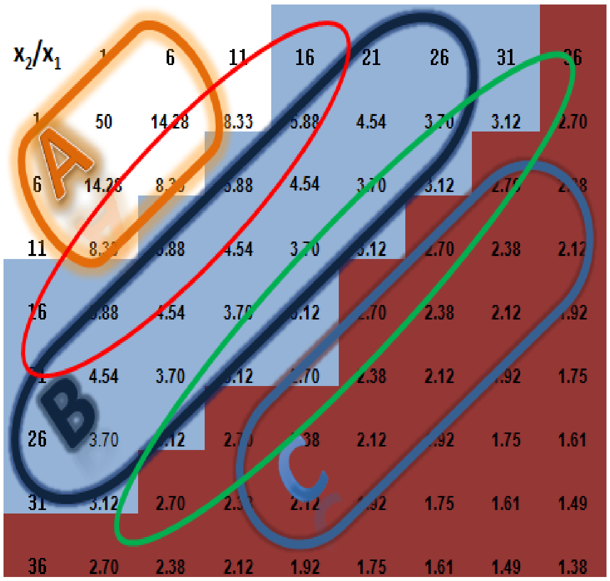


Figure 7: Changed Decision Boundaries in Q Chart

Table 3
Percentage analysis of various samples due to occlusion

Sr.No.	X	Avg. % $\{X_1\}$	Avg. % $\{X_2\}$	Avg. % $\{X_3\}$
1	51	11.7	3.9	84.4
2	51	19.6	3.9	76.5
3	48	20.83	6.2	72.97
4	50	24	4	72
5	46	17.3	6.5	76.2
6	49	38.77	0	61.23
7	53	7.5	5.6	86.9
8	49	32.65	12.24	55.11
9	46	10.86	2.17	86.97
10	49	22.44	6.1	71.46
11	54	18.5	5.5	76
Average		**20.3777**	**5.001**	

3. Materials & Methods

In this section we discuss the proposed algorithm to solve the problem of occlusion in quality evaluation of cumin seeds.

Considering one sample of cumin seeds without occlusion and with occlusion and applying the basic algorithm [19], we get the areas and minor axis lengths as given in Table 4 & 5. Where A represents area of each single cumin seeds with units in pixel square and M represents the minor axis length of each single cumin seeds

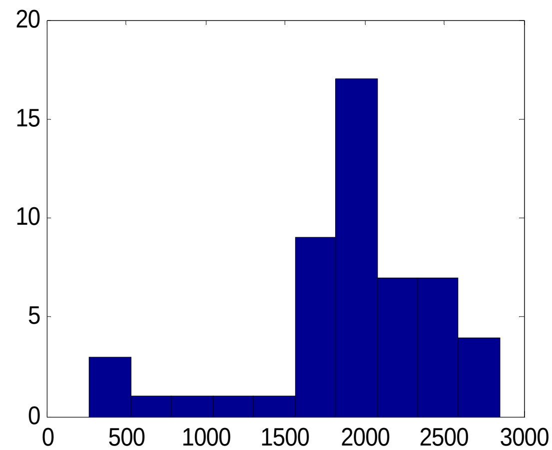


Fig 8: Histogram showing area of Cumin seed without occlusion

When we plot the histograms of both areas and minor axis for both the cases we get the results as shown in **Figure 8, 9, 10, 11.**

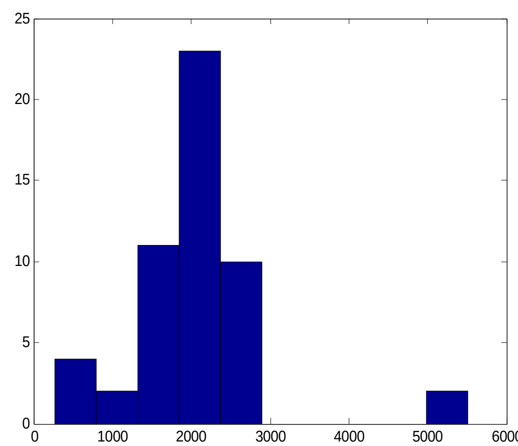


Fig 9: Histogram showing area of Cumin seed with occlusion

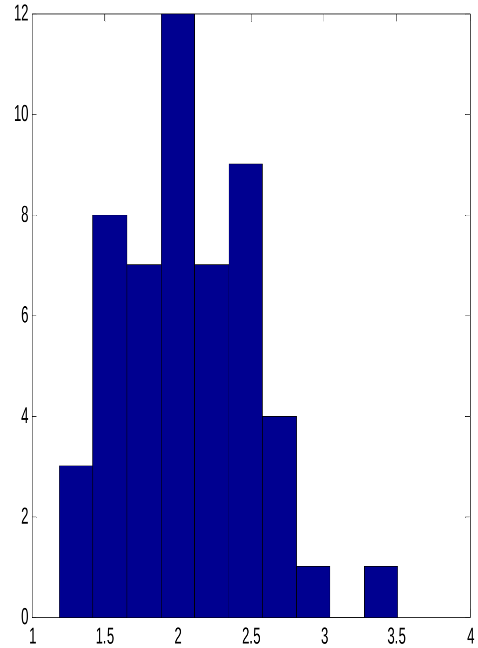


Fig 10: Histogram showing Minor Axis Length of Cumin seeds without occlusion

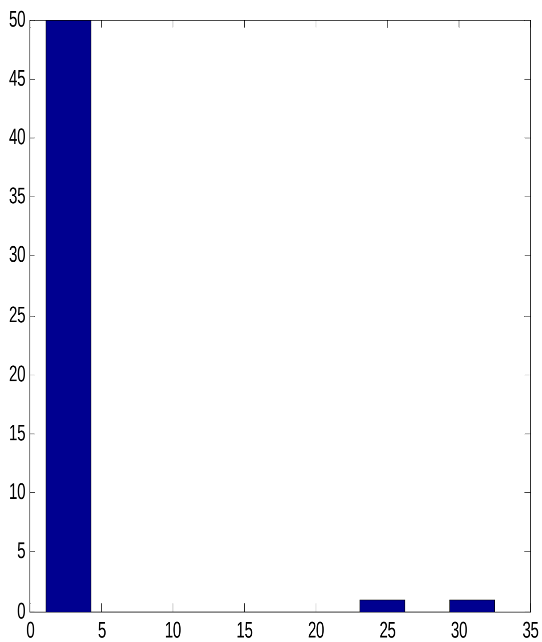


Fig 10: Histogram showing Minor Axis Length of Cumin seeds with occlusion

Table 4
Area & Minor Axis Length of one sample of cumin seeds with occlusion

SNo	A	M	SNo	A	M
1	1979	5.9253	26	2274	3.0929
2	2578	10.0521	27	1855	4.708
3	1650	1.1547	28	2198	1.1547
4	2118	1.1547	29	1706	1.1547
5	2192	1.1547	30	2581	1.1547
6	546	6.3253	31	1902	7.3391
7	2036	1.7405	32	2737	8.3523
8	2851	3.406	33	2754	2.3094
9	2548	1.1547	34	1610	2.1292
10	2045	1.1547	35	1978	1.1547
11	1382	4.944	36	1891	5.4671
12	1842	1.1547	37	1830	1.1547
13	1723	1.1547	38	509	1.1547
14	2148	1.1547	39	2294	4.6944
15	2337	1.1547	40	1932	1.1547
16	1189	1.1547	41	1920	1.1547
17	1881	3.1342	42	2074	4.4106
18	2219	1.1547	43	369	1.1547
19	1963	1.7638	44	1644	1.1547
20	2444	1.4739	45	1898	1.1547
21	992	1.1547	46	2510	1.1547
22	1792	1.1547	47	1646	1.1547
23	2803	1.7868	48	5155	1.1547
24	2064	1.1547	49	5262	3.656
25	1629	1.1547			

Table 5
Area & Minor Axis Length of one sample of cumin seeds without occlusion

SNo	A	M	SNo	A	M
1	1979	5.9253	27	2274	4.708
2	2578	10.0521	28	1855	1.1547
3	1650	1.1547	29	2198	1.1547
4	2118	1.1547	30	1706	1.1547
5	2192	1.1547	31	2581	7.3391
6	546	6.3253	32	1902	8.3523
7	2036	1.7405	33	2737	2.3094
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9	2548	1.1547	35	1610	1.1547
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15	2337	1.1547	41	1932	1.1547
16	1189	1.1547	42	1920	4.4106
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20	2444	1.4739	46	1898	1.1547
21	992	1.1547	47	2510	1.1547
22	1792	1.1547	48	1646	1.1547
23	2803	1.7868	49	2542	3.656
24	2064	1.1547	50	1972	1.1547
25	1629	1.1547	51	273	1.1547
26	1845	2.456			

From the histogram, we can conclude that the areas and minor axis length for the seeds having overlapping results as an outlier. So if we remove these outlier points from the data set and apply the normal procedure of evaluation of Q values then the resultant Q values will be the same as the basic algorithm. To remove these outliers automatically we use α-trimmed median filter. Where α can be taken as 1 or 2.

4. Result Analysis & Discussion

The histograms of combined parameters show clearly the outliers. Hence using α-trimmed median filter all eleven such sample values changes and the modified table is described in detail as follows in table 6.

Table 6
Percentage analysis of various samples after removing outliers on the basis of α-trimmed median filter

Sr.No.	X	Avg. % $\{X_1\}$	Avg. % $\{X_2\}$	Avg. % $\{X_3\}$
1	49	12.2449	4.081633	83.67347
2	49	20.40816	4.081633	75.5102
3	47	21.2766	6.382979	72.34043
4	48	25	4.166667	70.83333
5	44	18.18182	6.818182	75
6	47	40.42553	0	59.57447
7	51	7.843137	5.882353	86.27451
8	47	29.78723	12.76596	57.44681
9	44	11.36364	2.272727	86.36364
10	47	23.40426	6.382979	70.21277
11	52	19.23077	5.769231	75
Average		**20.83328**	**5.327667**	

As a result from the above table we conclude that the value of new Q calculated once again is 3.822 i.e. grade is once again B same as that calculated by Kavindra R. Jain et.al.[19]

7. Future Work

More parameters can be included for combined measurements technique which may result in to precise computation of Q values. A corrugated tray may also be used having depth of such a level that in each hole only one seed is set and hence the problem of overlapping may be solved.

8. Acknowledgement

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References

[1] Abdullah MZ, Fathinul-Syahir AS, Mohd-Azemi BMN (2005)"Automated inspection system for color and shape grading of starfruit (Averrhoa carambola L.) using machine vision sensor." Transactions of the Institute of Measurement and Control, 27 (2), 65-87

[2] Abutaleb AS (1989)"Automatic thresholding of grey-level pictures using two-dimensional entropies." Pattern Recognition, 47 (1), 22-32.

[3] Batchelor BG (1985)"Lighting and viewing techniques In Automated Visual Inspection" (Batchelor BG, Hill DA, Hodgson DC, eds). Bedford: IFS Publication Ltd, pp.103-179.

[4] Blasco J, Aleixos N, Molt E (2003)"Machine vision system for automatic quality grading of fruit." Biosystems Engineering, 85 (4), 415-423.

[5] Canny J (1986)"A computational approaches to edge detection." IEEETransactions on Pattern Analysis and Machine Intelligence, 8 (6), 679-698.

[6] Du C-J, Sun D-W (2006c)"Learning techniques used in computer vision for food quality evaluation: a review." Journal of Food Engineering, 72(1), 39-55.

[7] Gann TH, Pala P, Hutchins DA (2005)"Non-contact ultrasonic quality measurements of food products." Journal of Food Engineering, 77 (2), 239-247.

[8] Ginesu G, Guisto DG, Mrgner V, Meinlschmidt P (2004)"Detection of foreign bodies in food by thermal image processing." IEEE Transactions of Industrial Electronics, 51 (2), 480-490.

[9] Harmond J E,Kelin L M and Brandenburg N R.(1961)."Seed Cleaner and handling".USDA Handbook,179:38-48.

[10] R.P.Kachru et.Al.,"Development and testing of pedal cum power operated air screen cleaner."Agrcultural Machanization in Asia,Africa and Latin America.21(4):29-32.1990

[11] Kapur JN, Saho PK, Wong AKC (1985)" A new method for gray level picture thresholding using the entropy of the histogram." ComputerVision, Graphics, and Image Processing, 29, 273-285.

[12] Pun T (1980)"A new method for gray-level picture thresholding using the entropy of the histogram." Signal Processing, 2 (3), 223-237.

[13] Paulsen M (1990)"Using machine vision to inspect oilseeds." INFORM,1 (1), 50-55.

[14] Pearson T (1996) "Machine vision system for automated detection of stained pistachio nuts." Lebensmittel Wissenschaft and Technologie, 29 (3), 203-209.

[15] Xiaopei Hu, Parmeshwara K.MDavid V. "Development Of Non Destructive Methods To Evaluate Oyster Quality By Electronic Nose Technology". Springer Science Business Media, LLC2008

[16] Du CJ, Sun D-W (2004a) "Recent development in the applications of image processing techniques for food quality evaluation." Trends in Food Science and Technology, 15,230-249.

[17] Shen Castan, Sian Zhao,"A Comparitive study of Performance of Noisy roof edge detection "5th International conference on Computer analysis of Images and Patterns, volu.179,pp 170-174

[18] Vishwanathan R.et.Al..,"Development of hand operated rotary sieve cleaner -cum- grader for seasum seed."A.M.A,25(2):35-36,1994.

[19] Kavindra R. Jain, Chhintan K. Modi, Jalpa J. Patel et.al."non destructive quality evaluation with specific reference to cuminum Cyminum L (cumin seeds) " 2nd International Conference On Emerging Trends In Engineering & Technology,16-18th December 2009 At Nagpur.

[20] Kavindra R. Jain, Chintan K. Modi, Kunal J Pithadiya et.al. "non destructive quality evaluation with specific reference to cuminum Cyminum L (cumin seeds) " CITISIA IEEE International Conference in Malaysia during July 2009.

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