Defect Recognition of Fruit using Statistical Approach

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Abstract — An automated fruit defect recognition and a review of previous defect detection methods are reported. To identify the defects in various digital images visual inspection systems are used. Visual inspection systems have a scanned copy of an object to find the flaws in the object. The visual inspection systems are used in fruit defect detection, textile fabric defect detection, metal crack detection etc. In this work defect detection algorithm focuses on the cropped image (excluding background) of standard size 200*200. The images should be captured with proper focus. The region of the image is equally divided and computing the mean value of each region. Calculating the minimum mean, maximum mean, difference (minimum mean, maximum mean) and average (minimum mean, maximum mean). If the difference is greater than average then it is defected. This methodology is able to recognize fruit defects in natural conditions.

Keywords— **Min_mean, Max_mean, Diff (Min_mean, Max_mean), Avg (Min_mean, Max_mean)**

I. INTRODUCTION

In the rapid change of technological generation [1] manual inspection systems has been moderately reduced. The visual inspection systems are used in many commercial and industrial applications. Some of the visual inspection systems are defect detection of defected fruits, fabrics, tiles, cracked metals etc. Conventionally fruit sorting and grading done by hand is labour intensive [2] quality of fruit processing industry and it is time consuming. Labour shortages and a lack of overall stability in the process resulted in a pursuit for automated solutions .Quality inspection is important to deliver high quality products to the consumer. The various defects

detection techniques that have been proposed to find the different type of image defects are reviewed. Applying wavelet analysis [3] before ICA increases the defect detection rate compared to the use of wavelet transformation or ICA alone in fabric images. The image pixel is deducted from the mean value and divided by standard variance. The intensities that are below certain value are defected. This method [4] works on the analysis of fruit skin as texture image. Bank of Gabor filter is applied on fruit image then based on the response of filter optimal filter is selected. By thresholding the response of optimal filter, skin defects are detected. This method [5] has been offered to categorize normal and defective tiles using wavelet transform and artificial neural networks. The proposed algorithm calculates maximum and minimum medians as well as the standard deviation and average of detail images obtained from wavelet filters, then using feature vectors to classify the given tile using a Perceptron neural network with a single hidden layer. This method [6] extracts the defect from the images which contain complex background and noise. In this algorithm, there are two steps: one was segmentation target from the background and the other was segmentation defect from the target. In the first step, the target image was obtained using the morphology method. Then, the monolayer wavelet coefficient was applied to separate the target image. Next, the redundancy information in the image was removed by low frequency reconstruction. Finally, one and two dimensional Otsu algorithm was used to segment the defect from part surface. Various defect detection techniques are discussed [7] to find different types of image defects. These methods are used to find surface defect in tiles, defect in textile product, detecting skin defects in fruits, detecting defect for various digital image. This method [8] presents the grading of potato based on the green surface on it. The ratio of green pixels to the total number of pixels on the surface of potato is calculated. Higher the ratio worse is the potato. The green colour of the potato is shown by de-serializing the output.

II. PROPOSED ALGORITHM

The steps involved in this algorithm are:

Start

Step1: Reads the image of standard size 200*200

Step2: Converts the rgb image to grayscale image

Step3: Divides each region of the image equally (i.e 4 rows and 4 columns)

Step4: For i=1 to 4, for j=1 to 4

Step5: Finds the mean of each region separately

Step6: Cnt=cnt+1

Step7: Calculate the Min_mean, Max_mean, Diff (Min_mean, Max_ mean), Avg (Min_mean, Max_mean)

Step8: If the diff (Min_mean, Max_mean) > Avg (Min_mean, Max_mean) then the region is defected,
else the region is non defected.

Stop

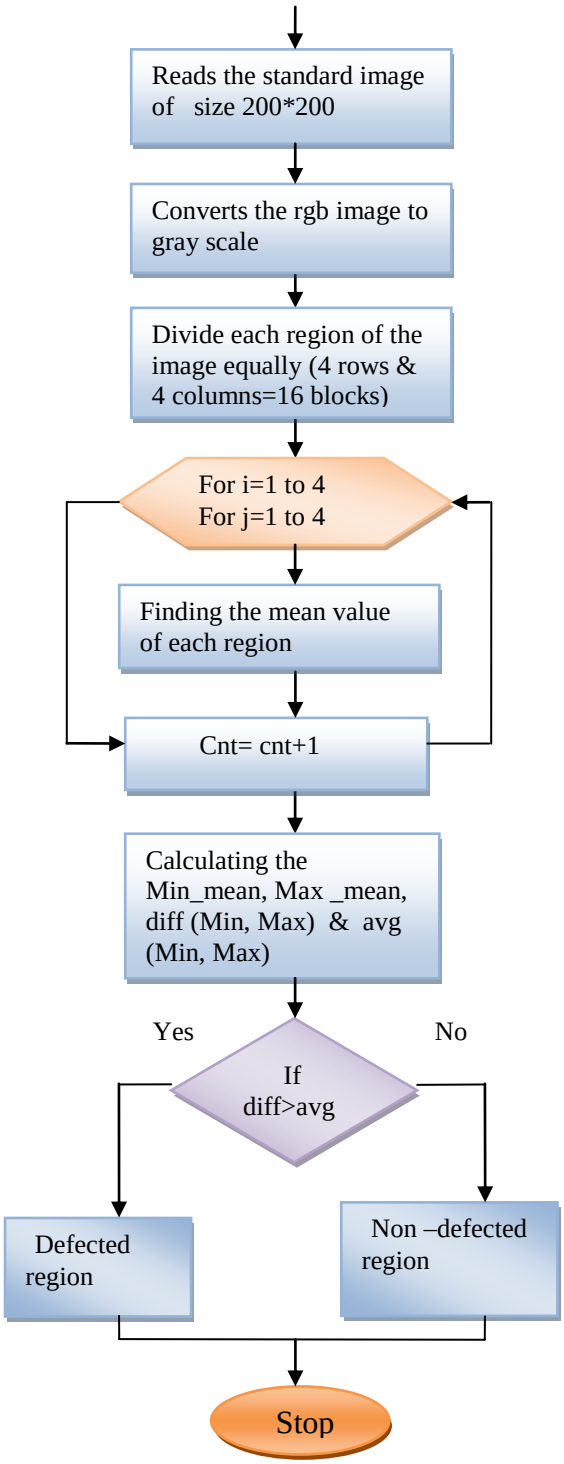

Figure 1.1 Flowchart

In this work, the cropped image (excluding background) of standard size 200*200 is taken as shown in the below figure 1.2. The algorithm converts the colour image to gray scale image. The image is segmented in such a way that the image is equally divided. In this case, four rows and four columns total sixteen regions. Using loop it calculates the mean value of 16 regions. Then calculate the Min_mean, Max_mean, Diff (Min_mean, Max_mean) and Avg (Min_mean, Max_mean). If the Diff (Min_mean) is greater than Avg (Min_mean, Max_mean) then it is defected and if the Diff (Min_mean, Max_mean) is less than Avg (Min_mean, Max_mean) then it is not defected.

If I= {a, b, c, d ……, y, z}

Min_mean= a …… i

Max_mean= z …… ii

Diff=Min_mean – Max_mean

Diff= a – z …… iii

Avg= (Min_mean + Max_mean)/2

Avg= (a + z)/2 …… iv

Diff > Avg is defected region

Diff < Avg is not defected region

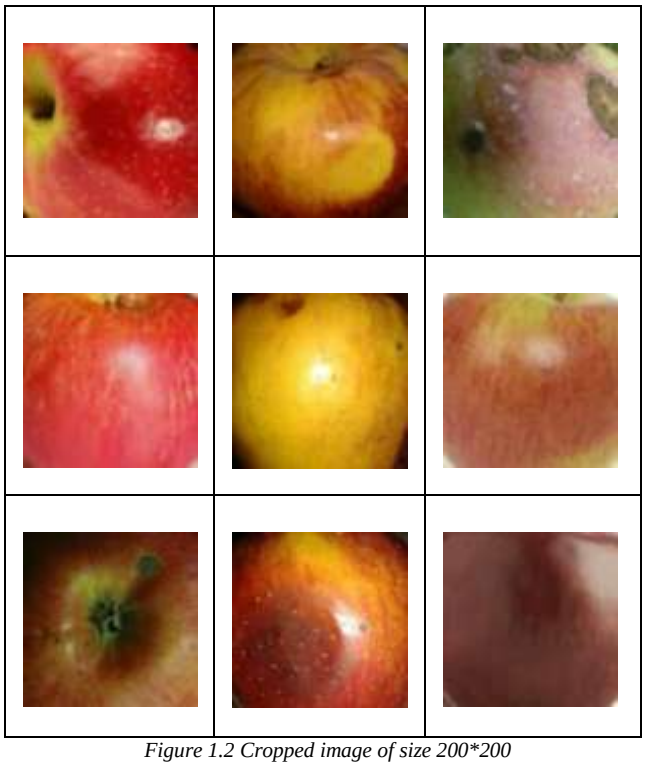

*Figure 1.2 Cropped image of size 200*200*

Case i: If the entire region of the apple is completely defective then difference (minimum mean, maximum mean) is less than average (minimum mean, maximum mean) because

the entire region is defected there is no good region to differentiate. The variation in the mean value is less as shown in experimental result.

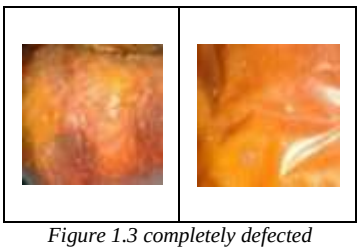

Figure 1.3 completely defected

Case ii: If the entire region of the apple is completely non defective then difference (minimum mean, maximum mean) is less than average (minimum mean, maximum mean) because the entire region is good. The variation in the mean value is less as shown in experimental result.

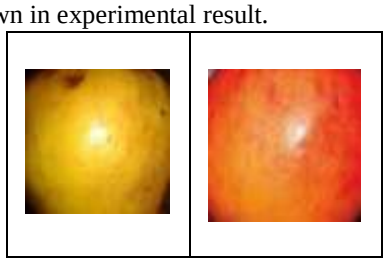

Figure 1.4 Completely non defective

Here, the cropped image has 16 segments as shown in figure 1.5.

Figure 1.5 Segmented Imsge

The algorithm shows that the segment S13 has the minimum mean value and the segment S7 has the maximum mean value. The difference, average between the maximum mean and the minimum mean for each segment can be calculated as follows

$$Diff_{1\ldots16} = Maximum - Maximum_{1\ldots16} \quad \ldots\ldots\ldots\ldots \text{(i)}$$

$$Avg_{1\ldots\ldots16} = {(Maximum + Minimum_{1\ldots\ldots16})}/{2} \quad \ldots\ldots\ldots\ldots \text{(ii)}$$

The value of the Minimum1 is 49.98 and the Maximum value of the image is 177.97 as shown in the below table1. Substituting the values in the equation (i) and (ii)

Diff1 = 177.97 – 49.98
= 127.99

Avg1 = (177.97 + 49.98)/2
= 113.97

Similarly Diff and Avg is calculated for remaining 15 segments.

Diff1 > Avg

If the Diff>Avg then that segment is defected and if the Diff<Avg then it is non-defected as shown in table 1

Segment	Value	Diff	Avg	Observation
S1	49.98	127.99	113.97	Defected
S2	135.08	42.89	156.52	Non defected
S3	136.21	41.76	157.09	Non defected
S4	81.50	96.47	129.73	Non defected
S5	63.60	114.37	120.78	Non defected
S6	112.50	65.47	145.23	Non defected
S7	177.97	---------	--------	--------
S8	140.94	37.03	159.45	Non defected
S9	47.88	130.09	112.92	Defected
S10	79.10	98.87	128.53	Non defected
S11	146.89	31.08	162.43	Non defected
S12	139.20	38.77	158.58	Non defected
S13	41.76	136.21	109.86	Defected
S14	66.20	111.77	122.08	Non defected
S15	102.14	75.83	140.05	Non defected
S16	95.05	82.92	136.51	Non defected

Table 1. Segment values

Applying the algorithm on the cropped image (excluding background) shows the accurate Min_mean and Max_mean values. If the diff (Min_mean, Max_mean) is greater than Avg (Min_mean, Max_mean) then it is defected. Experiments were

conducted on several images. The graph for 9 samples is as shown in the figure 1.6

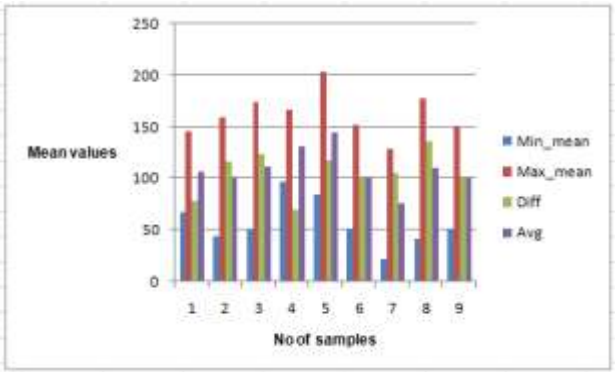

Figure 1.6 Graph for sample images

IV. CONCLUSIONS

The proposed algorithm can recognize the defects. Experiments were conducted on several images. The algorithm can be applied on natural conditions of the images. It is simple and efficient to find the defects. With further enhancement it can be used as an application in mobile.

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