

Automated Sorting And Grading of Vegetables Using Image Processing

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Abstract—The computer vision based system for automatic grading and sorting of agricultural products like strawberry and brinjal based on maturity level is presented in this paper. The application of machine vision based system, aimed to replace manual based technique for grading and sorting of fruit and vegetable. The manual works obtained problems in maintaining consistency in grading and uniformity in sorting. To speed up the process as well as maintain the consistency, uniformity and accuracy, a prototype computer vision based automatic grading and sorting system is developed. The proposed method is implemented by k-means clustering segmentation and color detection process with strawberry and brinjal. Feature extraction for various features like Entropy, Mean and standard deviation are calculated. The main aim of the proposed system is to sort and grade the variety of vegetables like strawberry and brinjal is implemented using image processing techniques. The simulated version of the proposed system is developed using MATLAB R 2013 version and desktop application of the project is developed using MATLAB GUIDE.

Key Words — Sorting, Grading, Kmeans clustering, Feature Extraction and Desktop Applications.

INTRODUCTION

Automated strawberry and brinjal gradation plays an important role to increase the value of produces. In general, the gradation indices are shape, size, color, maturity, defection, etc. With the progress in computer image vision technology, the gradation technique based on computer vision has developed. The computer vision gradation technology is real-time, objective, nondestructive, and can detect multi-index simultaneously, such as size, defection, color, shape and the maturity. There are many reports about qualitative evaluation of agricultural products like In order to determine the influence of mechanical harvest, tomato varieties were mechanical harvested and evaluated in laboratory[1]. According to the features citrus fruit can be classified by using GLCM features of the various citrus fruit[2]. Rapid Color Grading for Fruit Quality Evaluation Using Direct Color Mapping[3] color mapping process for various fruit and based upon the color of the gradation process was done. According to the shape, size and color the strawberry can grading by using automation process[4]. the apple fruit disease detection was compiled by using segmentation of kmeans clustering segmentation[5]. Estimation of Passion Fruit using Digital Images was implemented[6] according to the mass, volume and artificial neural network is used. Based upon Maturity Prediction System for Sorting of Harvested Mangoes[7] was support vector machine classification. According to the non-destructive quality evaluation[9] was implemented by using image processing with Phyllanthus Emblica(Gooseberry) fruit. From the report of qualitative evaluation of various agricultural products only used one type of fruit and vegetable based upon size, shape, color and their characteristics was done sorting and grading process.

In the paper used the two types fruit used to done the sorting and grading process. The two types are strawberry and brinjal is used to implement the sorting and grading process. The automated strawberry and brinjal sorting, grading system mainly consists of a some simulation process to implement image pre-processing, Histogram equalization, Color detection, segmentation, extracting grading characteristic, desktop application of the project is developed using MATLAB GUIDE. Image noise is defined as distinct pixels which are not similar in appearance with the neighborhood pixels. Over-segmentation occurs mainly due to presence of the noise and unimportant fluctuation which produces non real minima. Main objective of the pre-processing stage is to smooth the original image by removing the noise effect. That noise can be removing by using filters like median filter, Wiener filter and Adaptive filter. After the preprocessing technique next step to implement the histogram equalization. Segmentation process was done by kmeans clustering segmentation. classification was done by various features like entropy, standard deviation and mean based upon the maturity level of strawberry and brinjal.

PROPOSED METHOD

In the proposed system preprocessing, color detection method, and then segmentation process are applied over the image for classification. The purpose of Preprocessing technique is to remove the noise and enhance the image quality. For removing the noise median filter, wiener filter and adaptive filter are applied finally median filter gave better result compared to wiener and adaptive filter so have to taken the median filter to remove the noise and enhance the image quality. Color detection method demonstrates to the show the affected parts of the fruit by the band, and mask methodology. K-means clustering segmentation is used for the segmentation process. Features extraction was done by three features they are entropy, standard deviation and mean. Figure 1.1 shows the block diagram for the proposed work.

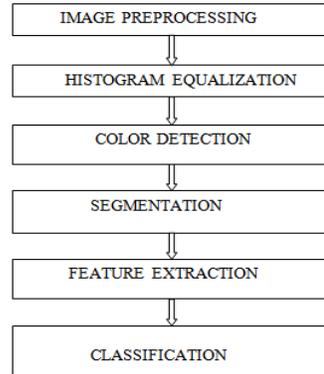


Figure 1.1 Block diagram of Proposed method

1)Preprocessing

In principle, Image noise is defined as distinct pixels which are not similar in appearance with the neighborhood pixels. Over-segmentation occurs mainly due to presence of the noise and unimportant fluctuation which produces non real minima. Main objective of the pre-processing stage is to smooth the original image by removing the noise effect and enhance the image quality of the strawberry and brinjal by using median filter. Median filter is more effective and robust than mean or average filter because a single unrepresentative pixel value in neighborhood affects very less to the median value. Median filter gives one of a neighbor value as an output pixel and hence it does not create new unrealistic values near the edges and preserves sharp edges. It is mathematically expensive to calculate the median value because it requires sorting of nine values for each pixel. Figure 1.2 shows the Concept of Median filter.

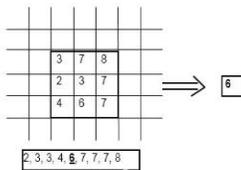


Figure 1.2 Concept of Median Filter

2)Histogram Equalization

The Histogram equalization represents the histogram counts and graphs the total number of pixels at each grayscale level. The output of median is filter is applied to the next step of histogram equalization. From the graph, it can tell whether the strawberry and brinjal image contains distinct regions of a certain gray-level value. A histogram provides a general description of the appearance of an image and helps to identify various components such as the background, objects and noise. The histogram is a fundamental image analysis tool that describes the distribution of the pixel intensities in an image. Use the histogram to determine if the overall intensity in the image is high enough for inspection task. Histogram can be used to determine whether an image contains distinct

regions of certain grayscale values. The distinct region of the histogram equalization of the threshold level value for strawberry is 120 similarly threshold level value for the brinjal is 138.

3) Color Detection

The color detection model is used to show the affected part of the fruit by increasing the threshold level value. In this process the red, green, and blue band are applied on the affected fruit image is obtained and then over which the mask like red and green and blue is applied. By increasing threshold level for red mask the affected part show the dark one for strawberry image these threshold level is 98. Similarly by increasing threshold level for green mask the affected part show the dark one for brinjal image these threshold level is 70.

4) Segmentation

Image segmentation is process of partitioning the image into multiple segments. In this process Kmeans clustering segmentation is used. The purpose of kmeans clustering segmentation is segmenting the defected part of vegetable and good part of vegetable then find the mean of each cluster.

K-Means is a least-squares partitioning method that divide a collection of objects into K groups. The algorithm iterates over two steps:

1. Compute the mean of each cluster.
2. Compute the distance of each point from each cluster by computing its distance from the corresponding cluster mean. Assign each point to the cluster it is nearest to.
3. Iterate over the above two steps till the sum of squared within group errors cannot be lowered any more. The above three steps was implemented to strawberry and brinjal by using image processing technique.

5) Feature Extraction

The feature extraction is done to measure the maturity level and affected part of strawberry and brinjal. Feature extraction is a method of capturing visual content of an image. The objective of feature extraction process is to represent raw image in its reduced form to facilitate decision making process such as pattern classification. Entropy, Mean and Standard deviation used to extract gradient feature in proposed project. A feature is extracted in order to allow a classifier to distinguish between diseased part and riped fruit.

Image entropy formula is expressed as,

$$\text{Entropy} = - \sum_i P_i \log_2 P_i \quad \dots\dots\dots(1)$$

Where,

- i) P_i is the probability that the difference between 2 adjacent pixels is equal to i .
- ii) \log_2 is the base 2 logarithm

The formula for the sample standard deviation is

$$s = \sqrt{\frac{\sum_{i=1}^N (x_i - \bar{x})^2}{N - 1}} \quad \dots\dots\dots(2)$$

Where,

- i) N is number of Pixel points
- ii) \bar{x} is the mean of x_i

iii) xi is Each values of pixles

The mean is the average of all numbers and is sometimes called the arithmetic mean. The mean formula is expressed as,

$$\bar{X} = \frac{\sum X}{N} \dots\dots\dots(3)$$

Where,

- i) X' is the mean
- ii) N is the number of values

DESKTOP APPLICATIONS

Desktop application was developed by using MATLAB Guide.GUI is expansion of graphical user interface. It is used Create Apps with Graphical User Interfaces in MATLAB. The GUI typically contains controls such as menus, toolbars, buttons, and sliders. Many MATLAB products, such as Curve Fitting Toolbox, Signal Processing Toolbox, and Control System Toolbox include apps with custom user interfaces. The GUI is typically used to develop a desktop applications.

EXPERIMENTAL RESULTS

A. Results for preprocessing technique

The results of preprocessing technique for strawberry and brinjal with various filters shown in Figure 1.3.



Figure 1.3 Different Filters for strawberry And brinjal

The figure 1.3 refers the various filters applied to the defected strawberry and brinjal finally median filter gave better result to remove noise and enhance image quality.

B. Result for histogram equalization

The Result for histogram equalaization for the strawberry and brinjal shown in figure 1.4 and 1.5.

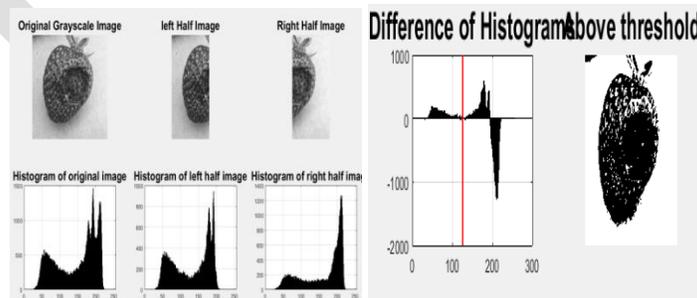


Figure 1.4 Histogram Equalization for strawberry

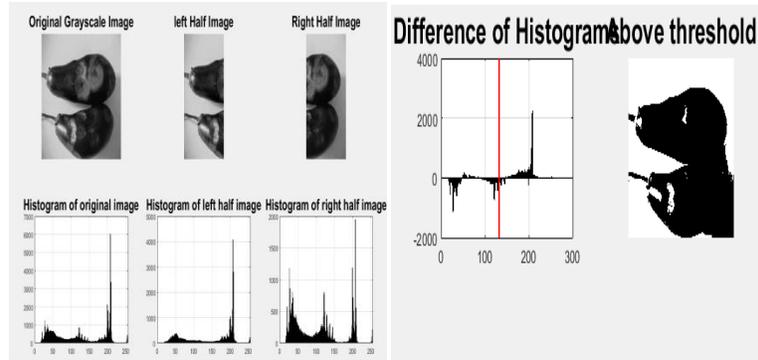


Figure 1.5 Histogram Equalization for brinjal

The figure 1.4 and 1.5 refers the histogram equalization for the defected strawberry and brinjal it gives the threshold level for the distinct regions for strawberry and brinjal.

C. Result for color detection

The experimental result of the color detection for the strawberry and brinjal are shown in figure 1.6 and 1.7

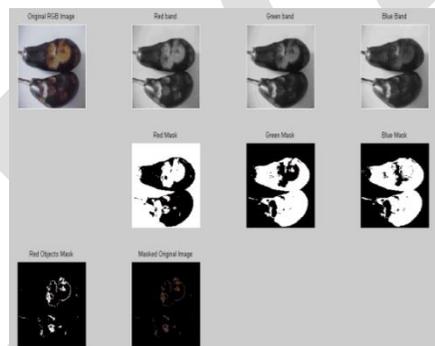


Figure 1.6 Color detection for brinjal

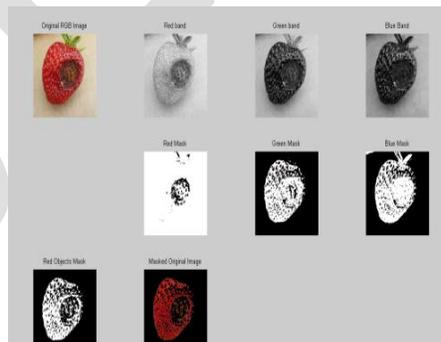


Figure 1.7 Color detection for strawberry

Figure 1.6 and 1.7 refers to show the affected part of strawberry and brinjal by increasing the threshold level value

D. Result for Segmentation

The experimental result of the kmeans clustering segmentation for the strawberry and brinjal are shown in figure 1.8 and 1.9.

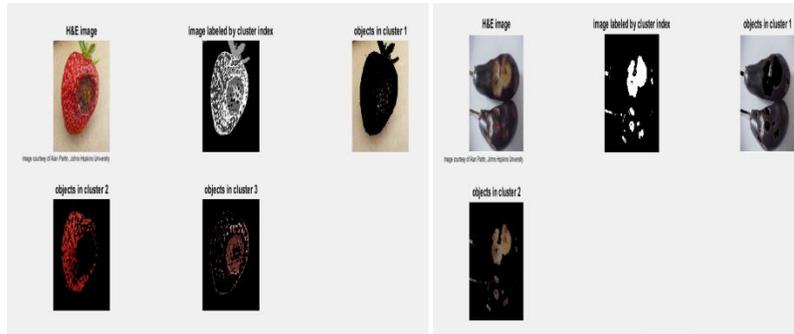


Figure 1.8 Kmeans clustering Segmentation for strawberry and brinjal

Figure 1.8 refers the kmeans clustering segmentation is used segment the defected part and good part of strawberry and brinjal.

E. Result for feature Extraction

The various features like Entrophy, Standard deviation and mean for various maturity level of strawberry and brinjal are shown in Table 1.1,1.2,1.3,1.4.

Table 1.1 Features for Ripe Strawberry Fruit

| Entrophy | Standard deviation | Mean | Images |
|----------|--------------------|---------|--|
| 7.497 | 84.614 | 155.117 |  |
| 4.538 | 83.21 | 192.66 |  |
| 5.279 | 103.289 | 151.151 |  |

Table 1.1 refers the various the features values for different ripe fruit of strawberry it can be use classify the strawberry and brinjal.

Table 1.2 Features for Unripe Strawberry Fruit

| Entropy | SD | Mean | Images |
|---------|--------|---------|--|
| 7.78 | 61.44 | 104.28 |  |
| 7.909 | 69.436 | 116.929 |  |
| 7.591 | 54.45 | 83.801 |  |

Table 1.2 refers the various feature values for different unripe fruit of strawberry. These features values can be used to classify the strawberry and brinjal.

Table 1.3 Features for Affected Strawberry Fruit

| Entropy | SD | Mean | Images |
|---------|--------|--------|--|
| 7.649 | 64.647 | 142.42 |  |
| 7.34 | 85.639 | 165.79 |  |
| 5.24 | 83.811 | 184.77 |  |

Table 1.3 refers the various feature values for different Affected fruit of strawberry. These features values used to classify the defected fruit and good fruit.

Table 1.4 Features for Various maturity level for Brinjal

| Brinjal | Entropy | SD | Mean | Images |
|------------------|---------|-------|--------|--|
| Ripe Brinjal | 7.507 | 55.82 | 109.45 |  |
| Unripe Brinjal | 7.284 | 77.62 | 159.35 |  |
| Affected Brinjal | 7.346 | 71.08 | 125.02 |  |

Table 1.4 refers the various feature values for the ripe, unripe and defected vegetable of brinjal. The features values can be used to classify the different maturity level of strawberry and brinjal.

F. Experimental results for desktop applications

The result of desktop applications using MATLAB GUIDE are shown in figure 1.7.

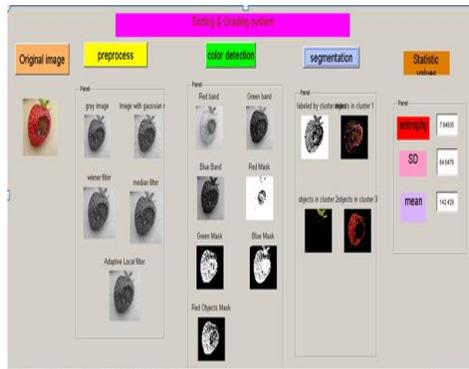


Figure 1.5 Desktop application result for sorting and grading using Strawberry

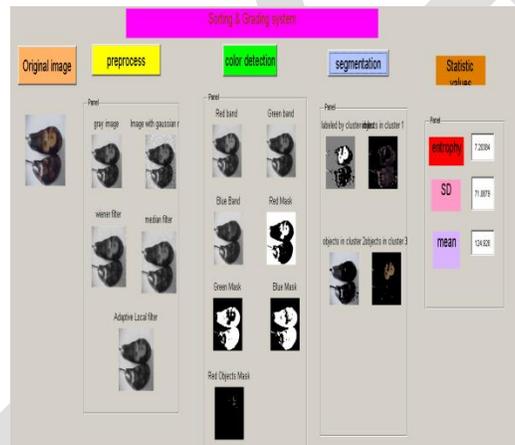


Figure 1.6 Desktop application result for sorting and grading using brinjal

Figure 1.5 and 1.6 refers the desktop application was developed by using MATLAB GUIDE

CONCLUSION

Thus proposed project classify the good and affected fruit of strawberry and brinjal with various techniques. The techniques contains, the preprocessing, Color detection model and segmentation process. The preprocessing technique demonstrates remove the noise and enhance the image quality. When the image is caused by some noise with light intensity or environmental problems to remove those noise by using median filter in this proposed system. Color detection model is used to identify the defected part with the threshold level then the threshold value for strawberry is 98 then threshold level value for brinjal is 70. Then segmentation technique is kmeans clustering segmentation concept this concept split into the different cluster like affected part, non affected part of strawberry and brinjal. After the segmentation process features extraction can be done by the different maturity level of strawberry and brinjal by using various features like entropy, standard deviation and mean. The Various maturity level are Ripe fruit, unripe fruit, affected fruit. Based upon the features values classify the strawberry and brinjal in different maturity level. The whole process is done by simulation in MATLAB and desktop application was developed by using MATLAB GUIDE.

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