Automatic Fruit Quality Inspection System

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***Abstract*— This paper presents the recent development in automatic vision based technology. Use of this technology is increasing in agriculture and fruit industry. An automatic fruit quality inspection system for sorting and grading of tomato fruit and defected tomato detection discussed here.The main aim of this system is to replace the manual inspection system. This helps in speed up the process improve accuracy and efficiency and reduce time. This system collect image from camera which is placed on conveyor belt. Then image processing is done to get required features of fruits such as texture, color and size. Defected fruit is detected based on blob detection, color detection is done based on thresholding and size detection is based on binary image of tomato. Sorting is done based on color and grading is done based on size.**

Keywords*— *Automation ,Fruit Quality, Grading, Image processiong, YCR-Luma, blue difference and red difference chroma components,RGB-Red green blue, Sorting, Texture.

I. INTRODUCTION

India is an agriculture country. Different types of fruits and vegetables are produced in India. India is at second number after china in production fruits. In India all the pre-harvest and post-harvest process are done manually with help of labor. Manual process is very time consuming, less efficient so to get accurate result automation in agriculture industry is needed. The post-harvest process includes sorting and grading of fruits. Different quality factors are considered for sorting and grading of fruits. These factors are internal quality factors and external quality factors. The external quality factors are texture, shape, color ,size and volume, and internal quality factors are test , sweetness, flavor, aroma, nutrients , carbohydrates present in that fruit[3].

Automation is playing important role in day today life. In India more than half population depends upon agriculture. Their main source of income is agriculture. Exporting of fresh fruit is increased day to day from India. People are very conscious about their health; they prefer only fresh, good quality fruit.

There is confusion between tomato is a fruit or vegetable. As per Fruit definition Fruits are developed from ovary. Ovary is placed in base of flower. Fruit contains seeds of plant. So based on above tomato is a fruit. Indian market export tomatoes to foreign countries.

II. LITERATURE SURVEY

Texture, Color and Size are the important parameters for fruit quality identification. The color recognition is very important process in ripeness detection. The ripeness detection is external quality factor. But texture is also very important. Because of texture defected fruit can be recognized. Texture analysis detects the non-uniformity of fruit outer surface. The size is also important parameter. It clearly seen parameter all customer select fruit based on size.

Dah-Jye Lee *et al*.(2011) [1]designed a Direct color mapping technique for obtaining the color of fruit. Advantage of this system is that it have arrangement of adjusting color preferences or grading parameters as per application. it is user friendly technique

H. Dang *et al* (2010)[2] developed a system for fruit size detection. All results are calculated based on image processing. Edge detection ,then fruit size detection and based on size grading of fruit is done. OSTU (maximum classes square error) is used to get binary image . For edge sequence detection 8-connected boundary method is used. For diameter detection symmetry is considered. Symmetry gives center co-ordinate. line diameter is calculated based on center point and axis going from centre. For accurate result two edge points are searched. If fruit is rotated then also diameter shown is same then the diameter indicated true fruit size. Then based on accurate size grading is done.

H. Alimohamadi *et al* (2013)[5] designed a system for skin defect detection in fruits. Gabor wavelet Filter is used for defect detection. Convert color image into texture image and then on that image Bank of Gabor filter is applied. Gabor Filter is linear filter and used as edge detector. Gabor filters with 4 scales and 6 rotations used in this paper. Obtained response shows image pixel is as defected or normal skin. Optimal filter is chosen from bank of Gabor filters depending upon the response . Thresholding the response of the optimal filter. Based on thresholding skin defect is detected. [5]

Y. Wang *et al* (2010) [6] designed a system in which Fruit quality inspection is done based on fruits surface color. It is nondestructive method. Fruit image is captured with camera, RGB image is converted into the HSI color model. Image is segmented based on hue value ,separate fruit and its background. Histogram of Hue and Saturation of fruits surface color is calculated. Input is given as histogram ,output obtained earlier of Hue and Saturation of surface color of fruit from back propagation network. Output as quality description

of given tested fruit. They performed experiment on banana and result obtained is accurate.

S. A. Khoje *et al* [15] developed a system of fruit grading for automated skin defect identification using Discrete Curvelet Transform. Discrete Curvelet transform is used for texture analysis. Multi resolution approach is used in DCT, By using low and high resolution capability local and global features of that fruit are found . Energy, entropy, mean and standard deviation of each good and defected fruit is calculated these are called as features.. Support vector machine and Probabilistic neural network for classification of good fruits and defected fruits. Based on obtained result SVM is more accurate than PNN [15]. M. Satpute *et al* [16] in this paper different technique of color, size, shape, texture and volume detection of fruit are discussed.

III. OVERVIEW OF PROPOSED SYSTEM

A. Block Diagram

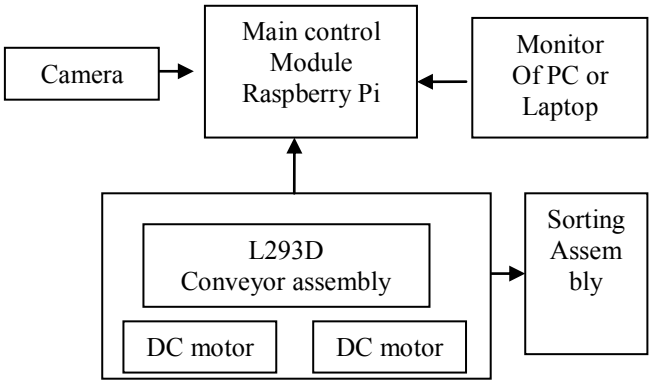


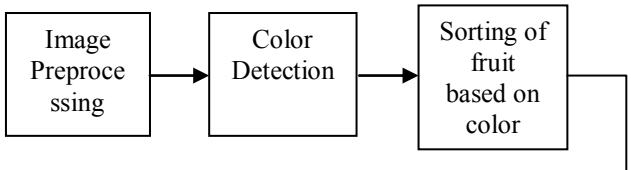
Fig. 1. Block diagram of System

B. Description

The Infrared sensor is placed on conveyor belt, when fruit is come in front of infrared sensor message will display as fruit detected then conveyor belt moves with small distance an stop when fruit come exactly in front of camera. Camera (High Quality CMOS sensor, 25 MPs, 30fps) always in video mode. When fruit is detected the image processing is done on that image captures and color is detected. Red, Green, Yellow color are detected. The system is divided into hardware control and image processing. The image processing results is based on camera image. The results such color detected. Second part is hardware is controlled based on color detection.

The image processing is done by software OpenCv using a language python. The software is divided into two parts first one is for image analysis and other is for controlling hardware based on image processing results. As per Fig 1 the system is operated in two different scenarios in first the image is captured with camera the all the image processing is done in the control module. All the process are shown on monitor and then based on decision taken by control module. The conveyor assembly is operated.

C. Processing flow



Fig,2. The fruit sorting and grading flow

Image Preprocessing

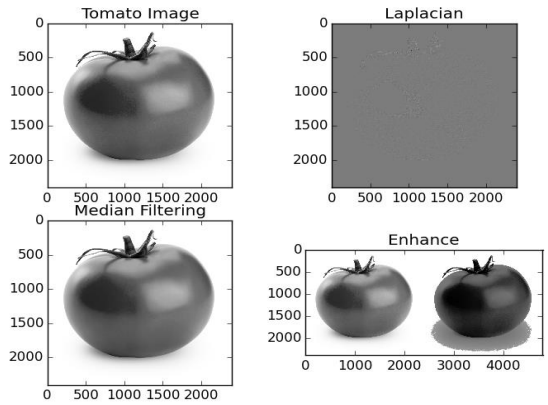


Fig3.Image Preprocessing

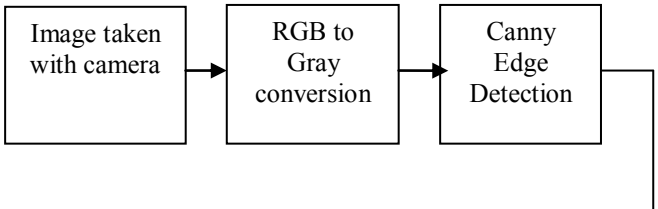
In the process of fruit sorting and grading to work system efficiently proper image acquisition is very important. The image is captured with camera that image is with noise and its features are not clearly seen so image preprocessing is done on that image.

In this project the features required are color, texture and size. To get exact feaure preprocessing is done on acquired image. The main aim of image processing is an improvement of image so that unwanted distortions are suppresed and enhance image features which are important for further processing.

The basic steps of preprocessing are first convert RGB image to gray scale image. Then image histogram equilization is applied on gray image. This helps in adjusting image intensities in order to enhance contrast. Remove noise with filter, here we use median filter for removing noise.The laplacian is used for edge detection as it highlights the region with rapid intensity change. So this enhanced, noise free, filtered image is ready for further processing.

Defected Fruit Detection

This is the flow for defected fruit detection. The image taken is RGB image. Firstly this image is converted to gray scale and the edge detection is performed and the blob detection is performed and defected region is marked with red circle. In [9] the Discrete Curvelet Transform is used for defected skin detection.



Fig,4. Flow for defected fruit detection

Another method used for defected fruit detection is that RGB image is converted to YCR color space. Then lower and upper ranges are defined. Then ranges of binary image are defined. Then convert single channel mask back into 3 channels.

Color Detection

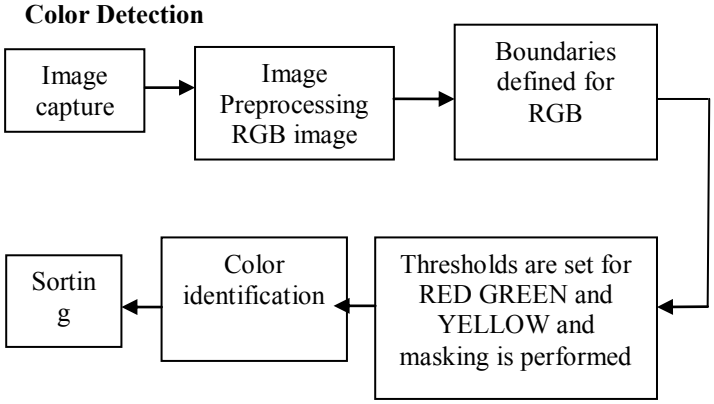


Fig5.Flow for color detection

The above figure.5 shows the flow of color detection based sorting of fruit. Image captured that is RGB image is given to preprocessing. Define the list of boundaries for BGR color. Apply loop over the boundaries. Find the colors within the specified boundaries and apply the mask. In [14] the sorting of mango is done based on color and grading is done based on both color and size here fuzzy logic is used for decision.

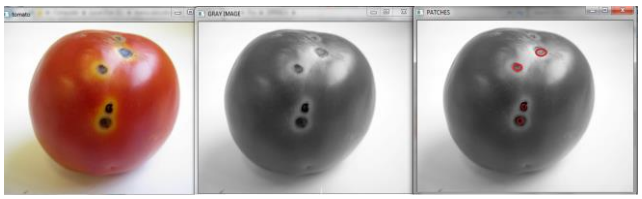
Size Detection

The image is captured. First convert RGB image to gray scale image. Then OSTU thresholding the binary thresholding is performed on that image. Then morphological operation such as dilation then erosion is performed. For boundary detection opening is performed. Then major axis and minor axis length is calculated. Then size is decided as small, medium and large.

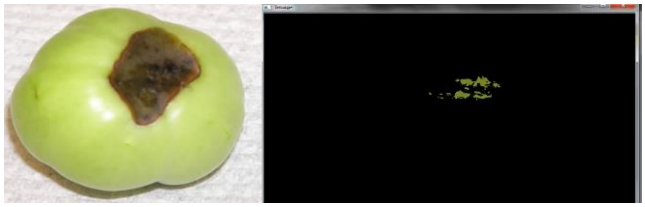
IV. DISCUSSION AND RESULTS

A. Defected Fruit Detection

Tomato is having different defects. Here blob detection technology is used for defect detection. This is the technique by which specific region is detected which is differ in properties compared to surrounding region such as color or brightness. In the following Fig.6(a). Color image, gray image and image showing defect on tomato surface is shown. The defects are highlighted with red circles. The defect which are present on red, green and yellow tomato are shown with green color as shown in fig6(b).



(a)



(b)

Fig.6(a) and (b). Defected fruit detection

B. Color detection

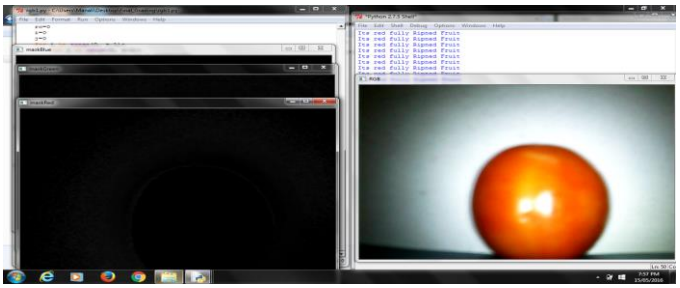


Fig7. Red Color detected

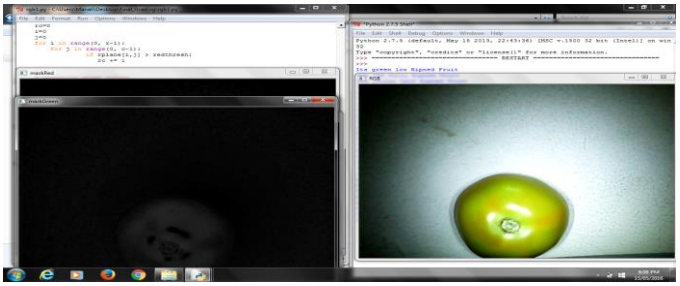


Fig8.Green Color Detected

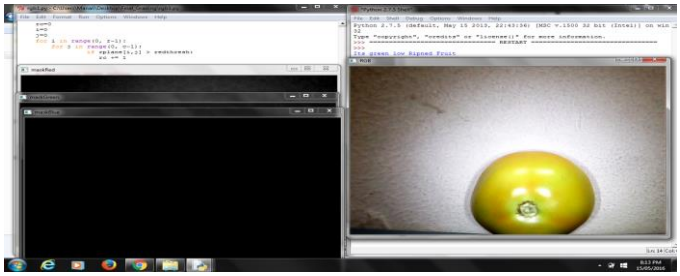
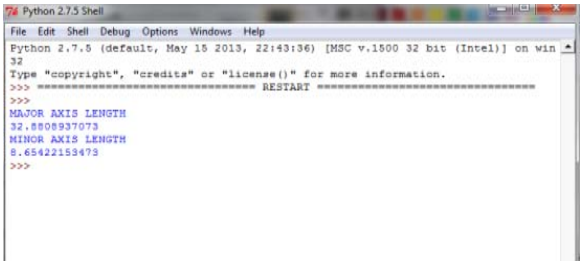


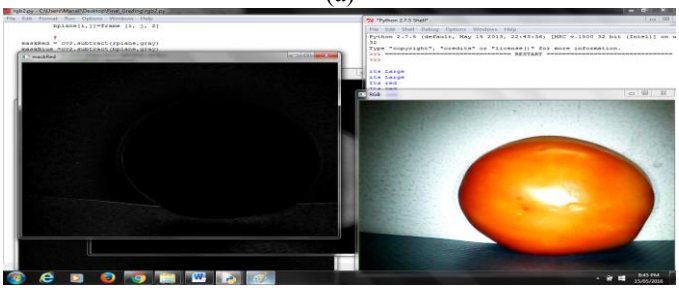
Fig9.Yellow Color Detected

C. Size Detection

Fruit size detection involves major axis calculation. The palette used for sorting changes its direction when image processing results are obtained.



(a)



(b)

Fig.10(a) and(b)..Size detection

Table 1: Result of sorting using color and defected fruit detection

Result table	Number of samples	Correctly detected	Accuracy
Red color	35	30	**85.71%**
Green color	35	33	**94.28%**
Yellow color	35	30	**85.71%**
Defected fruits	30	27	**90%**

CONCLUSION

In this paper automatic vision based system is discussed for sorting and grading of fruits based on its color and size respectively. The test performed on tomato for defect detection detects defected fruit. This test is performed for three color detection Red, Green and Yellow. And for three different sizes large medium and small. The variation in speed of conveyor and light, camera resolution affects the system. The accuracy of green color detection is 94.28% which more than red and yellow. The accuracy of defect fruit detection is up to 90%.This system is much closer to manual expert judge.

FUTURE SCOPE

Further design can be modified by increasing size of conveyor belt so that it is possible to perform quality inspection of large fruit than tomato, and increase accuracy of the system so that it can differentiate between artificial , hybrid color from original fruit color.

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