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Machine Vision System for on-Tree Fruit Detection

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***Abstract*— In agriculture the human resource plays a vital role. Especially in fruit cultivation fruit counting for yield assessment and fruit plucking for marketing is time consuming. It also requires more man power, which is expensive today. A machine vision system can be useful to reduce manual work in picking fruits. In the literature a number of machine vision systems with classification and clustering algorithms were proposed to identify the fruits like apple, citrus, jujube and pomegranate. This paper provides a study on machine vision system to detect on-tree fruits that can help in harvesting and counting the yield of the fruits.**
Keywords—Machine vision system, image processing, fruit detection, clustering

I. INTRODUCTION

Manual plucking of fruits on tree is a tiresome and repetitive job and takes more time. Hence vision-based system is needed for fruit identification. Nowadays, machine vision, computer vision and computational methods like image processing are found progressively more helpful in fruit counting and harvesting. Applications of computational methods are in wider range and its appliance in agriculture segment comprises observing the crops growth, disease identification in crops and fruits, weed controlling, sorting and grading of vegetables and fruits and categorization of vegetables and fruits and so on. Various methods and techniques were used for fruit detection and estimation but detecting fruits from the background is complicated and challenging task. Shape and color of fruits are the major properties to differentiate them from the leaves and branches of trees which leads to better classification. The image size of the fruit is another decisive factor to get better accuracy. The resemblance in the identification of fruits depends on shape, size and color. This paper provides an overview of identification of various fruit image processing techniques which can be embedded in machine vision systems.

II. METHODS USED FOR FRUIT DETECTION

A. Citrus Fruit Detection

Zeeshan Malik et al [1] used a k-means segmentation model for orange tree images. The following steps were used in his model. Fig.1 illustrates this step.

Step 1: Pre-processing
The image is preprocessed to remove noise. A model named Perona-Malik was used to reduce noise and enhance the image. The image features like edges and lines are important for image analysis as well as interpretation. So, the image should be smoothed without affecting this feature.

Step 2: Reducing shadows
The shadow effects are removed from the image. In lightning conditions shadows create difficulty in segmentation and object detection. So, the shadows are removed based on the RGB color space.

Step 3: Separation of objects.
Overlapping fruits are separated based on RGB mean value and threshold value.

K-means clustering method is used for segmentation process. The oranges are detected using size estimation and blob identification.

It shows 91.3% accuracy on three dissimilar datasets.

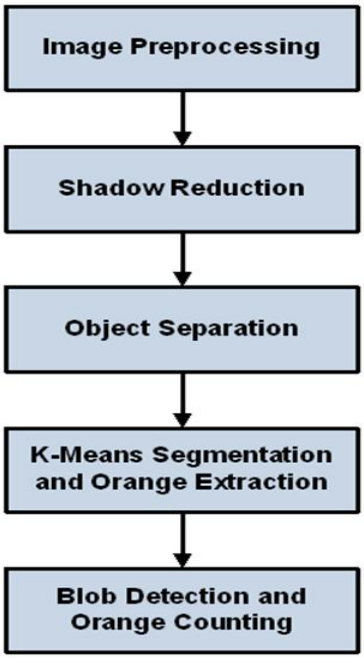

Fig.1

Saranya et al[2] proposed a model for citrus fruit identification. Fig.2 illustrates this. In this model three techniques such as bicubic interpolation, K-Nearestneighbour and Otsu's method were used for classification. Here the HSV based method is used to segment the image and detect and count the objects in it.

This model gave fine results on the orange tree images taken from different distances under different lighting conditions, intersection of fruits and closure of leaves. They showed 95% accuracy on three dissimilar datasets.

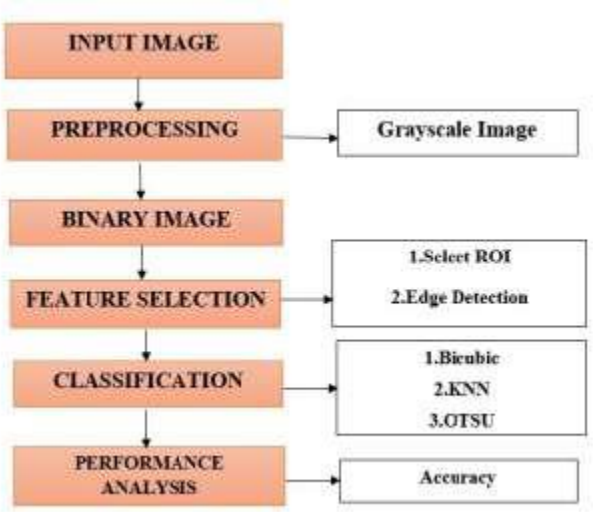

Fig.2

B. Mango Detection

Mohd Fadzil Abdul Kadir et al[3] used a system to detect partly covered mango fruits . First the image is grabbed using digital camera. Then it is pre-processed using the texture analysis that helps in determining the edges of each fruit and the real boundary is identified. Then, it is converted in to binary format and the object is determined by erosion and dilation. Finally, the hough transform with randomization method is used in ellipse fitting(to match with mango shape) to detect the potential area of mango fruit.

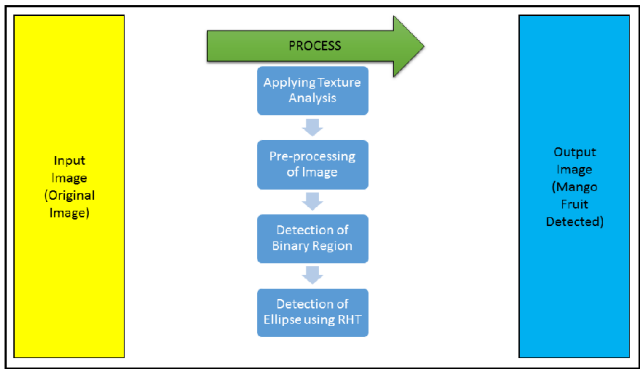

Fig.3

Dameshwari Sahu and Ravindra Manohar Potdar [4] suggested a framework to identify the defected and matured mango fruits by using their size, color and shape features. This framework uses three algorithms in sequence. The first algorithm pre-processes the database. It converts the color image into binary and grayscale image. Then filtering is applied to remove the foreground and background noise. Second algorithm uses quality ratio calculation *b=a/(x*y) to identify the defects*. Third algorithm detects the maturity of mango.

C. Pomegranate Detection

Akin et al [5] proposed a system to for on tree pomegranate fruits detection. The pomegranate images are obtained through camera stations from the groves. The pomegranate is red in color, so a color-based technique is used for to identify the on-tree fruits. Color alone is not enough to detect the pomegranate. Therefore, its shape is also considered in detection system. In general Pomegranate is round in shape, whereas leaves and branches of trees are in pointed shapes or straighter. Identifying round objects seem to be easy way to detect fruit. Fig 4 illustrates this methodology.

Abdolabbas Jafari et al[6] developed a novel approach that uses image processing and stereo vision technique to identify the spatial point of pomegranate fruit from the trees. The images are captured by using two cameras which have same resolution. Both cameras having the same elevation. Fruit is from the same distance from both cameras. First, red colour feature of the pomegranate fruit is used to differentiate fruits from other objects. Then the fruit centre is calculated based on the 2D location of the fruit in every image. Then the geometric equations are used to calculate the third dimension. The resultant coordinate is the spatial location of fruit on the tree which must be detected by the harvesting machine. Results showed that the stereoscopic vision system is able to determine the location of the fruit on the tree with an error less than 2.4 cm.

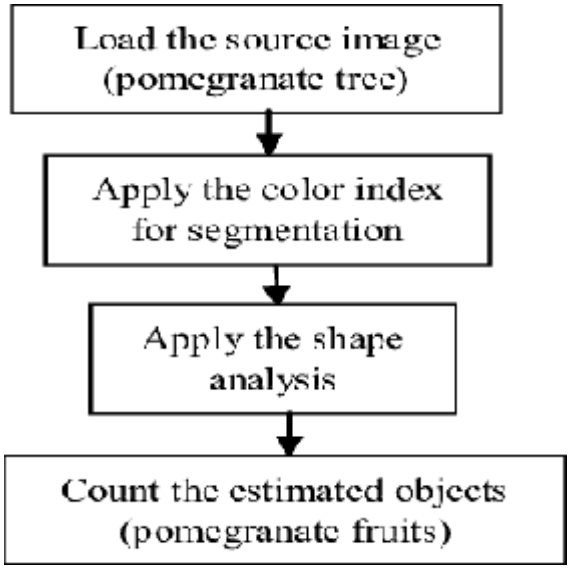

Fig.4

D.Apple Detection

Jun Zhao et al [7] used a stereo vision system to locate apples accurately in orchards. This system uses an algorithm that is vision based and it locates apples from single image. The green apples, red apples and green apples with poor contrast on tree were considered for detection. Texture-based edge detection is combined with redness measures, and area thresholding followed by circle fitting, to determine the location of apples in the image plane. In the case of severely cluttered environments, Laplacian filters were used to further clutter the foliage arrays by edge enhancement so that texture differences between the foliage and the apples increased thereby facilitating the separation of apples from the foliage. Results are presented that show

the recognition of red and green apples in a number of situations as well as apples that are clustered together and/or occluded.

Santi Kumari Behera et al [8] proposed an image processing system to classify different types of apples such as Golden delicious, Gala apple, Red delicious apple, Granny Smith apple. It has three steps. First k-means clustering method is used to segment the main parts of apple fruit. Then texture-based feature extraction is applied. Finally, training and test samples are compared using SVM multi class classifier. The result shows that the classification accuracy as 84%.

CONCLUSION

Image processing have more impact on fruit recognition and classification. These innovations will reduce time taken for fruit segregation as well as man power. This paper deals various methods and algorithms used for fruit recognition and classification based on computer vision approach. The results look promising, this recognition approaches could be applied in automatic picking devices. In future all these approaches can be combined to recognize more types of fruits with single device.

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