A Study on Image Processing Methods for Fruit Classification

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Abstract. Automation of fruit recognition and classification is an interesting application of computer vision. Traditional fruit classification methods have often relied on manual operations based on visual ability and such methods are tedious, time consuming and inconsistent. External shape appearance is the main source for fruit classification. In recent years, computer machine vision and image processing techniques have been found increasingly useful in the fruit industry, especially for applications in quality inspection and color, size, shape sorting. Researches in this area indicate the feasibility of using machine vision systems to improve product quality while freeing people from the traditional hand sorting of fruits. This paper deals various image processing techniques used for fruit classification.

Keywords: Thresholding, histogram, fruit classification.

1 Introduction

Fruit markets nowadays have more responsibility to distribute variety of fruits. The demand for fruit classification has been increased as different varieties of fruits come to the market in large quantities and distributed immediately to various retail shops. Manual classification is time consuming and is a tedious repetitive job to classify tons of fruits in a shorter time. Hence there is a need for vision based fruit classification which also assists in packaging of fruits by using optimal packaging configuration. It also reduces the labor and packaging expenses. The classification of fruits also provides benefits in quality evaluation and defect finding. Color and shape are primary properties of fruit images which help for better classification. The size of the image is also considered as another criterion to improve the accuracy. The uniformity in the classification of fruit is determined based on color, size and shape [1]. Classification of fruits can be based either on each of these aspects or on a combined decision considering all of them. In recent years, computer vision, machine vision and image processing techniques have been found increasingly useful in the fruit industry. Applications of image processing are wider in range and its application in agriculture sector includes monitoring the growth of crops, controlling weeds, grading and sorting of fruits and vegetables and classification of the fruits and vegetables etc. This paper reviews the image processing methods used in fruit classification.

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2 Methods used for fruit classification

There are various phases in image processing which are being used for classification of fruits. Color image processing and image segmentation are the methods used for fruit classification based on color. Regional descriptor is a method used for classification based on size. Boundary descriptor and feature extraction are used for classification based on a shape of the fruit. These methods can be combined together to classify the fruit based on three physical attributes, size, shape and size[7].

2.1 Color Image Processing

Color is a common descriptor used for object identification and extraction from an image. In color image processing, colors in the image are processed based on their color model. The image captured using cameras will be in RGB color model. These RGB color components can be calculated using histogram to calculate the mean value of each color component [fig.1]. Mean value obtained from the color components is used to set threshold value for the fruit selection.

Fig. 1 The histogram of the each color component is measured to calculate the threshold value

2.2 Image Segmentation

Image segmentation methods like thresholding, histogram, edge detection and clustering methods are used for fruit classification. Global threshold is used to calculate the binary mask [fig.2] of a fruit for performing further morphological operations [2]. The global color histogram is used to encode information from an image in the fruit classification [3]. It has a set of values and each group representing distinct color. Statistical information can also be calculated using global color histogram.

Fig. 2 The binary mask of an image is obtained using threshold segmentation for further morphological operations.
2.3 Regional and Boundary descriptors

Regional descriptors are used to compute regional properties of the image. The regional descriptors like texture and moment invariants are computed to extract the region properties in a binary image [Fig.3]. The moment invariants are used to quantify the texture content in an image. Size of the fruit can be easily identified using geometrical properties like area, perimeter, major axis length and minor axis length [8]. The shapes of a fruit are generally irregular and the boundary descriptors can be used to determine the shape of a fruit [9].

Fig.3 Regional properties calculated using the binary mask image

3 Role of features and classifiers in fruit classification

Feature extraction, pattern classification and k-Nearest Neighbors algorithms were commonly used in the classification of the fruit [1]. Various features and classifiers are combined to classify the fruit with higher accuracy [3]. Hybridization of features and classifiers will reduce time required by the training data. Classifiers compare the input data with the trained data and provide the classification result for the fruit. Widely used classifiers include support vector machines, neural networks, fuzzy and rough sets, Bayesian and evolutionary computing.

3.1 Pattern classification and Nearest Neighbor Classifier

Pattern classification is used to identify different objects in an image automatically and to extract the required features from an image [3]. Classifiers are generally categorized as supervised method and unsupervised method. The supervised classification is a set of feature vectors used to characterize the boundary that separate the fruit. Unsupervised classification is a set of feature vectors for which no characterization or training is given in prior. K-Nearest Neighbors algorithm is also used to identify the input data by comparing it with the trained data. It uses the Euclidean distance measures to measure the distance between points in the input data and trained data [4].

3.2 Neural network classifier

Artificial neural network classifier provides higher degree of accuracy when compared with other classifier models. The feed forward neural network model,
multilayer perceptron is preferred in the classification of the fruits. This model uses a supervised learning technique back propagation neural network (BPNN) to train the data sets. The basic network structure of BPNN has an input layer, hidden layer and an output layer [5]. Network is trained with a large number of input sets to predict the exact output result. The classifier uses different structure for each category of classification [6].

4 Conclusion

Image processing is having higher impact on fruit identification and classification based applications. 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. This paper also explains importance of color and region descriptors for better classification.

References