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The Fruit Quality Identification System in Image Processing Using Matlab

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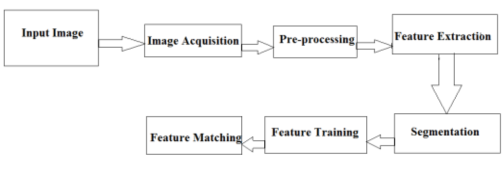
Abstract: *The ability to identify the fruits based on quality in the food industry which is the most important technology in the realization of automatic fruit sorting machine in order to reduce the work of human and also time consuming. This work presents a hierarchical grading method applied to the Fruits. In this work the identification of normal and defective Fruits is focused on the methods using MATLAB. First we extract certain features from the input fruit image, later using different method like thresholding, segmentation, k-means clustering and thus we get related databases. Comparing several trained databases, we get a specific range for the normal and defective fruits. From the proposed range we can identify the normal and defective fruits. Thus this paper analysis the normal and defective fruits with a very high accuracy successfully using image processing. For segmentation, k-means clustering method of reference taken .It has maximum similarities with k-means clustering. .In k-mean one cluster find but c-mean find all neighbouring cluster. Hence it is very advantageous than k-mean. For classification Probabilistic Neural Network method (PNN) is used instead of ANN. It is similar to ANN but training speed is more than ANN. It is more advantageous than ANN. Here clustering process has been used to extract features form normal and defective fruits.*

Keywords: *Image Acquisition, Pre-Processing, Segmentation, Feature Extraction, Feature Training, Feature Matching.*

1. PROPOSED METHODOLOGY

The stages in the proposed methodology are shown below.



The steps involved in identification of normal and defective quality of Fruits are image acquisition, pre-processing, segmentation, feature extraction, feature training and Feature matching. Finally the quality of fruit is identified.

1.1 IMAGE ACQUISITION: An image is analyzed as it is clicked. Then the user is given tools to discard that he considers noise. The image acquisition is done using a digital camera and it is loaded. An image of the fruit is captured by using any digital camera or any mobile phone camera, an image is captured.

1.2 PRE –PROCESSING: Basically the images which are obtained during image acquisition may not be directly suitable for identification and classification purposes because of some factors, such as noise, weather conditions, and poor resolution of an images and unwanted background etc. We tried to adopt the established techniques and study their performances.

The steps involved in pre-processing are

A. Input image

B. Converting RGB to gray

C. Converting gray to binary

D. Filtering

All the steps mentioned above is easily and efficiently done by using basic commands MATLAB toolbox.

1.2.1 RGB Image: RGB is one of the formats of colour images. Here the input image is represented with three matrices of sizes regarding the image format. The three matrices in each image corresponds to the colours red, green and blue and also says that of how much of each of these colours a certain pixel should use.

1.2.2 Gray Image Gray scale images have one colour which is a shade of gray in various ranges in between. Monochrome image is another name of gray image. This denotes the presence of only one (mono) colour (chrome). To convert any colour image to a gray scale representation of its luminance, we must obtain the values of its red, green, and blue (RGB) primaries in linear intensity encoding, by some expansion.

1.2.3 Binary Image: A Binary Image is a digital image which has two assigned pixel values. Typically the two colors used for a binary image are black and white. The gray image of Fruits is converted to binary image this means that each pixel is stored as a single bit (0 or 1). Binary images used in digital image processing as masks or as the result of some frequent operations such as segmentation, thresholding, and dithering.

1.2.4 Filtering The purpose of filtering is to smooth the image. This is done to reduce noise and improve the visual quality of the image. Often, smoothing is referred to as filtering. Here filtering is carried out by median filter since it is very useful in detecting edges.

A. Median Filter The best known order-statistics filter is the median filter, which replaces the value of a pixel by the median of the gray levels in the neighborhood of that pixel.

The original value of the pixel is included in the computation of the median. Median filters are quite popular because, for certain types of random noise they provide excellent noise reduction capabilities, with considerably less blurring than linear smoothing filters of similar size. The median value is not affected by the actual value of the noise cells. The Median filter is particularly good at removing isolated random noise, as in this example. It also preserves edges and line features better than the Low Pass / Average filter, but does produce some blurring.

1.3 FEATURE EXTRACTION Feature extraction is defined as grouping the input data objects into a set of features. The features extracted carefully will help to extract the relevant information from the input data in order to perform the feature matching .Using this we can reduce the representation input size instead of the full size input. Here clustering process has been used to extract features form normal and defective fruits.

In this process , we have extracted four features those are contrast , correlation, energy and homogeneity. It classifies the image into groups. If number of features increases then the accuracy of classification increases. These four features are extracted by using sub band. There are 8 sub bands. Hence we are extracting 32 features. Also wavelet filter is used.

1.3.1 Clustering Basics: Clustering is the processes of grouping together similar objects. The resulting groups are called clusters. Clustering algorithms group objects according to various criteria. Unlike most classification methods, clustering handles data that has no labels, or ignores the labels while clustering.

Clustering Algorithm: K-Means Clustering Algorithm

STEP1: The training vectors are grouped into M clusters based on the distance between the code vectors and the training vectors using the below equation (1) and (2).

dy= $|\boldsymbol{xi} - \boldsymbol{yi}|\ \boldsymbol{k}\ \boldsymbol{j}=\mathbf{1}$ -------------1

Where dy is the distance between the training vector Xi and the code vector Yi .

Sumij = Xij --------------2

STEP2: Compute the sum vector for every cluster by adding the corresponding components of all the training vectors that belong to the same cluster using the equation (3).

Centroid = Sumij /ni

Where i=1, 2….n)

STEP3: Compute the centroid for each cluster by dividing the Individual components of the sum vector by the cluster Strength in using the equation (3).

STEP4: Replace the existing code vector with the new centroid to form the revised codebook.

STEP5: Repeat the steps 1 through 4 till the codebooks of the consecutive iterations converge[8].

K-mean algorithm equation :

$$J(V) = \sum_{i=1}^{c} \sum_{j=1}^{c_i} (\|x_i - v_j\|)^2$$

where,

'$||x_i - v_j||$' is the Euclidean distance between x_i and v_j.

'c_i' is the number of data points in i^{th} cluster.

'c' is the number of cluster centers.

Recalculate the new cluster center using:

$$v_i = (1/c_i) \sum_{j=1}^{c_i} x_i$$

where, 'c_i' represents the number of data points in i^{th} cluster.

C-mean algorithm equation:

Fuzzy c-means (FCM) is a method of clustering which allows one piece of data to belong to two or more clusters. This method is frequently used in pattern recognition. It is based on minimization of the following objective function:

$$J_m = \sum_{i=1}^{N}\sum_{j=1}^{C} u_{ij}^m \left\| x_i - c_j \right\|^2, \quad 1 \le m < \infty$$

- where m is any real number greater than 1, u_{ij} is the degree of membership of x_i in the cluster j, x_i is the ith of d-dimensional measured data, c_j is the d-dimension center of the cluster, and ||*|| is any norm expressing the similarity between any measured data and the center.
- Fuzzy partitioning is carried out through an iterative optimization of the objective function shown above, with the update of membership u_{ij} and the cluster centers c_j by:

$$u_{ij} = \frac{1}{\sum_{k=1}^{C}\left(\frac{\left\| x_i - c_j \right\|}{\left\| x_i - c_k \right\|}\right)^{\frac{2}{m-1}}}$$

$$c_j = \frac{\sum_{i=1}^{N} u_{ij}^m \cdot x_i}{\sum_{i=1}^{N} u_{ij}^m}$$

- This iteration will stop when $\max_{ij}\left\{\left| u_{ij}^{(k+1)} - u_{ij}^{(k)} \right|\right\} < \varepsilon$, where ε is a termination criterion between 0 and 1, whereas k are the iteration steps. This procedure converges to a local minimum or a saddle point of J_m.

1.4 SEGMENTATION: The purpose of image segmentation is to divide an image into meaningful regions with respect to a particular application. The segmentation is based on measurements taken from the image, may be gray level. Here edge-based segmentation is properly suitable .As edge detection is a fundamental step in image processing, it is necessary to point out the true edges to get the best results from the matching process. That is why it is important to choose edge detectors that fit best to the application. In this way canny edge detector is chosen.

1.4.1 Canny Edge Detector: Canny edge detection algorithm is also known as the optimal edge detector. Canny's intentions were to enhance the many edge detectors in the image.

1) The first criterion should have low error rate and filter out unwanted information while the useful information preserve.

2) The second criterion is to keep the lower variation as possible between the Original image and the processed image.

3) Third criterion removes multiple responses to an edge.

Based on these criteria, the canny edge detector first smoothes the image to eliminate noise. It then finds the image gradient to highlight regions with high spatial derivatives. The algorithm then tracks along these regions and suppresses any pixel that is not at the maximum using non-maximum suppression. The gradient array is now further reduced by hysteresis to remove streaking and thinning the edge.

Here we use c-mean as well as k-mean clustering for segmentation. comparitively

1.5. FEATURE TRAINING Feature training method includes collection of large number of trained features of clustered values of good and bad fruits. More number of collecting trained features gives more accuracy. In this method, the number of closest code vectors for each training vector is identified and is stored as the corresponding cluster density. The cluster densities for all training vectors are computed and are sorted in descending order. From the sorted list, the top M training vectors with higher cluster densities are identified and grouped as codebook. This codebook is saved and loaded in MATLAB for feature matching.

1.6. FEATURE MATCHING Feature matching methods essentially consist of identifying features in images that can be matched with corresponding features in the other images from which a transformation model can be estimated. Feature matching is an important task in the area of image processing. Here correlation method is used for feature matching. Here the clustered values of normal and defective fruits are taken more in number. With the extracted features each value are correlated with one another and we get a specific value for normal and defective fruit. With these values we can identify good and bad Fruits.

RESULTS

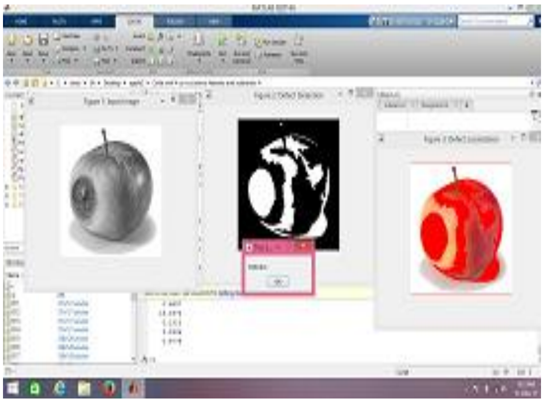


FIGURE 1: *defected fruit with cluster.*

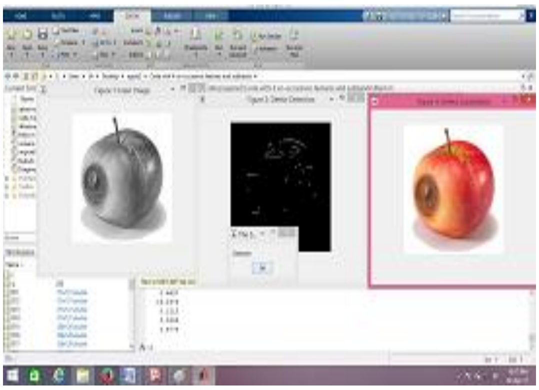


FIGURE 2: *defected fruit with cluster & canny edge.*

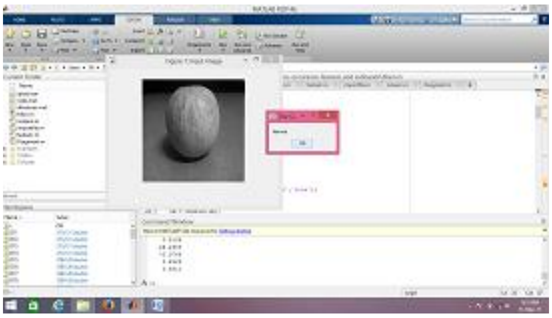


FIGURE 3:*Good/normal fruit*

2. CONCLUSION

In this paper the identification of normal and defective fruits based on quality in image processing using MATLAB is successfully done with accuracy. The use of image processing for identifying the quality can be applied not only to any particular fruit. We can also apply this method to identify quality of vegetables with more accuracy. Thus, this will enable the technology to be applied in many products. Here we use the k-means instead c-mean. Both are similar but in that small difference is k-mean find one cluster and c-mean find all neighbouring clusters. Finally our project is successfully done.

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