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Fruit Recognition with Multiple Features using Fuzzy Logic

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Abstract
Quality needs to be defined firstly in terms of parameters or characteristics, which vary from product to product. In previous years, several types of image analysis techniques are applied to analyze the fruit images for recognition and classification purposes. The proposed method can process, analyze, classify and identify the fruits images, which are selected and sent in to the system based on colour, shape and size and surf features of the fruit. The FCM algorithm is the appropriate and effective classification algorithm to be used in the Fruits Recognition System. The recognition system that has been developed is able to recognize all the test fruit images which are being selected by a user from the fruit selection menu which is based on GUI block in MATLAB on the system.
Keywords - fruit, recognition, computer vision, feature extraction, GUI Block, Image Processing, surf feature.

1. Introduction

Digital image processing analysis and computer visions have exhibited an impressive growth in the past decade in term of theoretical and applications. The fruits recognition system could be applied as an image contents descriptor which is able to describe the low level visual features or contents of the fruit images for the CBIR system. The most popular analysis techniques that have been used for both recognition and classifications of two dimensional (2D) fruit images are colour-based and shape-based analysis methods. However, different fruit images may have similar or identical colour and shape values. Hence, using colour, size and shape features analysis methods are still not robust and effective enough to identify and distinguish fruits images [1].

2. Present Work

The various steps used in the present Fruit Recogntion with multiple features using Fuzzy logic are discussed below:

2.1 Main features of proposed Topic

Therefore, a recognition approach for fruit images is proposed, which combines colour-based, shape-based, and size- based methods in order to increase the accuracy of the recognition result with enhancement of surf feature. System recognizes provided 2D query fruit image by extracting features values, including colour, shape and size and computing extracted features values to measure the distance between the computed features values of query image with the stored standard features values of every fruit samples using MATLAB.

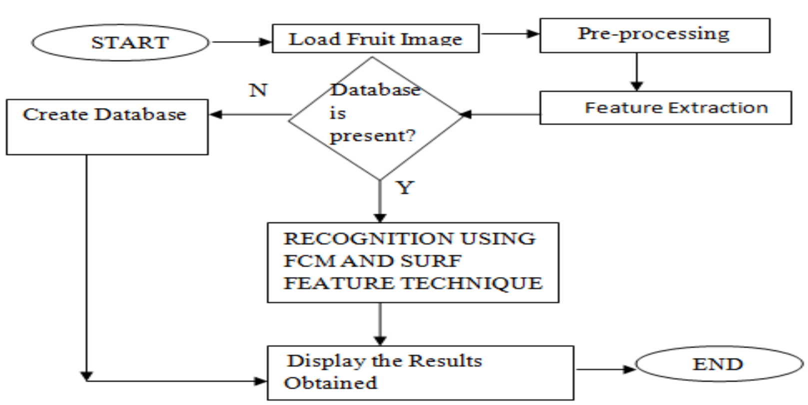


Fig.1 Flow Chart

2.2 Colour : Content-based image retrieval (CBIR), also known as query by image content (QBIC) and content-based visual information retrieval (CBVIR) is the application of computer vision techniques to the image retrieval problem, that is, the problem of searching for digital images in large databases. Content-based image retrieval is opposed to concept-based approaches.

2.3 Shape

The fruit shape roundness or metric values can be computed after extract and estimate the area and perimeter of the fruit by using equation as below:

$$shape = 4\pi\left(\frac{Area}{Perimeter^2}\right) \quad \textbf{(a)}$$

Shape feature helps to determine the measure of roundness of an object. To obtain the measure of roundness the area and the perimeter of the object has to be measured. Area can be measured by using segmentation techniques and edges of the object which is the perimeter can be obtained by going for various edge detection algorithms.

2.4 Size

The fruit area and perimeter are being chosen to represent the fruit size features, which are needed as one of the features to distinguish one type of fruit to another. The area and perimeter values of fruit are estimated in term of pixels values. In order to obtain or compute the fruit size values the algorithm will prompt the user to select a scalar value to resize the fruit image so that its size is approximately the size of fruit in real time environment. After selecting a scalar value, the algorithm will compute the new area and perimeter values for the fruit image. Size of fruit can be shown as large, medium and small.

2.5 SURF

Feature detection is the process where we automatically examine an image to extract features, that are unique to the objects in the image, in such a manner that we are able to detect an object based on its features in different images. This detection should ideally be possible when the image shows the object with different transformations, mainly scale and rotation, or when parts of the object are concluded. The processes can be divided in to 3 overall steps. **Detection** Automatically identify interesting features, interest points this must be done robustly. The same feature should always be detected regardless of viewpoint. **Description** Each interest point should have a unique description that does not depend on the features scale and rotation. **Matching** Given and input image, determine which objects it contains, and possibly a transformation of the object, based on predetermined interest points.

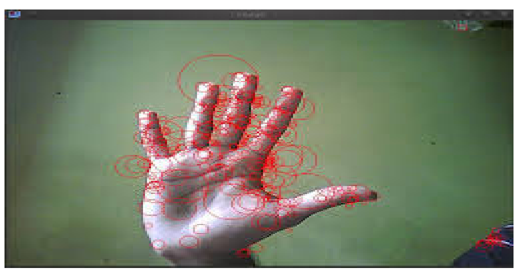


Fig 5.3 Example of surf feature

2.6 Feature map

Feature Mapping is an interactive classification process that can be applied to poor quality air video or higher quality imagery including hyper spectral imagery. Although human interpretation is limited to the visible portion of the spectrum, remotely sensed images often contain many more bands than can be translated into a single RGB representation. These additional bands may be the key to distinguishing one ground cover type from another. The goal of Feature Mapping is to identify, mark, and measure features in a set of processing rosters by combining your knowledge of the study site with TNT processing power.

2.7 Binary Map:

`BW = im2bw (I, level)` converts the gray scale image `I` to a binary image. The output image `BW` replaces all pixels in the input image with luminance greater than `level` with the value 1 (white) and replaces all other pixels with the value 0 (black). Specify `level` in the range [0,1]. This range is relative to the signal levels possible for the image's class.

`BW = im2bw(X, map, level)` converts the indexed image `X` with colour map `map` to a binary image.

`BW = im2bw (RGB, level)` converts the true colour image `RGB` to a binary image.

If the input image is not a gray scale image, `im2bw` converts the input image to gray scale, and then converts this gray scale image to binary by thresholding.

2.8 Fuzzy C-means Algorithm

The Algorithm Fuzzy c-means (FCM) is a method of clustering which allows one piece of data to belong to two or more clusters. This method (developed by Dunn in 1973 and improved by Bezdek in 1981) is frequently used in pattern recognition. It is based on minimization of the following objective function:

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

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:

$$u_{ij} = \frac{1}{\sum_{k=1}^{C}\left(\frac{\left\| x_i - c_j \right\|}{\left\| x_i - c_k \right\|}\right)^{\frac{2}{m-1}}} \quad , \quad c_j = \frac{\sum_{i=1}^{N} u_{ij}^m \cdot x_i}{\sum_{i=1}^{N} u_{ij}^m} \qquad \text{(c)}$$

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.

The algorithm is composed of the following steps:

1. *Initialize $U=[u_{ij}]$ matrix, $U^{(0)}$*
2. *At k-step: calculate the centers vectors $C^{(k)}=[c_j]$ with $U^{(k)}$*

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

3. *Update $U^{(k)}$, $U^{(k+1)}$*

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

4. *If $\| U^{(k+1)} - U^{(k)} \| < \varepsilon$ then STOP; otherwise return to step 2.*

Fig.3 Algorithm of FCM

3. Result and Discussion

The Fruit recognition system with multiple feature using fuzzy system results are shown by various figure below; In Fig(a) the start window is shown for the proposed topic. In Fig (b) Loading of image and various feature results are shown.

Fig (a) start window for the proposed topic

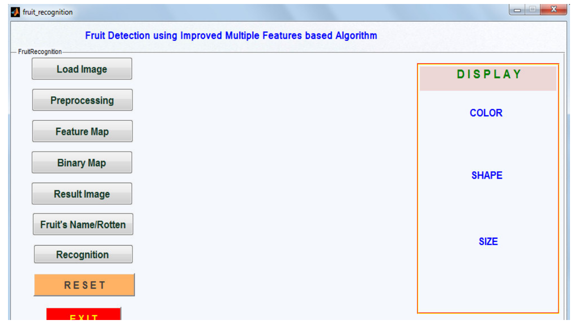


Fig (b) Loading of image with all features

In Fig(c) Mango Fruit image is loaded as an input image and all its features including shape, colour, size, feature map and binary map resulted images are shown. In fig(d) An example of rotten image is shown and result will show that fruit is rotten. So no features will be calculated for rotten fruit image

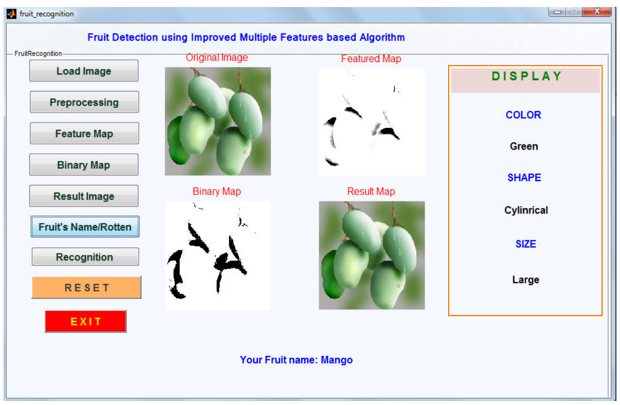


Fig (c) Mango Fruit results

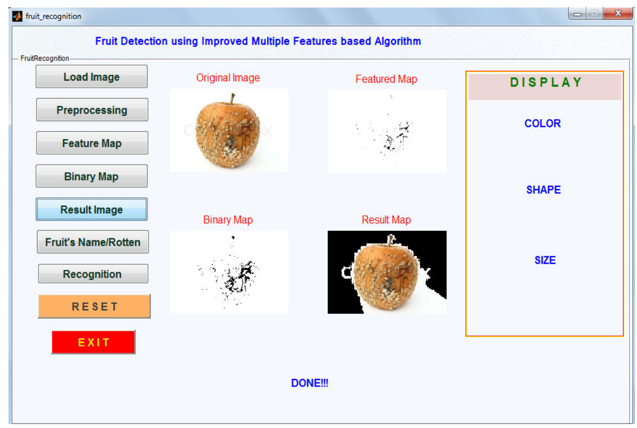
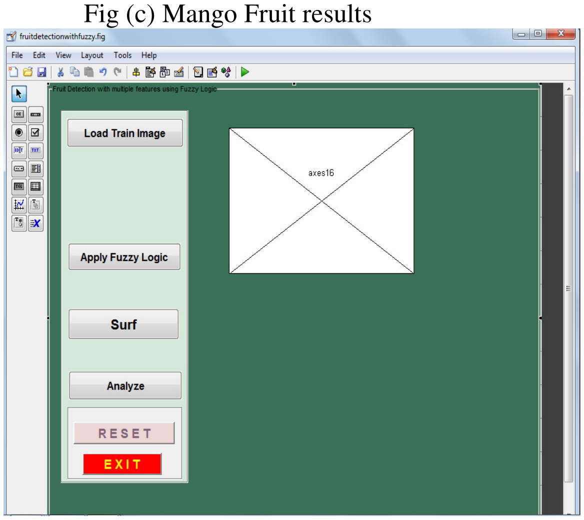
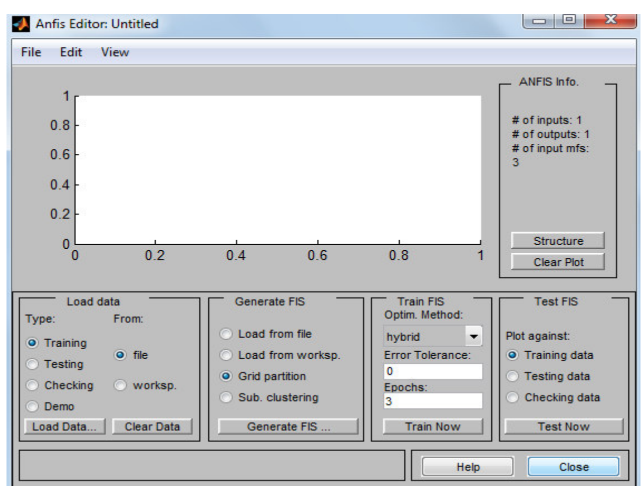


Fig (d) Rotten fruit results

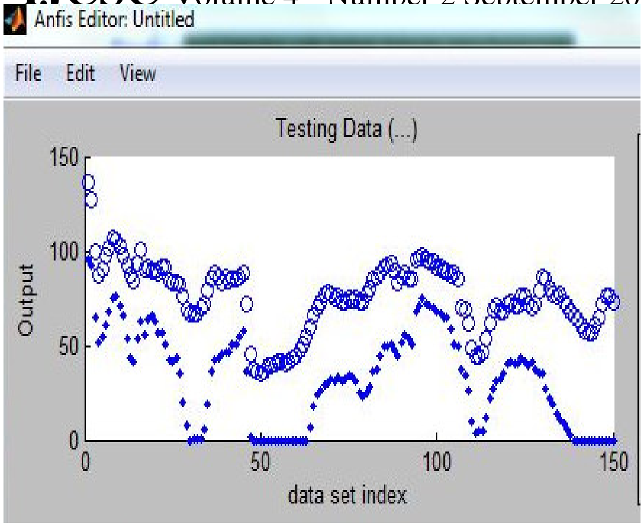


Fig(e) Fuzzy logic window



fig(f) Anfis window in MATLAB

In Fig(e) Recognition window where actually Fuzzy is applied and SURF feature results are shown. Fig(f) shows ANFIS window(Adaptive Neuro-fuzzy Inference System) which is Fuzzy logic window . This is an editor window where loaded image plots will be obtained in accordance to FCM.



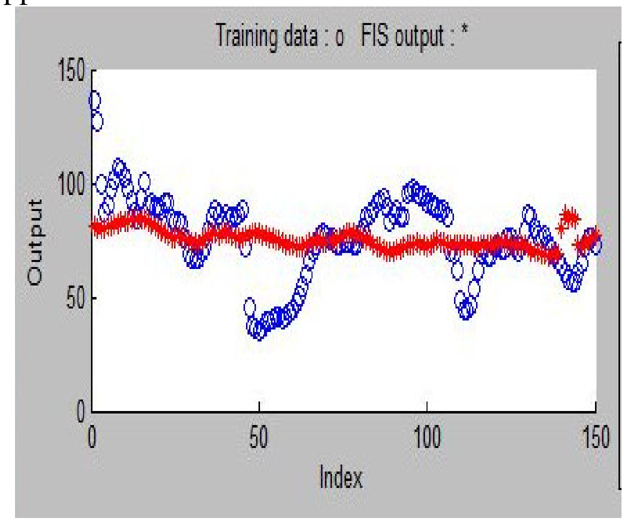
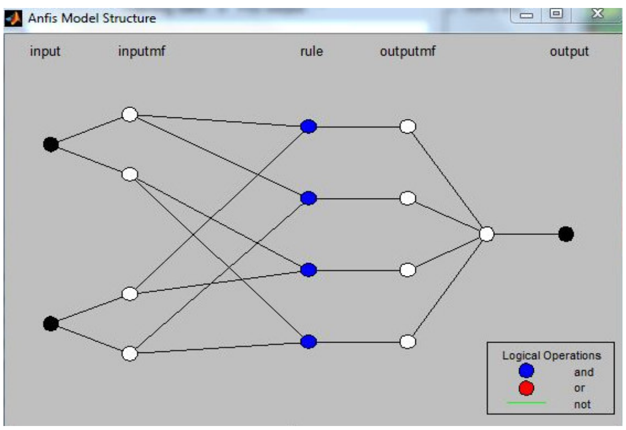
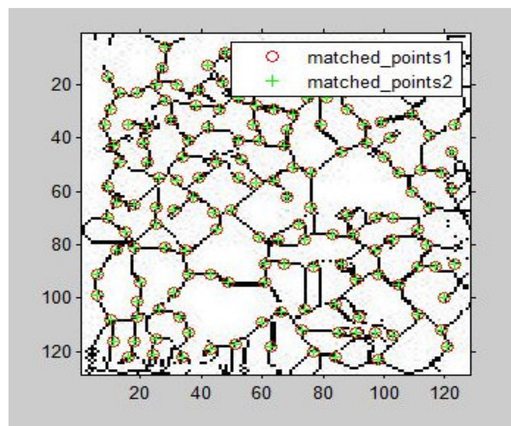


Fig (g) Testing image data results

Fig(h) Training data results

In Fig(g) Results in ANFIS window for testing image. The plot shows graph between output and data set index. In Fig(h) results for train image. Plot shows that testing and training image are matched and there feature extraction can be done. Fig shows plot for training image ANFIS window results.





Fig(i) Fuzzy model structure

Fig(j) SURF results

In Fig(I) fuzzy model structure which is obtained after selecting structure on ANFIS window. The Model structure for an train image is shown in the plot. In Fig (j) the SURF feature results which are extracted by matching two images and the result for SURF is obtained.

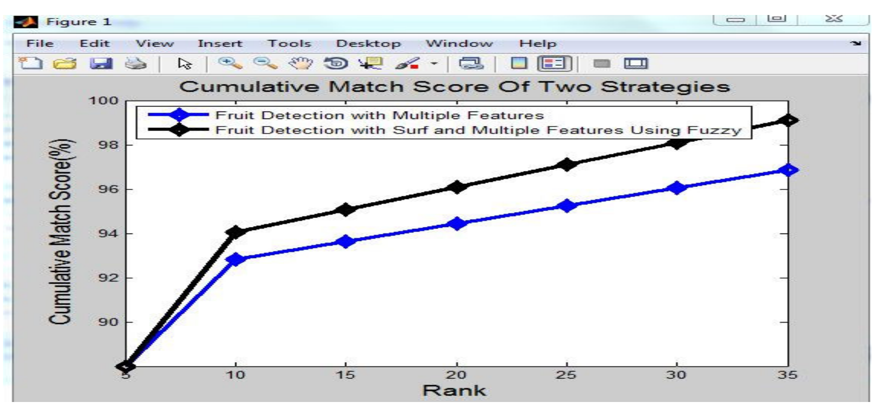


Fig (k) Plot for comparison between previous paper and new paper with surf using Fuzzy

Fig(k) is the graph plot for comparing results with previous paper and the current paper. In previous paper we have only colour, shape, size with neural network whereas in current paper SURF is added with fuzzy logic. So the results obtained are more advanced and more accurate. Up to 98% results are achieved in terms of accuracy.

4. Conclusion

The framework is to have a system for fruit quality determination completely on the basis of shape, colour, size, surf. Several fruit recognition techniques are developed based upon colour and shape attributes. Hence, using colour features and shape features analysis methods are still not robust and effective enough to identify and distinguish fruits images. A new fruit quality determination system has been proposed, which combines four features analysis methods: colour- based, shape-based and size-based and surf based in order to increase accuracy of recognition in a faster way.

The proposed method can also classifies and recognizes fruit images based on obtained feature values by using FCM. The proposed fruit quality determination system analysis classifies and identifies fruits successfully in a most accurate way. This system also serves as a useful tool in a variety of fields such as education, image retrieval and plantation science.

As In[1,2,3] research papers the results are concluded and implementations are required further so that system should be improved by extending its functions to process and recognize more variety of fruit images. Accordingly new proposed framework can have extended features with an advanced way of feature extraction and recognition using fuzzy logic. Some Possible Applications of Fruit Recognition are in educational sector, image retrieval and plantation science. These days, in super markets object recognition is frequently coming in use.

4.1 Future Scope:

This work can be enhanced in future by other researchers in following ways:

1. This dissertation focuses on the some basic parameters of fruit like colour , shape , size and surf points but in future by adding more parameters for example texture , skin of fruit , more accuracy can be achieved and as well as more study on this fruit determination system is required.

2. In future, some new features, which are local and based on the appearance of the object at particular interest points, and are invariant to image scale and rotation. In addition to these properties, which are highly distinctive, relatively easy to extract and allow for correct object identification with low probability of mismatch. So easy matching against a (large) database of local features on the basis of fruit recognition systems can be done.

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