

Classification of Fruits Based on Shape, Color and Texture using Image Processing Techniques

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Abstract: Food processing industry in any developing nation like India has been always a rough estimate. Food depends on agriculture and horticulture. Agriculture plays an important role in economic development of India. Food processing is needed to come up with some new technology so this will make the food sector with the best quality. Grading fruits is necessary in evaluating agriculture produce, meeting quality standards and increasing market value. This paper (envisages) proposes a system methodology for fruit classification based on shape, color, and texture. This work is particularly focused on improving the automation by successfully increasing the detection accuracy of fruits to be processed. This system methodology will successfully identify the different types of fruits by categorizing them into the type of category they belong. The system involved the application of a neural network to start with high-resolution images of fruits captured using a camera. Then, for faster processing, resizing, after the images were resized, then shape, color, texture features were extracted. After the features were extracted, the artificial neural network was used for testing purposes. The unclassified images were then fed into an ANN system to extract all specified features, and these extracted features were compared with stored features in a neural network on the basis of comparison. The fruits are classified. This methodology demonstrates improvement in the classification accuracy using MATLAB software from the previous research work.

Keywords: Shape, Color, Texture, Artificial neural network, Gray level co-occurrence matrix.

I. INTRODUCTION

India ranks second in the world in the production of fruit [1]. The quality of fruits plays a crucial role since they are used in a variety of applications like export, producing fruit jam, fruit juice, etc. The fruit industry plays a vital role in a country's economic growth. Now a days, fruit classification and quality evaluation is a major research area in the mechanization world. In this paper, the main focus has been laid on an economic way used to analyze the fruit quality which is based on color, shape, and size.

II. PROPOSED METHODOLOGY

The developed methodology consists of three steps. In the first step, a digital camera is used to capture an image, followed by preprocessing of the image. In the second step, features are extracted from the fruit image. In this, we proposed a texture feature to enhance the classification accuracy. In the last step, classification of fruit takes place on the basis of knowledge gained during the training phase.

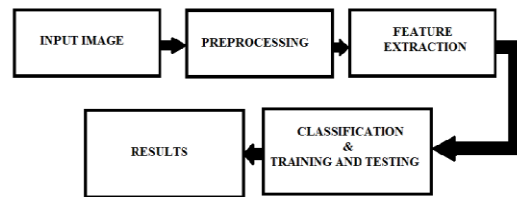


Fig.1 Block diagram of Proposed Methodology

(a) Image Capture

A digital camera is used for capturing images of fruits. Five fruits such as apple, orange, banana, mango, and pomegranate are captured as shown in figure 2.

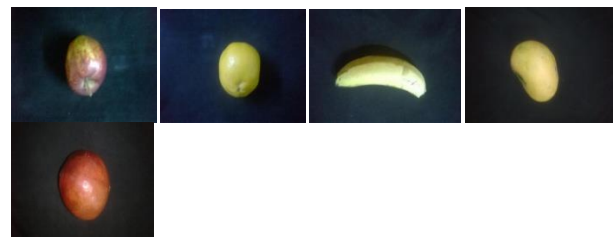


Fig.2. Image of different fruits

(b) Preprocessing

Preprocessing refers to the initial processing of the input image to eliminate noise and correct distorted or degraded data. First, the captured image is too big in size, so a program is developed to resize an image without affecting the quality of the image. The image is represented in the form of RGB pixels. Edge detection is used for the enhancement of the image. The desired fruit image is obtained after filtering, and this image can be used for feature extraction.

(c) Feature Extraction

The image obtained after image preprocessing can be used for feature extraction. The features that can be extracted from an image of any fruit are its shape, color, and texture. These features help the user to classify the fruits in different categories.

i. Shape feature

There are several techniques which can be used to extract morphological features from an image. For size/shape, five edge detection techniques are used [2]. Shape modeling is the foundation for object recognition under change of pose, deformation, and varying lighting conditions [3]. Shape-based

classification of fruits takes care of various features like area, perimeter, major axis length and minor axis length. The image generally consists of pixels which includes RGB (Red, Green and blue) components. For calculating these shape features RGB image is converted into gray scale image.[4]. When the image is converted into gray scale image then it represents a different intensity value. There is a difference in intensity value of an object to be classified and the background. A threshold value is decided to separate an object from its background. With the help of this threshold value a gray scale image is converted into binary image in which the value greater than the threshold is 1 and the value lower than the threshold is 0. With the help of this binary image different shape features are calculate. The most common shape features calculated from the image are area, perimeter, major axis length and minor axis length.[11,12]

II COLOR FEATURE

An image generally consist of RGB components (red, green and blue) which represents three planes $M*N*3$. [5] Fruits classified on color bases consist of these three color space RGB. RGB color space is converted into another color space such as HIS, HSV etc [6]. HSI stand for hue, saturation and intensity. Pure color attribute of image is described by hue and the amount by which pure color image is diluted by white color is described by saturation. The RGB components are separated from the original image, and the Hue (H), Saturation(S) and Intensity (I) components are extracted from RGB components [7].

iii. Texture feature extraction

Texture is calculated by the outer part of an object which measures the roughness, coarseness and smoothness of an image. Texture is classified by the spatial distribution of gray levels in a neighborhood. It also helps in surface determination and shape determination. Gray level co-occurrence matrix is used to calculate different texture features[8]. Gray level co-occurrence matrix (GLCM) is used to extract texture features of an image. The Grey Level Co-occurrence Matrix, GLCM is also called as Grey Tone Spatial Dependency Matrix. It represents the image in the form of tabulation which contains different combinations of pixel brightness value (gray levels) that occurs in an image.[9] To calculate different texture feature like entropy, energy, homogeneity and dissimilarity a gray level co-occurrence matrix is created[14,15].

III. PROPOSED SCHEME

Methodology for the fruit classification is mention as above whose operation divided into two phase .Neural network is used to classify the fruit in different categories. Neural network is consist of three layer are input layer, hidden layer and output layer. Working of neural network is divided into

two phase are Training phase and testing phase. 100 image of each fruit is taken out of which 50 are used for training and remaining 50 images are used for testing.

Training phase: 50 images are used to train the neural network and it gained information about each image. During training phase neural network is trained to identify the fruit on shape, color and texture bases.

Testing Phase: neural network identified the image of unknown fruit on the bases of earlier information that it gained about. Neural network analyses the various shape, color and texture features for unknown image and compared with that are store in the data base and classified the unknown imaged to desired known fruit image on the basis of knowledge gained by neural network during training.

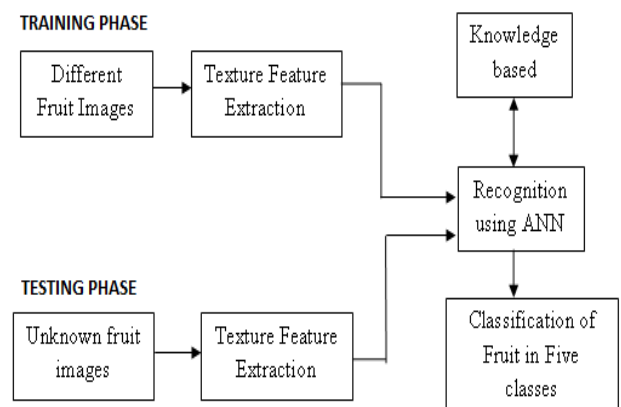


Fig.3 Block Diagram for Classification of Fruits on Texture bases

IV. IMPLEMENTATION PHASE

Shape Feature Extraction-Using the `i = rgb2gray` matlab command RGB image is converted into gray scale image Different shape features(area, perimeter, major-axis length and minor-axis length) [11]are calculated for different fruits shape features calculated are shown in Table 4.1.[10]

Table 4.1 Shape Features Calculated for Different Fruits

Images \ Shape feature	Apple	Orange	Banana	Mango	Pomegranate
Area	53035	38059	60593	98729	81640
Perimeter	10.2426	806.222	1403.5	1328.2	1487.68
Major-axis length	5.56553	233.843	549.187	420.059	328.759
Minor-axis length	2.53211	208.356	160.216	304.27	320.387

Color Feature Extraction-After the images capturing and resized the RGB image of different fruits are converted into different color space like HSV, HIS, $L \times a \times b$, YCbCr etc. with the help of MATLAB command. After the images wear converted in different color space mean and standard deviation is calculated for each color space and Sixteen color features are extracted as shown in Table 4.2[10,13]

Table 4.2 Sixteen Color Feature Extracted for Five Fruit

Images Color feature	Apple	Orange	Banana	Mango	Pomegranate
Red mean	0.162509	0.066535	0.049865	0.046677	0.042253
Red standard deviation	0.036625	0.023403	0.01427	0.020203	0.009642
Blue mean	0.13995	0.112376	0.188167	0.209123	0.20816
Blue standard deviation	0.042445	0.03702	0.054137	0.089881	0.093184
Green mean	0.127934	0.018478	0.027767	0.043664	0.084059
Green standard deviation	0.258911	0.244883	0.243238	0.231106	0.215012
Hue mean	0.13995	0.112376	0.188167	0.209123	0.20816
Hue standard deviation	0.042445	0.03702	0.054137	0.089881	0.093184
Saturation mean	0.097801	0.149325	0.11631	0.143217	0.109527
Saturation standard deviation	0.091346	0.112357	0.094047	0.119876	0.108023
Cb mean	0.013974	0.021423	0.036676	0.038023	0.017633
Cb standard deviation	0.498523	0.494647	0.491718	0.486294	0.494115
Cr mean	2.129738	2.771175	1.461737	0.751103	5.904745
Cr standard deviation	0.499704	0.948295	0.422866	0.205475	2.618134
a* mean	4.557135	6.812269	10.88757	11.70979	5.971108
a* standard deviation	1.125508	2.326853	3.073394	4.882813	2.654861

Table 4.3 22 Texture features extracted for five fruits

Images Texture feature	Apple	Orange	Banana	Mango	Pomegranate
Energy	2.0900	2.4900	5.0600	3.3500	2.5300
Entropy	0.0128	0.0090	0.0247	0.0116	0.0116
Contrast	0.9900	0.9950	0.9950	0.9950	0.9920
Variance	0.9900	0.9950	0.9950	0.9950	0.9920
Correlation	192.5121	293.3886	815.5628	233.5887	92.4434
Homogeneity	19.1649	30.3257	81.2426	30.5873	14.2692
Dissimilarity	0.0128	0.0089	0.0226	0.0116	0.0116
Max. probability	0.8095	0.8484	0.7261	0.7201	0.7095
Sum of squares	0.5231	0.4546	0.7708	0.7213	0.7048
Sum average	0.9936	0.9955	0.9890	0.9942	0.9942
Sum variance	0.9936	0.9955	0.9889	0.9942	0.9942
Sum entropy	0.8983	0.9206	0.8503	0.8460	0.8383
D V	2.0600	2.4513	5.0223	3.3067	2.4991
D E	2.4300	2.4992	3.1990	2.8721	2.6741
M CC	6.1400	7.9117	16.0193	9.8056	6.9099
IMC1	0.5140	0.4483	0.7516	0.7132	0.6968
IMC2	0.0128	0.0090	0.0247	0.0116	0.0116
I D	0.0686	0.0512	0.1080	0.0633	0.0631
IDN	0.8894	0.9085	0.8756	0.9199	0.9159
IDMN	0.7532	0.7290	0.8360	0.8410	0.8340
CS	0.9986	0.9990	0.9975	0.9987	0.9987
CP	0.9998	0.9999	0.9996	0.9998	0.9998

Texture features Extraction-In Texture features Extraction RGB image is converted into Gray scale image. By this image GLCM matrix is determined.[10,13] Using this GLCM matrix 22 texture features are extracted are shown in Table 4.3.

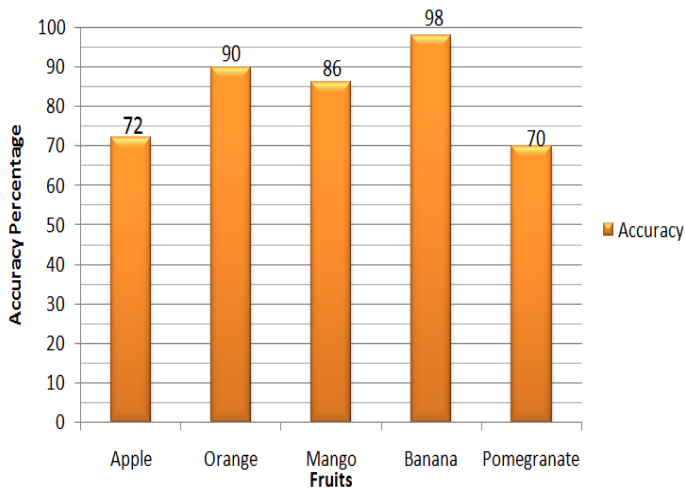
V. RESULT

For the best classification of fruits.classification accuracy should be high.it is calculated by the equation .

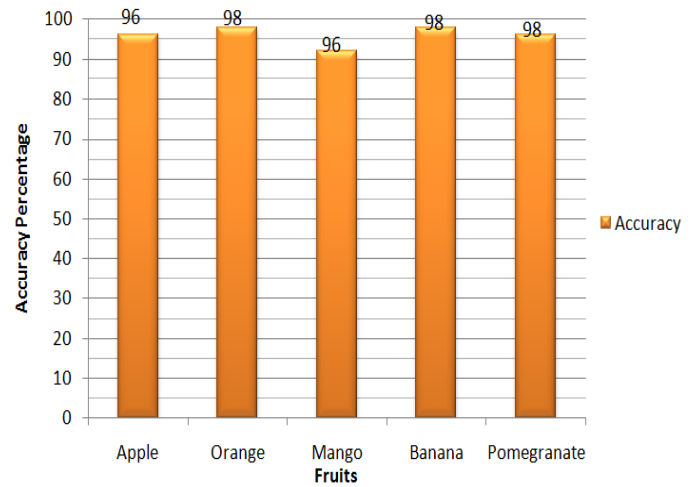
$$\text{Classification accuracy} = \frac{(\text{Number of inputs given} - \text{No of misclassified})}{\text{Number of Inputs given}} \times 100$$

Graph 1,2,3,4 shows the result of classification of percentages accuracy on shape,color, texture and both color and texture. Graph 1 show the fruits are classified on the basis of shape. By graph it finds that only 72 % of apples are accurately classified. This occurs because most of the time shape of an apple resembles to the shape of Orange and pomegranate. This is the main drawback of shape basis classification. To overcome this drawback a new feature is used that is color. Graph 2 shows the classification percentage on color basis. As the classification accuracy is improved to 94% for apple because apple and orange have different color. But colour basis classification also faces problem when two fruits have same color. Many a times apple and pomegranate have same red color so this will affect the classification and only 84% of pomegranates are accurately classified[14,15]. Graph 3 show texture features is also included to perform the classification but it also does not improve the classification because most of the fruits have smooth surface. But the classification accuracy is efficiently improved when color and texture feature are amalgamated. Classification accuracy is improved for all fruits and 97.2 % pomegranates are accurately classified.

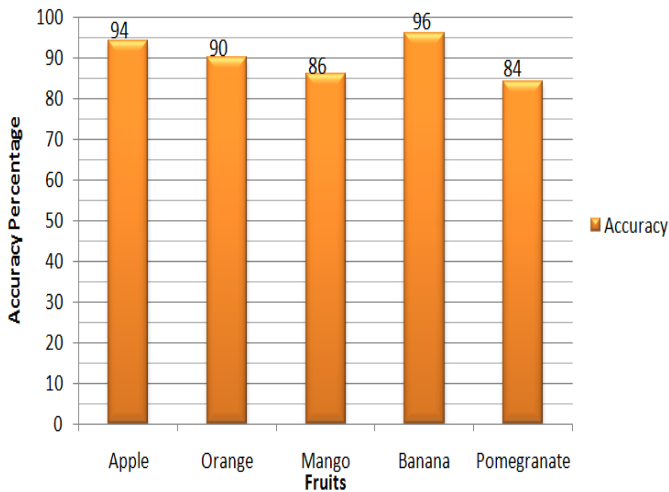
SHAPE BASED CLASSIFICATION



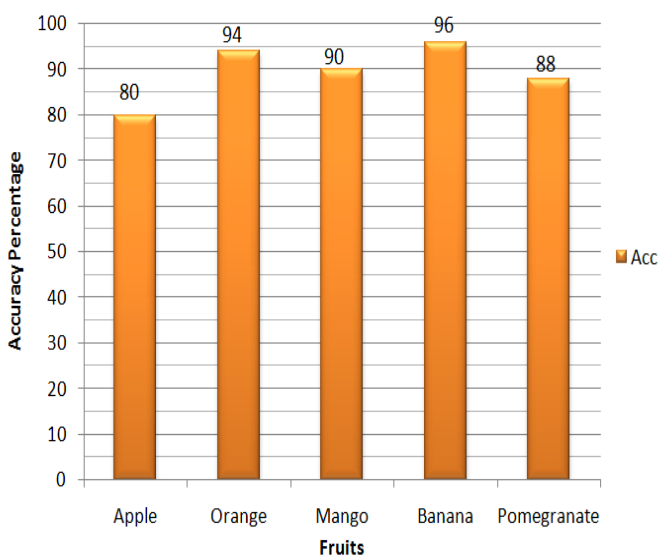
COLOR+TEXTURE BASED CLASSIFICATION



COLOR BASED CLASSIFICATION



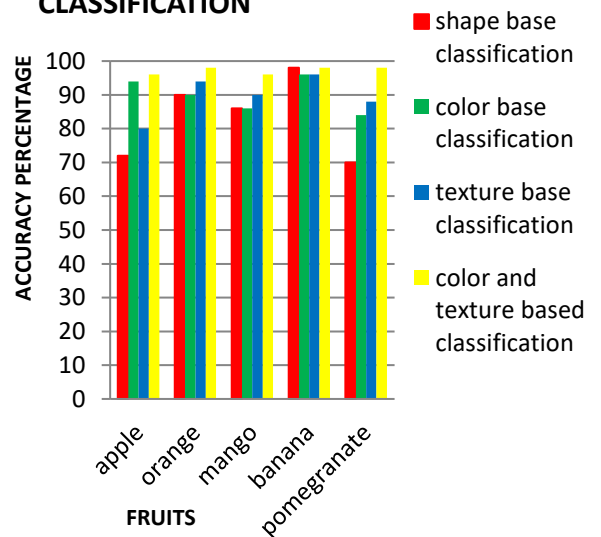
TEXTURE BASED CLASSIFICATION



VI. CONCLUSION

This paper proposes that when color and texture features are amalgamated, it gives better result over the all other previous method such as shape, color and texture. From the result we can find that shape based classification gives 83.2% accuracy, Color basis gives 90%, Texture basis give 89.60% and results are improved to 97.2% when the color and texture features are amalgamated. Hence it can be concluded that color and texture together give better result

OVERALL CONCLUDED CLASSIFICATION



VII. ACKNOWLEDGMENT

The authors would like to acknowledgement to P.G. Coordinator, Faculty of Engineering Mewar University for his valuable suggestions & guides.

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