Mango Classification Using Texture & Shape Features

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Summary

Mango is a national fruit of Pakistan and also called king of fruits. There are many varieties of mangoes, which are distinguishable on the basis of their taste, shape, colour intensity, etc. These features are utilized technically and are able to distinguish different varieties well enough. Mango is widely used in food products like jams, juices, medicines, and bakery items. The purchase of this fruit from the local market totally depends upon the human visual perception. A mistake in picking the wrong variety against the demand causes a loss in quality of that product in which it has to be used and also an international disrepute in case of exporting. Texture technique and shape extraction is broadly used for image classification. In our work, these techniques are applied on mango images for their categorization i.e. matching, extracting, object classification and for analysis. The results achieved are quite promising and proves that these techniques can be used to identify types of Mangoes and not only their sizes.

Key words:

Mango types, mango categorization, shape, texture, MaZda, B11 program

1. Introduction

Pakistan has four seasons i.e. summer, winter, spring and autumn. Its major economy based on agriculture. Mango is a one of its major crop of summer, its export volume is one million and gulf countries are its major market. Mango is also Pakistan's national fruit and known as "King of the Fruits". The 50% of the mango production is the yield of Sindh province and the other 50% is of Punjab province. District Multan and Rahim-Yar-Khan are well known for best quality mango grower areas. Eastern and south Asia are regarded as the native of this fruit. Hot, humid and steamy atmosphere is best suitable for this fruit (Syed and Syed, 2010).

Mangoes are normally classified by their names and its features include their shape, color, growing place and taste etc., manually through the labour work. We can say this is a categorization, based on which the types of mangoes are distinguished. The well known mango types are Anwar Ratole, Bengan Phali, Chaunsa, Collector, Dasehri, Fajri, Langra, Maldah, Neelam, Saroli, Sindhari, Samar Bahist, Tuta Pari but the Sindhari is special (Syed and Syed, 2010).

To reduce this labour work, computer vision provides a standard quantitative approach using almost the same shape features and the skin texture where data used in this approach can be obtained with standard sensors, normal photographic cameras. This technology exists in grocery stores to calculate the final bill through bar coding, packing date, lot number and expiry date. It is also recommended for gathering data about plants in botanical research work and in agriculture development (Seng and Mirisaee, 2009). So, the idea is to classify the mango types using this technology by collecting the data in the form of mango textures and features.

The texture is defined as the regular pattern repeated on any surface. It is the appearance and the general features of the surface of any object. The adjectives used for the texture to differentiate objects include smooth, soft, matt, rough and glossy etc., (Raju, J., and Durai, C. A. D., 2013; Kim et al., 2014; Dash et al., 2015). The features like size, location and alternation define the shape. It is a significant visual feature (Arivazhagan et al., 2010). For object analysis matching, mismatching, shape extraction and recognition techniques help a lot. Similarly, the chain code technique based on the shape used for identification of borders and the curves in x-y plane along with the boundaries of an object (Kakadiya et al., 2015).

In our work, the B11 model is trained on the image data set of different mango types with different lengths and widths. Then a technique named Region Of Interest (ROI) is used to extract various texture features and finally, data processing is performed through Lobe Component Analysis (LCA), Linear Discriminant Analysis (LDA) and Nonlinear Discriminant Analysis (NDA). The result of this data processing was the mango types and their respective features, which were stored in the B11 database. The detailed design of the B11 is discussed in Section III. After that the testing images have been given to B11 and results are reported in Section IV, which concludes that such

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techniques can be used to classify mangoes and reduce the labor work.

2. Setting Up Tools And Definitions

2.1 Properties of Mangoes Size

Our algorithm discovers and categorizes mangoes based upon its size mainly along with the quality and skin spotlessness. Using the mango image, the characteristics of the mango are gathered and used along with the features to recognize the mango class. These features are mango's roundness and the area of blemish. These features are used as the standard for the mango quality to categorize that this fruit is for the local market or export class or the wastage. Ideal thresh-hold is used in division and boundary finding to define the perimeter. The human visual system observes a color incentive in the way of chrominance and luminance. The YCBCR color space is used in our work. Y stands for luma section and the CB stands for blue difference chroma section and the CR stands for the red difference chroma section. To extract the image from its background, the CB color value has been used and to define the converged threshold, iso-data algorithm (Ganiron Jr, T. U., 2014) has been used.

2.2 Quality Inspection of Mangoes using Size and Color

Our algorithm sorts out mangoes with speed. Unripe, ripe and semi-ripe mangos are used as the dataset, which is used as an input to our algorithm. The color and size properties are extracted from the mangos' images. For the color properties, interpretations of the 'a' channel leading intensity from the lab-color-space are used. The size of the main axis accounts for the size properties depends on the selected parameters with the classifying rules. Mangoes are categorized into four grades i.e. grade1, grade2, grade3 and rejected. Two methods (Vyas et al., 2014) are used with the algorithm for obtaining better results. First is based on extracting the color properties from the full mango image while the second is based on extracting the color properties partially.

2.3 Mango Leaves Identification

Mango leaves can be classified by applying a novel artificial intelligence technique (Maqbool et al., 2015; Quadri, A. T., and Sirshar, M., 2015). To extract morphological features and specific shape features via implementation of this artificial neural network model on mango leaves is quite complex. The properties of mango leafs can be recognized using a method of novel features selection. In short, this technique was first analysed but then delayed for the future implementation.

2.4 MaZda and B11

In our work, we used the MaZda package along with the B11 program.[1] This program can be used for texture analysis and visualization using magnetic resonance imaging (MRI). The objective was to use this program for a different purpose with a hope of success. The package MaZda (Varjo, J., 2014) is used to examine mango images and then limitations observed are reported in Section V. In addition to MaZda, the MATLAB is selected as the programming stand. MaZda is able to analyse grey, 2D and 3D images. It allows 300 texture features approximately. It contains a process for their decrease and categorization. It also provides clustering feature. Now it is a consistent and effective tool that is being used by several research institutions for analysis of various image (Szczypiński et al., 2007).

3. Designing Methods

The mangoes' images have been captured using an 8 mega pixels digital camera. The time of image acquiring was 10AM to 6PM. To use these images, we first transferred these images on a computer from the memory of the digital camera. We divided these images into training and test data. Training data set contains those images from which the texture features are collected and stored while the test data set contains those images, which are tested for the evaluation purpose. The process followed to do the image recognition and classification is depicted in Figure 1.

[1] http://www.eletel.p.lodz.pl/programy/mazda/index.php?action=mazda

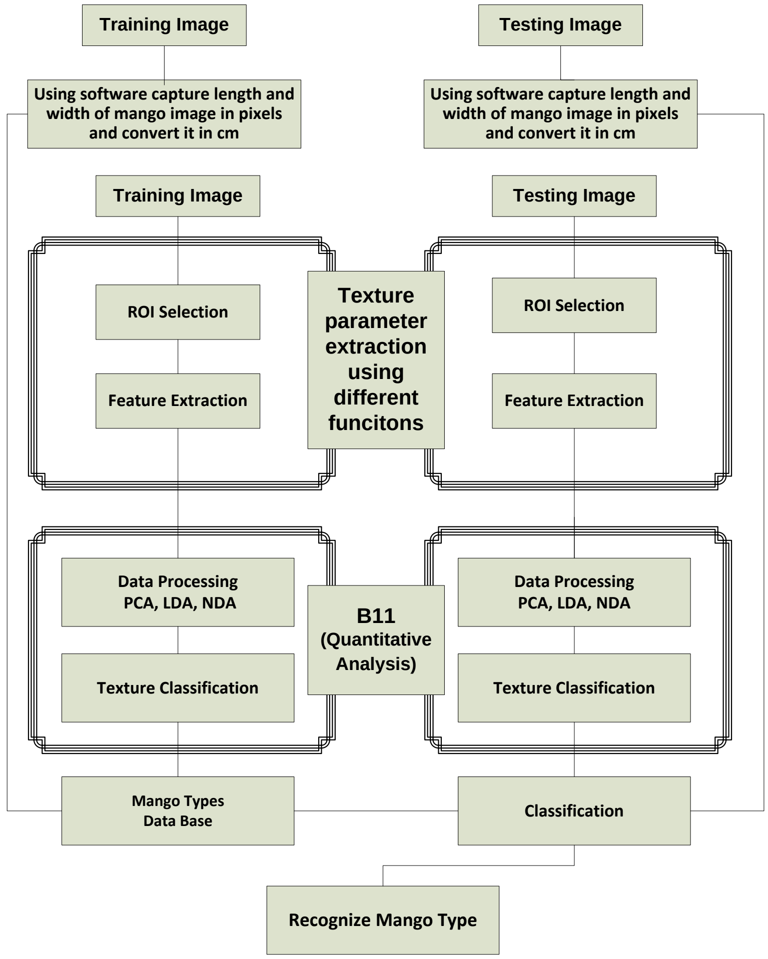

Fig. 1 Image Recognition and Classification Process

In the environment of MaZda package, different types of mangoes images have been tested using the B11 program and the following steps are performed in an algorithmic way.

1. Loop: a mango image is selected from the training data set
   a) Extract its length and width using B11 on the basis of pixels and convert it into centimeters.
   b) ROI defined in Section I, based texture features using B11 are extracted.
   c) First The B11 program is empowered with some other coded techniques like LCA, LDA, NDA and texture classification (discussed in Section I and Section II) and then the texture features collected in (a) and (b) are used by the B11 program for further data processing.
   d) Save the features in the database against that mango type.
2. For testing an image to classify its mango type, use all (a) to (c) steps in (1) except (d) and finally the image will be returned with features.

Match these features in the database and then classify the mango type as a result.

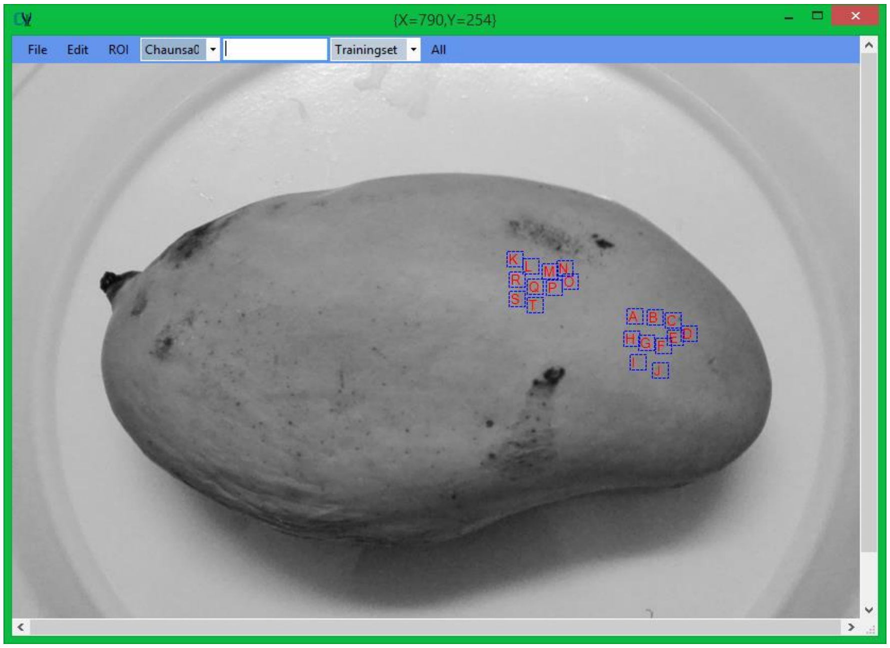

Fig 2: ROI Selection For Texture Feature Analysis

The algorithm mentioned earlier is quite simple, however, the steps involved in (1) are exposed here for readability. For texture parameters extraction, first of all, we insert an image in the MaZda-B11 program and then ROI is selected as depicted in Figure 2. ROIs are those areas, which are used for the texture feature calculation. These ROIs also called the classes. We can select maximum 16 ROIs in an image. Then apply the following functions to extract a report displayed in Figure 3 that has different parameters, which are further used for the texture analysis of these mango images for classification. Angular Second Moment, Contrast, Correlation, Variance, Inverse Difference Moment, Sum Average, Sum Variance, Sum Entropy, Entropy, Difference Variance and Difference Entropy are the functions that are used for the texture features extraction.

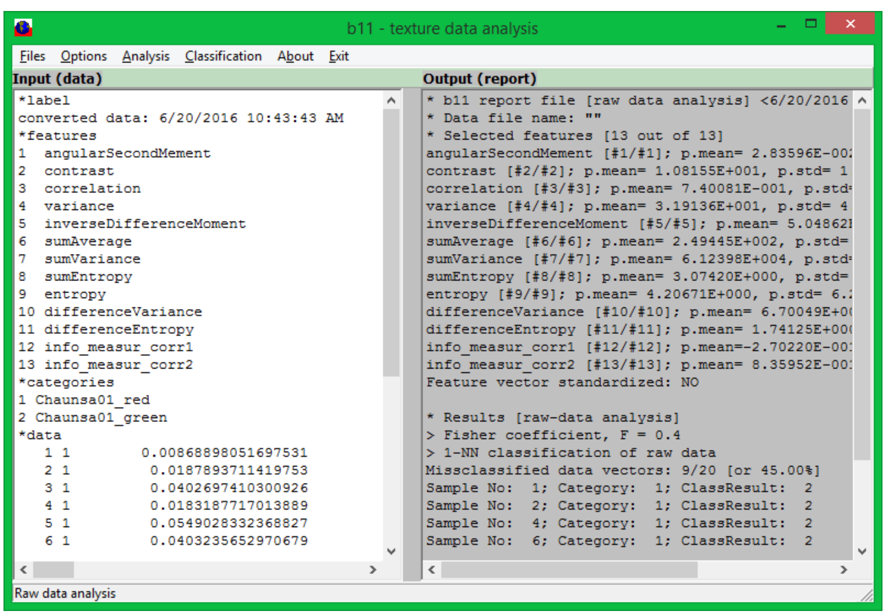

Fig 3: Report imported in B11 for Analysis

At this stage a quantitative analysis of an image has been developed in the B11 program. Extracted texture features of the ROI are used as an input to analyze the training data using coded Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA) and Nonlinear Discriminant Analysis (NDA) techniques. In comparison with the existing work (Ganiron Jr, T. U., 2014) on mangoes based on their sizes, our work has its specialty that the classification is being performed not only with the size but texture & shape features along with the B11 program equipped with the other coded techniques.

4. Results And Discussions

Our experiments are started with twenty-eight mango images of seven types of mangoes. First, texture features are extracted by applying different functions on these images and after extracting these features we used these features as an input to the B11 program where we applied different techniques for analysis. It is noticed that the evaluation of three different techniques come out with different values which becomes the basis to differentiate the mango types from one another.

The length and the width calculations for different mango types extracted through the images are displayed in Table 1 according to a procedure detailed in (Ibrahim, M., Hussain, A., & Tajammal, M. A., 2005). Similarly, the texture analysis of different types of mango with respect to PCA and LDA are calculated and displayed in Table 2. These length, width, PCA and LDA calculation is discussed in algorithmic steps (a) to (c) of (1) in Section III. The graphical view of the PCA and LDA calculation is drawn in Figure 4 and 5 respectively.

Table 1: Measurement Of Different Mangoes

Sr. No.	Mango Type	Pixels		cm	
		L	W	L	W
1	Anwar Ratual-1	493	277	13	7
2	Anwar Ratual-2	393	296	10	7
3	Anwar Ratual-3	493	332	13	8
4	Anwar Ratual-4	444	285	11	7
5	Chaunsa Kala-1	312	232	8	6
6	Chaunsa Kala-2	275	175	7	4
7	Chaunsa Kala-3	125	81	3	2
8	Chaunsa White-1	628	373	16	9
9	Chaunsa White-2	689	392	18	10
10	Chaunsa White-3	571	335	15	8
11	Chaunsa White-4	422	279	11	7
12	Chaunsa White-5	420	245	11	6
13	Chaunsa White-6	717	455	18	12
14	Dosahre-1	574	341	15	9
15	Dosahre-2	239	141	6	3
16	Dosahre-3	265	150	7	3
17	Dosahre-4	303	196	8	5
18	Dosahre-5	219	136	5	3
19	Langra-1	654	465	17	12
20	Langra-2	663	421	17	11
21	Langra-3	507	383	13	10
22	Malda-1	489	391	12	10
23	Sindhri-1	652	406	17	10
24	Sindhri-2	712	443	18	11
25	Sindhri-3	706	466	18	12
26	Sindhri-4	465	262	12	6
27	Sindhri-5	361	170	9	4
28	Sindhri-6	435	263	11	6

Table 2: Texture Analysis Of Different Mangos (Fisher Coefficient FC, Linear Separability LS)

Sr	Mango Types	PCA	LDA	
		FC	FC	LS
1	Anwar Ratual-1	220.5	1777.2	1
2	Anwar Ratual-2	29.3	234.2	0.98
3	Anwar Ratual-3	35.5	149.3	0.97
4	Anwar Ratual-4	46.4	124.9	0.97
5	Chaunsa Kala-1	501.7	1402.6	1
6	Chaunsa Kala-2	21.8	217.2	0.98
7	Chaunsa Kala-3	12.4	222.1	0.98
8	Chaunsa White-1	7.5	52.9	0.93
9	Chaunsa White-2	240.8	979.2	1
10	Chaunsa White-3	4.2	59	0.94
11	Chaunsa White-4	196.7	380.8	0.99
12	Chaunsa White-5	102.2	619.7	0.99
13	Chaunsa White-6	290.2	1100.4	1
14	Dosahre-1	125.6	890.7	1
15	Dosahre-2	0.6	131.6	0.97
16	Dosahre-3	42	2441.9	1
17	Dosahre-4	6	34.2	0.90
18	Dosahre-5	6.1	16.3	0.80
19	Langra-1	370.5	1600.5	1
20	Langra-2	4.3	37.7	0.89
21	Langra-3	10.3	75.1	0.95
22	Malda-1	221	2004.1	1
23	Sindhri-1	116.9	583.9	0.99
24	Sindhri-2	114.3	576	0.99
25	Sindhri-3	254.6	784.1	0.99
26	Sindhri-4	165.4	769.7	0.99
27	Sindhri-5	645.7	8398.2	1
28	Sindhri-6	153.7	2808.8	1

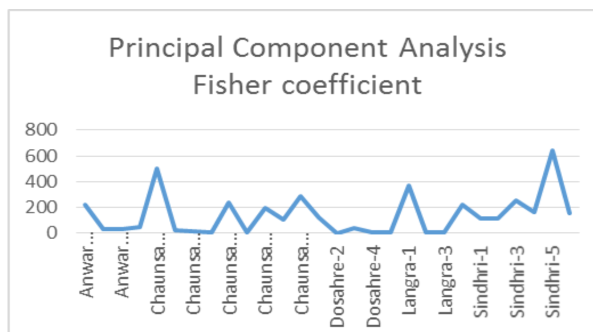

Fig. 4 PCA Graph

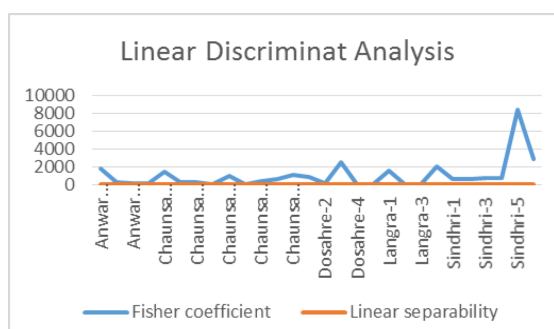

Fig. 5 LCA Graph

With this approach discussed, finally we trained our model with 22 mangoes images of 7 types and then tested on remaining 6 images. The identification result for 5 images were correct, hence evaluating the test data set with 83% accuracy. It was observed that the result for the 6th image was wrong but the number of features matched was 98 among 140 features, which is 70% and can be shifted to final decision using some probability mechanism in future to enhance the accuracy of our work.

5. Conclusions And Future Direction

This work of mango classification is mainly to help out in sorting and packing speedily. Mango images can be processed further and its features can include roundness, total area, perimeter and the defected area if any. Accumulatively, these features can be helpful to decide the exportability decision by judging the qualified vs disqualified mangoes. Our work focuses on the classification of mango types using shape and texture via the B11 program, which is a model used for medical image processing (Hájek, M., 2006) primarily. The future work can be the exploration of the mango surface-texture feature and the grading method to identify good and bad conditioned mangoes. Such techniques can be used to ensure that the mango surface is free from micro-germs and their eggs, which cause the spoliation of mangoes at later stages.

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