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A Survey on Detection of Disease and Fruit Grading

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ABSTRACT:
A research on detection of disease and fruit grading is useful for agriculture and farmers. By identifying type of disease in fruits and also grading of fruit based on its quality. For detection of disease required different features of fruit and classifier classified these features. For fruit grading segment the image after segmentation calculate infected and healthy portion of fruit and grading based on percentage of infection on fruit. This paper represents different features for fruit, different classifier for disease detection and different segmentation techniques for fruit grading process. Also gives summary of different color techniques, different texture techniques and different classifier all with its merits and demerits.

Keywords: features, colour feature, texture feature, different classifier, fruit grading, segmentation techniques

I. INTRODUCTION

India has a second rank in the production of fruit [15]. So fruits play very important role for farmers and also for agriculture. There are many applications related with image processing for agriculture. Like harvesting, grading, detecting damage and disease, plant growth monitoring are as under:

Automatically grading of fruits for oil fresh fruit bunches and strawberry [3] [6].

Calculating the size of fruit and also ripeness of fruit for its quality given in [17].

Crop disease and insects on crops are identifying for pest management system [18].

Xavier et al [19] give the real time image processing system for weed/crop discrimination in which identified plant growing at different illumination and soil condition.

Greenness was identified for plant and crop [20].

Harvesting, Grading, Detection of damage and disease, Plant growth monitoring all applications given in [21] for different fruits like apple, tomatoes etc.

In this paper working for two applications one is detection of disease and another is grading of fruit. For these two techniques first application disease detection required different features for fruit like colour, texture and shape. After feature extraction required classifier which classify disease. Second application is fruit grading. This application required fruit image segmentation after segmentation calculate healthy and infected portion of fruit.

Different feature extraction techniques for colour and texture summarise respectively in table 2 and table 3.For classification purpose different classifier techniques summarise in table 4 and for fruit grading different segmentation techniques summarise in table 5.

II. DISEASE DETECTION AND CLASSIFICATION

In disease detection process identify which type of disease available in fruits. Like in [1] they give disease detection for two grapes disease and two for apple disease. For that first of all extract the different features from the fruit. After extraction classify disease of fruit based on its features.

A. *Feature extraction*

Features are extracted from the fruit because based on its features able to classify fruit disease. Extract different features from fruit. Like colour of fruit, texture and shape.

In this paper [1] two types of grapes disease and two types of apple disease have been taken. In which color, texture and shape selected as a feature vectors. Color feature extracted by HSV histogram value. Morphology used for shape detection of disease. Texture find out by wavelet transform method used for visual pattern of skin of fruit. Color and morphology give better result than texture. Morphology gives 90% result.

Shiv et al.[2] three apple diseases have been taken apple rot, apple scab and apple blotch. First step is image segmentation by K-mean clustering. Second step is extracted features from the segmented image and features are global

colour histogram, colour coherence vector, local binary pattern (LBP) and complete local binary pattern (CLBP). In which complete local binary pattern feature give 93% correct classification than other features because its calculate magnitude ,sign and centre value for pixels.

For extraction of colour feature from oil fresh fruit bunches [3], first of all convert to L*a*b* space consists of a luminosity L* or brightness layer, chromaticity layer a* indicating color falls along the red/green axis, and chromaticity layer b* indicating color falls along the blue/yellow axis. After this calculate standard deviation and average for three different colours red, green and blue.

Mango fruit grading by fuzzy rule based on three features size, shape and colour [4]. First size of mango identify then after colour calculated based on mean of three colour value for red, green and blue and last feature skin calculated by mean skin value by edge detection algorithm for three different value.

Detection and classification of plant leaf disease [5] for which they were used HSI (Hue Saturation Intensity) colour space. Here used HSI space because it's give good result and also light invariant. After HSI create SGDM (spatial gray level dependency matrix) for texture analysis of disease. This matrix depended on intensity value at one pixel how it's related with another pixel. It gives accuracy around 93%.

Three features are extracted for Strawberry respectively shape, size and colour [6]. Shape feature find out by drawing the line and get shape by K-mean clustering method. For colour feature used dominant colour method for a* channel. For size used largest diameter method. These three features are shape, size and colour able to grade the Strawberry. Colour accuracy is 88.8% and shape accuracy is above 90%.

Date fruit classification based on different features like flabbiness, size and shape [7]. For flabbiness give date quality calculate it by color intensity. For size calculate area covered by date .For shape calculate outer edge of date. Classification of date fruit was done by back propagation neural network. Grading in three grades respectively grades 1, grade 2 and grad 3.Its gives 80% accuracy. Also for date fruit extract main three features names are color, texture and shape [8]. In which color feature find out by mean and deviation values for three main colors red, green and blue. Shape was identified by number of pixels covered by date area. Texture was found out by entropy and Gray level dependency matrix.

Table 1: Summary of different features [1-8]

Fruit	Features	Accuracy
Apple	Color, texture, shape	Color and shape give more accuracy Shape give-90%
	Global color histogram ,color coherence vector, local binary pattern	Local binary pattern give more accuracy-93%
Palm oil fresh fruit bunches	Color	73.3%
Mango	Size, shape, color	More than 80%
Plant leaf and steam disease	Texture	93%
Date	Flabbiness, size ,shape	80%
	Color , size and shape ,texture	98.6% (top-99%)
Strawberry	Shape , size ,color	Color- 88.8% Shape- above 90%

Table 2: Summary of different colour techniques

Method	Merits	Demerits
HSV histogram[1]	1. High accuracy. 2. Suitable for real time application.	1. Less sensitive to lighting variations.
Global color histogram(GCH)[2]	1. Simplest approach for distinct color.	1. Not more suitable.
L*a*b*[3]	1. Colour and intensity manage independently. 2. Ability to measure small color difference.	1. Singularity problem as other nonlinear transformations.
Mean of three color array[4]	1. Very easy for implementation.	1. Not accurate as other methods.
Dominant color method[6]	1. It's very close to human vision.	1. It's a complex method.
Color intensity[7]	1. Easy for implementation but required gray conversion.	1. Required high contrast image.

Table 3: Summary of different texture techniques [10]

Method	Features	Merits	Demerits
Grey Level Cooccurrence Matrices (GLCM)[8]	1. It is in tabular form. In which how different combinations of pixel gray levels occur in an image. 2. In which second order calculate relation between groups of two pixels.	1. Smaller length of feature vector. 2. Applied it with different color space for color cooccurrence matrix.	1. They require a lot of Computation (many matrices to be computed). 2. It's not invariant with rotation and scaling.
Gabor Filters	1. It is a signal processing method used for defining a set of radial center frequencies and orientations.	1. It's a multi-scale, multi- resolution filter. 2. It has selectivity for orientation, spectral bandwidth and spatial extent.	1. Large bank of filters used in application so computational cost is very high.
Wavelets Transform[1]	1. It is preformed on the frequency domain rather than the spatial domain.	1. Produces best features with higher accuracy.	1. It is more complex and slower.
Independent Component Analysis (ICA)	1. It decomposes mixed signal into a set of linearly independent signals.	1. It is capable of obtaining higher order statistics. 2. It is used to separate a multivariate signal implemented in texture classification.	1. It is new and not much popular method.
Local Binary Patterns (LBP)[2]	1. In which center pixel and its corresponding neighbor pixels, calculate thresholding value for neighbor based on centre pixel.	1. Its robustness to monotonic gray-scale changes caused such as illumination variations. 2. Its computational simplicity.	1. Binary data is sensitive to noise.

B. *Classifier*

Classifier is used for classifying images based on their features.

There are many classifiers are available. Naive Bayes Classifier, k-Nearest Neighbors (k-NN), Support Vector Machine (SVM), Artificial Neural Network (ANN) and Random Forest Tree Classifier.

1. Naive Bayes Classifier

Bayes classifier is a simple probabilistic classifier. It is based on applying Bayes' theorem (from Bayesian statistics).Bayes theorem is basically strong independence assumptions theorem. In [9] used Maximum a Posteriori (MAP) Naive Bayes classifier in which probabilities obtained from the estimates of the probability mass function using training data.

2. k-Nearest neighbour classifier (k-NN)

k-NN is a statistical classifier. k-NN calculate distance metric for samples and classify based on this distance. It assigns data to the most represented category within its closest k neighbours [8].In which mostly Euclidean distance used for distances calculation between the features values of the test input with training fruits. In k-NN algorithm will find out the 'K' shortest distance for the input fruit and then after assign the input fruit to their respective class based on 'K' values are closest.

3. Support Vector Machines (SVM)

SVM is used as a classifier. SVM was proposed for only 2-class problems, but for multi-class problem we can extend SVM using near-against-one or one against-all strategies [13]. SVM also used for decision making. It works on two stages. First is the off-line process, where training is performed with the set of cells requiring to be sprayed and not to be sprayed and also decision function is computed. Second is the on-line process, where decision making is performed for each new incoming cell, based on the decision function computed in off-line process. Another one use Multi-class Support Vector Machine (MSVM) as a set of binary Support Vector Machines (SVMs) for the training and classification [2].

4. Artificial Neural Network (ANN)

Artificial neural network is inspired by the concept of the biological neurons system; it is a most popular method in which it gives top accuracy 99% for date fruit [8].In which two dataset available one for training and another for testing. Train the dataset first after that compares it with testing dataset.

Neural Network (NN) was used for detection of disease for apple fruit and classifies for two apple disease [1] in this paper they are used mean squared error condition for training dataset. In this paper [14] identified normal and infected apple fruits by two layer feed forward network with sigmoid function for neurons. Network is trained with the scaled conjugate gradient back propagation algorithm.

5. Decision Tree Classifier

Decision tree classifier as name suggested is structure like a tree in which first of all source is split into subset based on its attribute values [22].In which leaves represent class labels and branches represent conjunctions of features that lead to those class. This process split the data until no further splitting possible or all has a same value of target variable. Many decision trees are consist by random forest tree classifier and outputs the category based on classes output by particular trees. Each tree gives a classification, and we say the tree "votes" for that class [9]. The forest chooses the classification having the most votes (over all the trees in the forest).

Table 4: Summary of different classifier

Classifier	Merits	Demerits
Naive Bayes	1. Naive Bayes classifier is required only small amount of training data for classification.	1. It can't learn interaction between different features because it dependency exist among variable.
k-NN	1. Simple implementation. 2. Classes don't have to be linearly separable.	1. Sensitiveness to noisy or irrelevant data. 2. Testing procedure is time consuming because of calculation of distance to all known instances.
SVM	1. SVM is well suited to work with high dimensional data. 2. Classification accuracy is more as compared to other conventional classification techniques. 3. SVM is robust enough, even when training samples have some distortion.	1. Selection of kernel function and kernel parameters for mapping original data into higher dimensional data is difficult. 2. Learning process can be time consuming.
ANN	1. Robust and user friendliness and can handle noisy data. 2. Well suited to analyze complex problem.	1. Scalability problem. 2. Require large number training samples. 3. Requires more processing time
Decision Tree	1. Easy to interpret for small-sized trees. 2. Accuracy is comparable to other classification techniques for many simple data sets.	1. Decision tree have been observed to overfit for some datasets with noisy classification/regression tasks.

III. FRUIT GRADING

In fruit grading process first step is to segment the image. After segmentation calculate infected portion of fruit and based on percentage of infection grading the fruits. Segmentation done by different segmentation techniques are as under.

A. *Segmentation techniques*

Segmentation means identifying region of interest from the image. In other word similar pixels are connected with each other.

Table 5: Summary of different segmentation techniques [11]

Segmentation Method	Description	Merits	Demerits
Histogram Matching	Histogram is constructed having peaks which correspond to a region.	Low computational complexity. No prior information needed.	Spatial details not considered, cannot guarantee the segmented regions to be contiguous.
Region based approaches	Pixels are grouped in the homogeneous regions, and region merging, splitting or their combination is used	Noise immune in edge detection approach	High computational complexity. In region splitting segments appear square due to splitting scheme

Edge detection approaches	Tries to locate the points having changes in gray level	Works well for high contrast images	Less immune to noise and doesn't work well if the image have too many edges
Fuzzy approaches	Fuzzy operators, inference rules and properties are applied.	Approximate inference can be performed by fuzzy IF-THEN rules.	Computation can be intensive and determination of membership function is not an easy job.

IV. CONCLUSION

In this paper conclude different colour and texture techniques for feature extraction. Each and every technique has some merit and demerits. Based on requirement we want to use method for colour and texture. Also give summaries of different classifier with its merits and demerits ANN and SVM give better accuracy then other classifier. Also see different segmentation techniques with its merits and demerits no such segmentation technique applicable in all images so use any of technique which is suitable for our application.

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