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A Computer Vision Based Diseases Detection and Classification in Apple Fruits

G. Ramya [1], S. Menaga[3]
[1]Assistant Professor,
Department of ECE,
Jay Shriram Group of Institutions, India

S. Dinesh [2]
[2] Department of ECE,
Kongu Engineering College, India

Abstract: **- India ranks second in the production of fruit. Consistently huge amount of apples are delivered and reaped all through world. Agriculture is a significant sector of Indian economy because it contributes around 17 percent of India's total Gross Domestic Product (GDP) and provides the employment to over 60 percent population. To deliver good quality of product it is important to discover infections in a fruit. The traditional methodology for diseases detection due to infection and identification of fruit depends on the exposed eye perception by the specialists, counseling specialists are expensive and complex because of the remote areas of their availability. Aim to automatically identify fruit diseases and manifestations of disease are crucial. Sicknesses of apple organic products showing up at reaping can bring about noteworthy misfortunes in yield and quality appeared in harvesting.**

Diseases in fruit in particular apple, cause devastating problem in economic losses and production in agricultural industry worldwide. In this project, a solution for the detection and classification of apple fruit diseases is proposed and experimentally validated by simulation. The image processing based proposed approach is composed of the following main steps: in the first step K-Means clustering technique is used for the image segmentation, the second step to as texture feature were extracted using GLCM algorithm, the third step Particle Swarm Optimization algorithm is used for feature selection, and finally images are classified into one of the classes by using a Multi-class Support Vector Machine. Our analyzed results intimate that the proposed solution can significantly support accurate detection and automatic classification of apple fruit diseases. The classification accuracy for the proposed solution is achieved up to 93% as compared with other benchmark algorithm.

Keyword: Clustering; Support Vector Machine; Feature extraction; Texture; Neural Network

1. INTRODUCTION:

The traditional approach for detection and identification of fruit diseases is based on the uncovered eye observation by the experts. In few developing countries, consulting experts are exorbitant and too much time due to the distant locations of their availability. Continuous detection of fruit diseases is essential to detect the indication of diseases as early as they appear on the growing fruits. Diseases of apple fruits appearing at harvesting can cause significant losses in yield and quality. To know what control factors to take next year to avoid losses, it is crucial to recognize what is being observed. Some common diseases of apple fruits are apple scab, apple rot, and apple blotch, Visual inspection of apples is already automated in the industry by machine vision with respect to size and color. However, detection of defects is still problematic due to natural variability of skin color in different types of apple, high variance of defect types, and presence of stem/calyx.

2. METHODOLOGY:

The Apple images are first preprocessed to remove the unwanted noise from the image.

Then preprocessed output images are given into the segmentation process for detect defected region of apple fruit images. The features are extracted from the images using GLCM algorithm. The features are extracted for all the images in the database and saved as training image features. The features are extracted for the test image and they are saved as test image features. The Training image features and the test image features are passed into the classifier. The Neural Network classifies the image into disease affected or normal image. If the given image is abnormal means the images are segmented using k-means segmentation algorithm. By using feature selection algorithm features are extracted. To dimonsiality reduction Particle Swarm Optimization algorithm is used. Then the type of the disease in the image is identified using Multi SVM Classifier. Finally the accuracy of the classifier is calculated. The accuracy of the classifier shows that the accuracy of the proposed method is 93% compared to the previous algorithms used. The features extracted using GLCM algorithm is more efficient and more reliable which helps the classifier to produce better results.

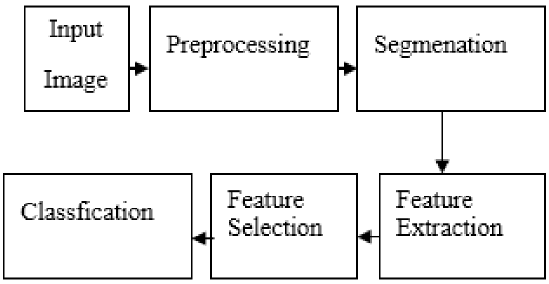

Fig 2.1 Block Diagram

The block diagram of the proposed method for apple diseases identification is shown in Fig 2.1

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2.1 Preprocessing

In preprocessing the noises in the images are removed. A noise in the image represents the unwanted pixels. The Wiener Filter is applied to remove noises from the image. This will smooth the image and make all the pixels in the image clearer. In Preprocessing, wiener filter is used to remove Gaussian noise present in the images. Images are reconstructed and shadows are removed. PSNR value also computed to know filtering accuracy.

2.2 Segmentation

The main aim of segmentation is to separate and/or change the representation of an image into something that is more meaningful and easier to analyze. If the images are classified as abnormal images the infected region is segmented K-means algorithm is used to segment the images. The input color image of the fruit is transformed from RGB to L*a*b* Color Space. The defected regions are grouped into a single cluster. The image is segmented into clusters based on the pixel value changes in the image

Algorithm Steps for K- means clustering

Let S = {w1,w2,w3,……..,wn} be the set of data points and V = {u1,u2,…….,uc} be the set of centers.

1. Randomly select 'c' cluster centers.

2. Calculate the distance between each data point and cluster centers.

3. Assign the data point to the cluster center whose distance from the cluster center is minimum of all the cluster centers..

4. Recalculate the new cluster center using:

$$V_i = (1/C_i)\sum_{j=1}^{C_i} x_i$$

Where, 'ci' represents the number of data points in ith cluster.

5. Recalculate the distance between each data point and new obtained cluster centers.

6. If no data point was reassigned then stop, otherwise repeat from step 3).

2.3 Feature Extraction

Feature extraction gives reducing amount of resources required to analysis a large set of data very accurately. For Feature extraction GLCM algorithm is used. Also referred as co-occurrence distribution. It is the most classical second-order statistical method for texture analysis. The GLCM functions gives the texture of an image by computing how often pairs of pixel with specific values and in a specified spatial relationship occur in an image, creating a GLCM, and then extracting statistical measures from this matrix [10]. Texture feature calculations use the contents of the GLCM to give a measure of the variation in intensity at the pixel of interest. GLCM texture feature operator produces a virtual variable which represents a specified texture calculation on a single beam echogram. Following 23 properties are measured.

Computed Features are,

1. Autocorrelation
2. Contrast
3. Correlation: matlab
4. Correlation
5. Cluster Prominence:
6. Cluster Shade
7. Dissimilarity
8. Energy: matlab
9. Entropy
10. Homogeneity: matlab
11. Homogeneity
12. Maximum probability
13. Sum of squares: Variance
14. Sum average
15. Sum variance
16. Sum entropy
17. Difference variance
18. Difference entropy
19. Information measure of correlation1
20. Information measure of correlation2
21. Inverse difference (INV) is homom
22. Inverse difference normalized (INN)
23. Inverse difference moment normalized

2.4 Feature Selection

Feature selection gives the best features for classification. Dimensionality of the features is also reduced. It can significantly improve a learning algorithm's performance. Particle Swarm Optimization (PSO) algorithm is used which chooses best features and eliminate irrelevant, noisy and redundant features in the calculated subset of features. For diseases classification in fruit, out of 23 features only 14 features are selected by PSO [5]. And these features are very accurate and important.

2.5 Classification

Classifier performs classification of remotely sensed data, which is used to assign corresponding levels with respect to groups with homogeneous characteristics, with the aim of discriminating multiple objects from each other within the image [6]. In this proposed work the Support Vector Machine (SVM) Classifier can be used to disease affected apple fruit.

3. SIMULATION AND RESULTS:

3.1 Data set preparation

To show the performance of the proposed method, we have collect a data set of healthy apple and Unhealthy apple fruits, which contains four different categories: Apple Blotch , Apple rot, Apple scab, and Healthy Apple: totalizing 237 apple fruit images. Fig. 6 represents the classes of the data set. Collected dataset apple fruit images are more realistic and captured in real-time.

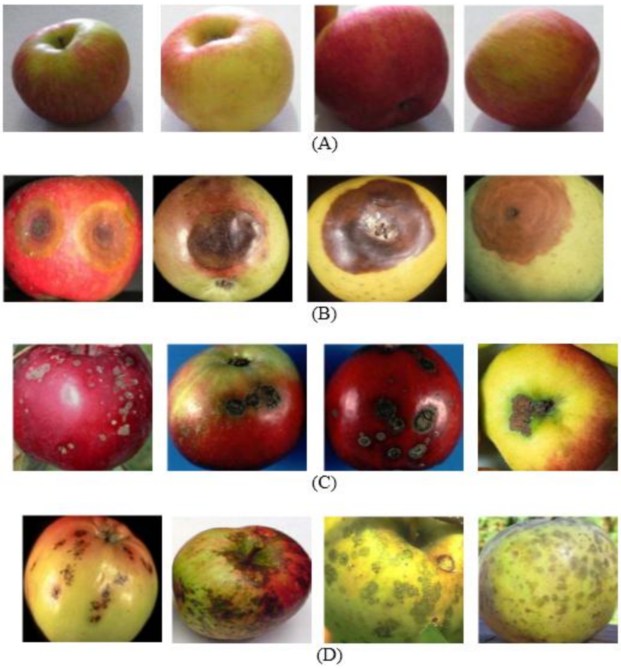

Figure 3.1 Sample Images from different data set

The figure 3.1 shows the sample images from data set of type (A) Healthy apple,(B) Apple Rot,(C) Apple Scab,(D) Apple Blotch

Category-A repsents healthy apple
Category-B repsents apple rot
Category-C repsents apple Scap
Category-D repsents apple Blotch

3.2 GLCM Features for category-A

Features	Max	Mini
Autocorrelation	50.6433	50.6406
Contrast	0.9564	0.8623
Correlation	0.9400	0.9461
Cluster Prominence	3.0543	3.0695
Cluster Shade	-251.939	-253.186
Dissimilarity	0.1366	0.1232
Energy	0.6556	0.6565
Entropy	0.5983	0.5922
Homogeneity	0.9829	0.9846
Maximum Probability	0.7858	0.7860
Sum of squres Variance	13.1381	13.1271
Sum variance	188.5053	188.5326
Sum averge	13.1381	13.1271
Sum Entropy	0.9564	0.0885
Difference Variance	0.0962	0.0885
Diference Entropy	0.7507	0.7555
Information measure of correlation	0.9909	0.9981
Inverse difference normalized	0.5983	0.5922
Inverse difference moment normalized	0.9915	0.9924

Table 3.2 shows the maximum to minimum GLCM features of all four Category images. Grey co-matrix creates a GLCM by calculating how often a pixel with grey level value (i) occurs horizontally adjacent to a pixel with value (j).
Each element (i, j) in GLCM specifies the number of times that the pixel with value i occurred horizontally adjacent to a pixel with value j. The Table 3.2 shows the GLCM features values for the different disease affected apple.

3.3 Recognition Results

Figure 3.3 shows the for the given apple images are identified as apple rot

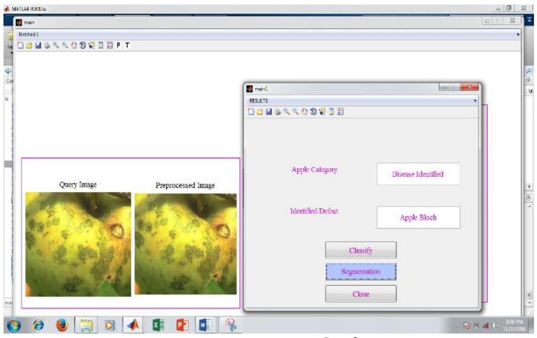

Figure 3.3 Recognition Results for Category – B

3.4 Performance Analysis

Results Comparisons of all Four Category Apple Images PSO Optimized SVM

Category	Total images	Time	Accuracy
A	150	57secs	89.01%
B	150	1mins 03secs	91.13%
C	150	1mins 17secs	89.47%
D	150	1mins 14secs	93.83%

Table 3.4 Performance comparison of results optimized PSO-SVM

3.5 Results Comparisons of all Four Category Apple Images PSO-SVM

Category	Total images	Elapsed Time	Testing Accuracy
A	150	34secs	90.37%
B	150	1mins 00secs	92%
C	150	59secs	90.93%
D	150	1mins 09secs	93.71%

Table 3.5 Performance comparison of results PSO-SVM

3.6 Result Discussions

With feature selection, the PSO-SVM approach yields a higher classification accuracy compared with those without feature selection. The features selected by PSO are able to classify more accurately than direct SVM classifier. The overall classification accuracy of direct SVM is 90.86 %. And the overall accuracy of the PSO-SVM is 91.7525.

This means that not all features are needed to achieve total classification accuracy. The computation time used in PSO is less than in GAs. The parameters used in PSO are also fewer. However, if the proper parameter values are set, the results can easily be optimized.

4. CONCLUSIONS

The presented algorithm that segments the apple images to identify the defected region and classifies the given image using the features extracted. In the preprocessing stage the noise in the images are removed. The color channels of the images are separated and color histogram is applied to each color channels. The GLCM algorithms were used to extract the features the apple images are converted into L*a*b color format. Using the extracted features and the true label the SVM classifier identified the defects in the apple such as apple scab, apple rot, apple Bloch. It is find that by using direct classification of SVM requires more time to take execution and accuracy is 91.1%. Here all GLCM features are extracted and classified. By using SVM with PSO optimized features gives improved accuracy about 93% and less execution compared than direct SVM classification. The proposed solution can significantly support automatic detection and classification of apple fruit diseases. Future work includes the simulated results to be implemented in hardware for automatic sorting defeated fruit using conveyor belt or robotic arm.

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