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ISSN: 2249-6661
Vol-43, No.-03 (III) November-December (2020)

Identification of Different Plants through Image Processing Using Different Machine Learning Algorithms

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***Abstract*—Identification of plants through plant leaves on the basis of their shape, color, and texture features using digital image processing techniques for classifying the plant species using different machine learning algorithms.**

This research work includes reviewing multiple image processing methods to use machine learning to identify multiple plants using its leave feature in the form of an image. Here the image processing technique is considered as the main method for classifying different plants of different characteristics or specific portions or regions of the plant leaves which will be then identified through image processing. Theproposed research work only focuses on the identification and classification of different parts of leaves to identify the plant species. This research paper offers an overview of the various classification methods used in the classification of plant leaf identification. Throughout the research work, SVM is the main method or algorithm that we are using for the identification or classification of plants. The proposed work through experimental results claims a better accuracy in the identification of plant species through its leave feature and it makes the identification of plants much easier and safe time.

Keywords: - image processing, SVM, plant identification, Identification and Classification, machine learning, image pre-processing, image segmentation, feature extraction, Gaussian filtering, K-means clustering,Principal Components Analysis (PCA).

I. INTRODUCTION

THEplants play an important role in nature, this paper deals with plant identification and classification. There are many plants known and unknown to the people also the plants are of many categories or species. In this we use the machine learning algorithm to identify the plants using different image processing algorithm. Using the different image processing algorithm method**,** the image of plants can be identified. The identification of plants will be a much easier and save time. This project primarily focuses on the identification and classification of different plants. There are so many methods for classification, such as Support Vector Machine Classifier, Classification and Regression Tree, Naive Bayes, Analysis, Random Forest Classification. Selecting a classification technique is always a challenging job because distinct input information can differ in the quality of the consequence.

The Plants are basically identified by their leaves. There are different varieties of trees grown throughout the world. Some are an important cash crop. Some are used in medicine. Tree identification is very important in day to day life. Their identifications had been studied using various laboratory methods. The morphological and genetic characteristics were employed to classify different leaves. However, the presence of wide morphological varieties through evolution among the various leaf cultivars made it more complex and difficult to classify them. Therefore manual identification, as well as classification of these leaves, is a tedious task. During the last few decades, computational biologists have studied various diversities among leaf due to a huge number of evolutionary changes. Leaf structures play a very crucial role in determining the characteristics of a plant. The broad and narrow shaped leaves, leaf arrangement, leaf margin etc. characteristics feature that differentiate various leaf of a tree. This project proposed the methods to identify the leaf using an image analysis-based approach.

a. The Leaf structure: To identify a leaf, first we have to know the structure of the leaf.
b. Identify Plants: If we can able to identify leaf, we can easily able to identify plants.
c. Plant leaves classification: If we can able to identify leaf, we can easily able to classify the plants.
d. Flower classification: If we can able to identify the flower, we can easily able to classify the plant.

A. *Objective*

The objective of this paper, the machine learning is to use leaf images and extracted features, including shape, margin, and texture, to accurately identify different species of plants. Leaves, due to their volume, and unique characteristics, are an effective means of differentiating plant species. They also

ISSN: 2249-6661
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provide a fun introduction to applying techniques that involve image-based features. We are going to apply different classification techniques to benchmark the relevance of classifiers in image classification problem.
The overall concept that is the framework for any related algorithm of image classification is almost the same. First, the digital images are acquired from the environment using a digital camera. Then image-processing techniques are applied to the acquired images to extract useful features that are necessary for further analysis. After that, several analytical discriminating techniques are used to classify the images according to the specific problem at hand. Figure III.1 depicts the basic procedure of the proposed image processing based identification a plant in this research.

B. *Scope*

Uses of machine learning algorithm plants identification and classification will be accomplished at each point more quickly and more accurately. Using different machine learning algorithms the Analysis of images is a significant technique that helps segment images into objects and backgrounds. One of the most important steps in image analysis is the detection of features. The input information will be then transformed into a feature set known as extraction of the feature. The image processing now becomes the main method for identifying the different plant.

II. LITERATURE REVIEW

Researchers have tried many methods to derive the characteristics and automatically to identify as well as classify the species of plants. Most of these approaches use different parameters such as colour, shape and texture features to combine.

In contrast to studies on leaves or plant foliage, a smaller number of primary studies identify species solely based on flowers. [1] Some studies did not only focus on the plant but also on the flower region as a whole but also on parts of the flower. Hsu et al. analyzed the color and shape not only of the whole flower region but also of the pistil area.[1] The authors proposed analyzing the lip (labellum) region of orchid species. This proposes features, which capture color, texture, and shape of petals as well as their arrangement. Which we can also analyze and uses to identify the species, color, and shape of any particular of a plant leaf.

Shape

The shape is known as an important clue for humans when identifying real-world objects. A shape measure in general is a quantity, which relates to a particular shape characteristic of an object. An appropriate shape descriptor should be invariant to geometrical transformations, such as rotation, reflection, scaling, and translation

Color

Color is an important feature of images. Color properties are defined within a particular color space. Once a color space is specified, color properties can be extracted from images or regions. A number of general color descriptors have been proposed in the field of image recognition [2, 3]

Two studies analyzed venation in combination with the shape of leaves [2]. These groups of researchers [3] studied the ratio of leaf-area after morphological opening is found that using a combination of all features (leaf area, shape, color, and texture) yielded the highest classification accuracy. It is found that color information of leaves increased accuracy from 84.45% (shape only) to 91.30% (shape + color)

Arun Priya et al. [3] compared SVM with k-NN classification based on shape and vein features and found that SVM with 94.5% outperformed k-NN with only 78%.

Abdul Kadir et.al [4] proposed a method to identify the plants and various features like texture, vein, shape and color of the leaves are extracted. The paper limits in achieving reliability with respect to a colour feature.

AbdolvahabEhsanirad et.al [5] proposed a methodology to extract the texture feature of the leaf image and classification.

A.J. Pérezet.al [6] focuses on the color and shape feature of leaf image. For the proposed methodology different shape features like the ratio of the major axis length squared to the area, first invariant central moment, major axis length, ratio of the perimeter squared to the area, minor axis relation, distance to the plant row. K-Nearest Neighbor (KNN), Bayes rule and heuristic approaches are used in classifying the leaf image. An accuracy of 89.7% is acquired from the proposed method.

Vijayashree[7] introduced a method called Computer-Aided Plant Species Identification Technique (CAPSI), which is based on the image matching technique of leaf shape. Different biometric features like width factor, diameter, major axis, minor axis, area, perimeter, and aspect ratio of the leaf image are extracted. An artificial neural network (ANN) classifier is used for the classification of leaf images.

Im, C., Nishida, H. and Kunii [8], they proposed a system that uses contour of leaves as the main feature to classify the leaf image. In the first step teeth of the leaf and secondly the global structure of the leaf are calculated. For classification, a hierarchical method is used. Based on the parameter like apex numbers and similarity measures, the leaf is detected.

Sanjeev S Sannakki et.al [9] presented a paper on the comparison between different edge detection methods for leaf images.

Vijay Satti et.al [10] describe how features are extracted after pre-processing. The procedure involved is pre-processing, RGB to Grayscale and then Grayscale to binary followed by smoothing and filtering. Finally, the color shape and geometric features are extracted.

Kumar et.al [11] proposed a system with a devised methodology that gives the identification of plants based on its edge features. The color image is converted to its grayscale equivalent image. From this grayscale image, edge histogram is calculated Detection algorithm is implemented in this work. The process includes the stages of Image acquisition, feature extraction and comparing the image with those images that are previously stored on the database and the area of leaf, which is comparatively effective since the

ISSN: 2249-6661
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photograph taken may vary from person to person. This work is limited to detect only the mature leaves since the tender leaves changes slightly when it became mature.

Ji-Xiang Du et.al [12] proposed a new classification method called Move Median Centres (MMC) hypersphere classifier. From the experimental results of this paper, the methodology saves both storage space and reduces the classification time.

Pavan et al. [13] proposed an algorithm for identification using a multiclass classification based on color, shape volume and cell feature. They performed three-stage comparisons: the first stage compares redness, greenness, blueness index feature, the second stage compares shape feature and the last stage compares cell feature and volume fraction feature. The experiment is performed on a sample of a diverse collection of 1000 leaf and flower images. The limitation of this approach is that it semi-automatic approach and its recognition rate is up to 85% percent on average.

Arun Priya [14] the proposed approach consists of three phases such as preprocessing: transforming to grayscale and boundary enhancement, feature extraction: derives the common DMF from five fundamental features and classification: Support Vector Machine (SVM) classification for efficient leaf recognition. 12 leaf features which are extracted and orthogonalized into 5 principal variables are given as input vector to the SVM. Valliamal et al.

[15] A probabilistic curve evolution method with particle filters is used to measure thesimilarity between shapes during the matching process. The experimental results prove that the preferential image segmentation can be successfully applied in leaf recognition and segmentation from a plant image. Dr. H.B.Kekre et al.

[16] the method of CBIR is discussed in this paper to filter images based on their content. In this paper,a feature vector is generated using a color averaging technique, similarity measures and performance evaluation. Precision-Recall crosses over plot is used as the performance evaluation measure to check the algorithm. The effect due to the size of the database and the number of different classes is seen on the number of the relevancy of the retrievals. Javed et al.

From the above review of literature, it is very clear that no effective methods were proposed for the identification of plant and hence this proposed system addresses the identification of the different plants.

III. PROPOSED METHODOLOGY

The following figure represents the steps involved in the proposed approach in a sequence manner:

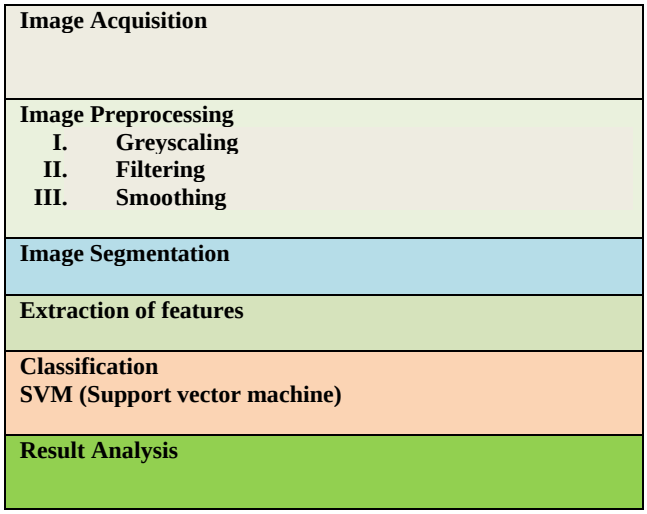

Fig:1. Project Procedure framework

STEP 1: Image Acquisition

The general aim of Image Acquisition is totransform an optical image (Real World Data) intoan array of numerical data that could be latermanipulated on a computer before any video orimage processing can commence an image that mustbe captured by the camera and converted into amanageable entity.

Image Acquisition is achieved by a suitable camera. We use different cameras for different applications. If we need an x-ray image, we use a camera (film) that is sensitive to x-ray. If we want the infra-red image, we use a camera thatis sensitive to infrared radiation. For normal images (family pictures etc) we use cameras that are sensitive to the visual spectrum. Image Acquisition is the first step in any image processing system.

In image processing, it is defined as the action of retrieving an image from some source, usually a hardware-based source because, without an image, no processing is possible. The image that is acquired is completely unprocessed.

STEP 2: Pre-Processing

Pre-processing is a common name for operations with images at the lowest level of abstraction - both input and output are intensity images. These iconic images are of the same kind as the original data captured by the camera. The aim of pre-processing is an improvement of the image data that suppresses unwilling distortions or enhances some image features important for further processing, although geometric transformations of images are classified among pre-processing methods. We need pre-processing for achieving better results from the applied model in Machine Learning projects the format of the data has to be in a proper manner. Some specified Machine Learning model needs

ISSN: 2249-6661
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information in a specified format, for example, Random Forest algorithm does not support null values; therefore to execute random forest algorithm null values have to be managed from the original raw data set.

Gaussian filtering

It is a widely used effect in graphics software, typically to reduce image noise and reduce detail.Gaussian smoothing is also used as a pre-processing stage in computer vision algorithms in order to enhance image structures at different scales.

Gaussian filtering is more effective at smoothing images. It has its basis in the human visual perception system it has been found that in the human visual perception system. It has been found that neurons create a similar filter when processing visual images.

Gaussian filtering g is used to blur images and remove noise and detail. In one dimension, the Gaussian functions. Where σ is the standard deviation of the distribution. The distribution is assumed to have a mean of 0. Shown graphically, we see the familiar bell-shaped Gaussian distribution. Gaussian distribution with mean 0 and σ = 1

Standard Deviation

The Standard deviation of the Gaussian function plays an important role in its behavior.

The values located between +/- σ account for 68% of the set, while two standard deviations from the mean (blue and brown) account for 95%, and three standard deviations (blue, brown, and green) account for 99.7%. account for 99.7%. This is very important when designing a Gaussian kernel of fixed length.

The Gaussian function is used in numerous research areas:

– It defines a probability distribution for noise or data.
– It is a smoothing operator.
– It is used in mathematics.

The Gaussian function has important properties which are verified with the Gaussian function has important properties which are verified with respect to its integral:

In probabilistic terms, it describes 100% of the possible values of any given space when varying from negative to positive values ( ) 2 I dx exp x π ∞ −∞ = −= ∫ 21 given space when varying from negative to positive values Gauss function is never equal to zero. It is an asymmetric function. When working with images we need to use the two-dimensional Gaussian function. This is simply the product of two 1D Gaussian functions (one for each direction) and is given by: A graphical representation of the 2D Gaussian distribution with mean(0,0) and σ = 1 is shown to the right.

The Gaussian filter works by using the 2D distribution as a point-spread function. This is achieved by convolving the 2D Gaussian distribution function with the image. We need to produce a discrete approximation to the Gaussian function. This theoretically requires an infinitely large convolution kernel, as the Gaussian distribution is non-zero everywhere. Fortunately, the distribution has approached very close to zero at about three standard deviations from the mean. 99% of the distribution falls within 3 standard deviations. This means we can normally limit the kernel size to contain only values 23 this means we can normally limit the kernel size to contain only values within three standard deviations of the mean.

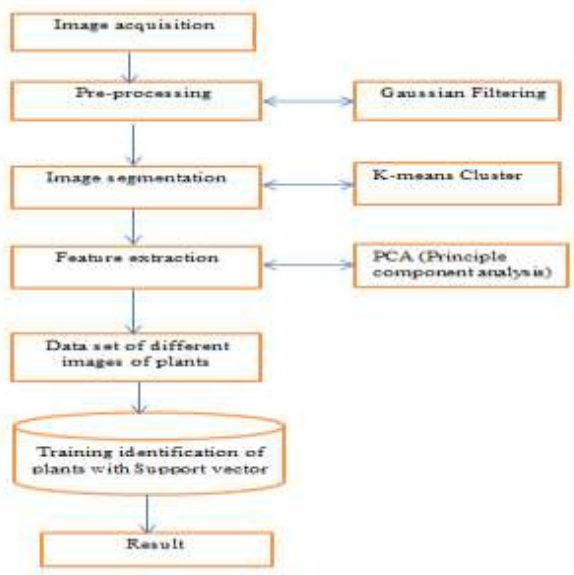

Fig:2Flowchart for Identification of a plants System

STEP 3: Image Segmentation

Image segmentation is an important and challenging process of image processing. Image segmentation technique is used to partition an image into meaningful parts having similar features and properties. The main aim of segmentation is simplification i.e. representing an image into a meaningful and easily analyzable way. Image segmentation is a necessary first step in image analysis. The goal of image segmentation is to divide an image into several parts/segments having similar features or attributes. The image segmentation can be classified into two basic types: Local segmentation (concerned with specific part or region of image) and Global segmentation (concerned with segmenting the whole image, consisting of large number of pixels). The image segmentation approaches can be categorized into two types based on properties of image.

A)Discontinuity detection based approach

This is the approach in which an image is segmented into regions based on discontinuity. The edge detection based segmentation falls in this category in which edges formed due to intensity discontinuity is detected and linked to form boundaries of regions.

ISSN: 2249-6661
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B)Similarity detection based approach

This is the approach in which an image is segmented into regions based on similarity. The techniques that fall under this approach are: thresholding techniques, region growing techniques and region splitting and merging. These all divide the image into regions having a similar set of pixels. The clustering techniques also use this methodology. These divide the image into a set of clusters having similar features based on some predefined criteria.

In other words, we can also say that image segmentation can be approached from three perspectives: Region approach, Edge approach, and Data clustering. The region approach falls under similarity detection and edge detection and boundary detection falls under discontinuity detection. Clustering techniques are also under similarity detection.

The clustering-based techniques are the techniques, which segment the image into clusters having pixels with similar characteristics. Data clustering is the method that divides the data elements into clusters such that elements in same cluster are more similar to each other than others. There are two basic categories of clustering methods: Hierarchical method and Partition based method. The hierarchical methods are based on the concept of trees. In this the root of the tree represents the whole database and the internal nodes represent the clusters. On the other side, the partition-based methods use optimization methods iteratively to minimize an objective function. In between these two methods, there are various algorithms to find clusters. There are basically two types of clustering

1. Hard Clustering:

Hard clustering is a simple clustering technique that divides the image into a set of clusters such that one pixel can only belong to only one cluster. In other words, it can be said that each pixel can belong to exactly one cluster. These methods use membership functions having values either 1 or 0 i.e. one either certain pixel can belong to a particular cluster or not. An example of a hard clustering-based technique is one k-means clustering-based technique known as HCM. In this technique, first of all, the centers are computed then each pixel is assigned to the nearest center. It emphasizes on maximizing the intracluster similarity and also minimizing the inter-cluster equality.

2. Soft clustering:

Soft clustering is a more natural type of clustering because in real life exact division is not possible due to the presence of noise. Thus soft clustering techniques are most useful for image segmentation in which division is not strict. The example of such type of technique is fuzzy c-means clustering. In this technique pixels are partitioned into clusters based on partial membership i.e. one pixel can belong to more than one cluster and this degree of belonging is described by membership values. This technique is more flexible than other techniques.

The K-means clustering algorithm tries to classify objects (pixels in our case) based on a set of features into K number of classes. The classification is done by minimizing the sum of squares of distances between the objects and the corresponding cluster or class centroid. However, K-means clustering is used to partition the leaf image into 3 clusters in which one or more clusters contain the plant image in the case when the leaf is identified by more than one leaf image. In our experiments, multiple values of the number of clusters have been tested. The best results were observed when the number of clusters was 3.

STEP 4: Feature Extraction

The feature aims to reduce the number of features in a dataset by creating new features from the existing one and discarding the original features. It is done for training as well as for the testing phase. The main propose is to identify the maximum similarities between the training plant images and the testing image. For accuracy improvement, overfitting risk reeducation, speed up in training and improved data visualization.

Principle Components Analysis (PCA)

PCA is one of the most used linear dimensionality reduction technique. When using PCA, we take as input our original data and try to find a combination of the input features which can best summarize the original data distribution so that to reduce its original dimensions. PCA is able to do this by maximizing variances and minimizing the reconstruction error by looking at pair wised distances. In PCA, our original data is projected into a set of orthogonal axes and each of the axes gets ranked in order of importance. PCA is an unsupervised learning algorithm therefore it doesn't care about the data labels but only about variation.

In feature extraction using PCA, we use the old independent features to create new independent features which are a combination of the old features. We order the new independent features and drop the least important features. As the new features are a combination of the old features, we have all the benefits/ information that we had initially.

Using principal components, we will be able to identify the image from database which is similar to the features of test image; PCA is a powerful tool for analyzing data. The other main advantage of PCA is that once you have found these patterns in the data, and you compress the data, i.e.by reducing the number of dimensions, without much loss of information. PCA has several advantages. It helps find the most effective transformation of existing attributes through a linear transformation technique. It helps with dimensionality reduction, which makes things faster by reducing the size of

ISSN: 2249-6661
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the dataset to be stored and processed PCA with dimensionality reduction.

STEP 5: Support Vector Machine (SVM)

Support Vector Machines are a type of supervised machine learning algorithm that provides an analysis of data for both classification and regression analysis. While they can be used for regression, SVM is mostly used for classification. We carry out plotting in the n-dimensional space. The value of each feature is also the value of the specified coordinate. Then, the proposed SVM is to find the ideal hyperplane that differentiates between the two classes.

These support vectors are the coordinate representations of individual observation. It is a frontier method for segregating the two classes.

Working of SVM

The SVM model tries to enlarge the distance between the two classes by creating a well-defined decision boundary,The propose of support vector machine is to find the hyperplane in N-dimensional space (n-the number of features) that classify the data points.

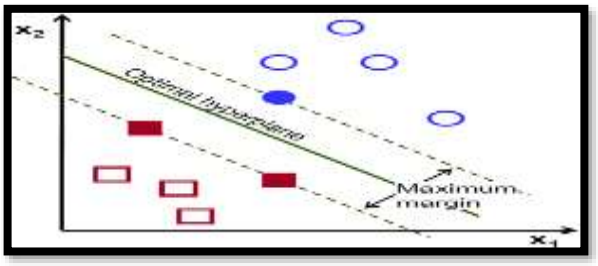
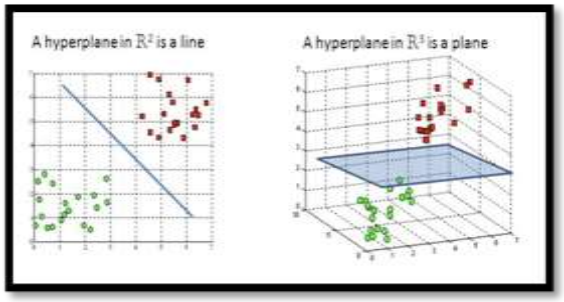


Fig: 3. Optimal hyperplane[24]

We separate the two classes of the data point; it is possible in SVM to choose any hyperplanes. But our goal is to find the plan that has the maximum margin (a margin is a line closest to the class point), the distance between the two data points of both the classes. Maximizing the distance between the two classes so that the future data points can be classified more accurately.



F Fig.4.Hyperplane line and plane[24]

Hyperplanes are the decision boundary that helps classify the data points. Data points fall on the opposite of each other of the hyperplane. Also, the hyperplane dimension depends upon the numbers of features. If the input number of features is 2 then the hyperplane is just a line. But if the number of feature inputs is 3 then then the hyperplane are two-dimensional planes. It is difficult to predict when the number of the input feature exceeds 3.

SVM algorithm is implemented with kernel that transforms an input data space into the required form. SVM uses a technique called the kernel trick in which kernel takes a low dimensional input space and transforms it into a higher-dimensional space. In simple words, kernel converts non-separable problems into separable problems by adding more dimensions to it. It makes SVM more powerful, flexible and accurate.

Reasons for choosing SVM

Svm is one of the most robust and accurate algorithm among other classification algorithms

So svm is the best first choice of any classification

1. Stability:- a small change to the data does not greatly affect the hyper hyperplane and hence svm. So the svm model is stable
2. Svm handles non-linear data efficiently using kernel tricks
3. Solve both classification and regression problems leaf. Efforts may be made to develop methods to identify these types of plants.

IV. Experimental Result

The proposed methodology is tested with different sample leaf images of different species and noticed positive response in most cases.

The selected 20 feature combination is further tested using 1 classifier with image processing with various techniques. The technique or methods listed below performed better in plant leaf identification problems.

1) Image acquisition.
2) Pre-processing for filtering (Gaussian filtering).
3) Image Segmentation (K-means Clustering).[24]
4) Feature Extraction (PCA).
5) Classifier (Support Vector Machine).

*IV.1 Pre-processing:*The Pre-processingtechnique performs well in the implemented result work. Gaussian filtering are applied in pre-processing for filtering the images for further processing. And the fig: 5.IV.1 shown below is the result that we have obtained.

ISSN: 2249-6661
Vol-43, No.-03 (III) November-December (2020)

Fig: 5.IV.1 Pre-processing using Gaussian filtering

IV.2 Image Segmentation: Image segmentation technique performs well in the implemented result. K-means Clustering are applied in the image segmentation for segmented the image from its background into 3 clusters.
See fig: 5.IV.2

Fig: 5.IV.2 Cluster are segmented in 3 part.

While segmenting the image the feature extraction are also extracted with the help of PCA (principle component analysis)techniqueright after segmenting the cluster, so the result obtained is shown in fig:5.IV.3

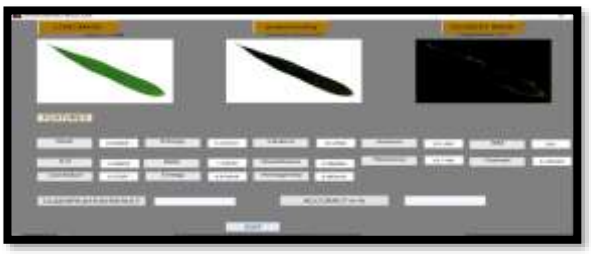


Fig:5.IV.3 Segmented image and Feature extracted

IV.4 SVM Classifier: SVM classifier also performs quite well in the implemented result. We have train the samples that are extracted from feature extraction (through image processing) that can be applied to the SVM classifier for classification and accuracy. We are taking the dataset image from the Flavia dataset to analyze the review. The result obtained the implemented result shows below in fig: IV.4

Fig: 5.IV.4 Classification of a plant.

The SVM classifier and accuracy that we have obtained from the implemented result is 95.17% and the plant leaf species that are identified known as pubescent bamboo shown in the figure below fig: 5.IV.5

The accuracy percentage can be 90% in minimum and 98% in maximum.

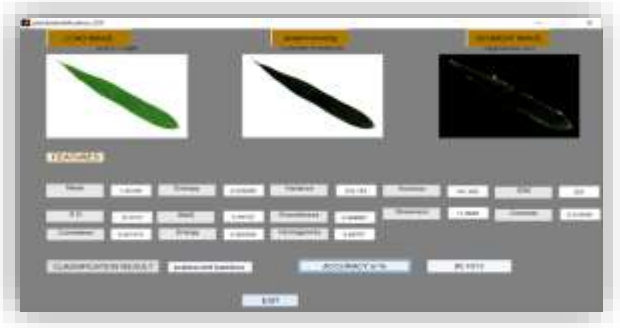


Fig:5.IV.5 Accuracy percentage

V. Conclusion and Suggestion

The main benefit and the importance of the proposed approach presented in this paper are that through machine learning algorithm plant species can be identified using leaf feature which can save and eases the identification of plants. With the help of Image processing algorithms, we perform the extraction and enhancement of images, thereby turning the same into some useful information and process it in Support Vector Machine classifier for classifying and accuracy.

The experimental results support the supremacy of the proposed approach.

Future Suggestion

Possible future suggestions that can be extendedto plant leaf disease detection. The proposed methods are not suggested for tiny leaves or plants, so research works will be carried out to deal with this problem.

Acknowledgment

We would like to express our gratitude and thanks to Dr.Dibya Jyoti Bora for his constantly guiding and supporting us throughout the project and also like to thanks the Kaziranga University for giving us this opportunity to carry out this research work.

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