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# Identification of Plants Through Leaves Image Using Pattern Recognition Techniques

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## ABSTRACT

Medicinal plants have been used throughout the human history. Ayurveda is one of the oldest medicine systems, which is even recognized in the modern medical society, uses plants for the preparation of medicines. There are thousands of species of plants used in the preparation of medicines. The difficulty lies in the identification of plant species. An individual with deep knowledge of plants can only differentiate between these species. This makes leaf identification very difficult. A reference guide to plants identification may ease up the problems. This is where nature needs engineering. In this work, a system is being developed which helps in the identification of the plants based on the leaf. This system takes input as a leaf image and outputs the name of the species and other relevant details which are stored in the database. The system is designed using the technique of image identification using pattern recognition. The approach of shape and texture identification, both are combined for designing such a system. The segmentation of the images was done using the techniques of graph-cuts. The descriptor used for shape identification was Shape Context and textures were described using Local Binary Patterns. The classification was done using feed forward Multi-Layered Perceptron (MLP) neural network with back propagation training algorithm. The system was tested of certain class of leaves and the performance of the system is compared with an existing system.

**Keywords:** Graph Cuts, Shape Context, Local Binary Patterns, Multi-Layered Perceptron (MLP).

## I.INTRODUCTION

Image processing is operations performed on a digital image for the purpose of enhancement, data extraction or some other application. Image enhancement has no formal definition, but vaguely it can be said that Digital image enhancement deals with the alteration of digital image so as enhance the visual context, so that the image is more perceivable. One of the application used in this project is in computer vision. In the computer vision, there is a need for identification of the object of interest from the image itself. Thus it is required to separate out the object of interest from the background. This is called segmenting image. But if the image is itself corrupted by noise, then the segmentation is not perfect and erroneous edges are detected of the object under study which at the end leads to erroneous results. Thus it was observed that the image segmentation is a very important step in identification of objects. And if done wrongly, a chain of error propagates down from the top to the bottom.

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## II. COMPUTER VISION

A human brain understands things much clearly by seeing than by any other means and thus images fulfils the purpose very well. An image is a method of representation of any subject of interest, by presenting a visual depiction of subject in a two dimensional surface (paper or a display screen) or in three dimension (a statue). Presently a digital image is a two dimensional representation of images on the digital screen (say a computer). Computer Vision: As the name suggests, computer vision is the entire process which by which a computer understands the image. By understanding it means, the computer analyzes the image, processes the image, extract the information and produces the results based on the information gathered from the image. It is a part of artificial intelligence and the vision is like seeing things by animals. The computer vision involves steps such as acquiring the image from an input device (cameras, scanners, sensors, etc.), analyzing based on algorithms and produce symbolic information. In the digital image processing, the contents of the image are the source of information. To extract the information the foremost step is to the segment the image. The segmentation is the process of portioning the image into distinct contents based on the interest of user. The region of interest is called the foreground and the region which is not part of interest is called the background of image. This foreground part is separated from the background part and background part is discarded. Then the visual features of the foreground are analyzed. The information extracted from the analysis is then quantified. The quantification of information is done by descriptors. The descriptors is a terminology given to entire process of analyzing the content of foreground based on certain algorithm and produce symbolic information. This symbolic information can be used further as the application is required, for example this information can be used to identify one class of objects from different class of objects.

## III. PATTERN RECOGNITION

Machine learning is a branch of engineering that helps the machine to recognize the patterns. This pattern recognition problems find applications in the field of speech recognition, fingerprint recognition, optical character recognition, DNA sequence recognition, etc. For the image identification process, it is best to design a system that works based in the same way as nature recognizes the patterns. Any recognition system is based on the mathematical model and the features selected. Feature is a distinctive attribute of the sample which helps in recognition process. For example, in the plant recognition system, the feature of leaf images can be leaf shape, leaf texture, venation pattern, etc. These features are mathematically coded and are fed to the models for the identification.

## IV. PROPOSED MODEL

As describe in chapter one, the project is about the identification of the plants on behalf of the image of the leaf. All the technique from image segmentation to classification as described in the chapter one to four are used in the project. The project maybe assumed as similar to that of projects of face identification or finger print recognition, but plant identification problem is more complicated than these. It is so because the overall shape of and the position of visual features remains same. For example, in face recognition, the position of eyes will remain fix relative to that of nose. But in plant recognition, a single plant may have variety of leaf differentiated shapes or color. Hence the problem becomes slightly difficult.

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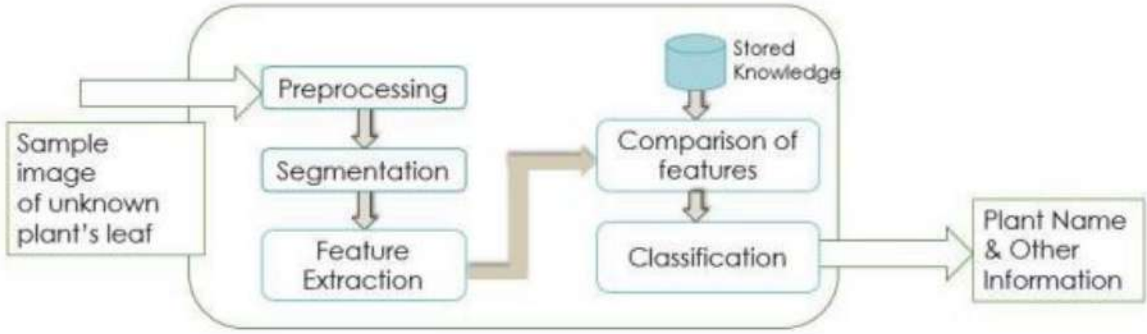


**Figure 1 : Shows the Block Diagram of Proposed Model**

The sample input is taken from the camera and is fed to the system. The steps of preprocessing are applied and the leaf part (which is object of interest) is segmented from the background. Then the features of are extracted from the sample image. These features are compared with the stored knowledge and a decision is made by the system that which type of leaf it is. Or if the leaf is in database itself or not. The project is divided into two phases of implementation: the training phase and the testing phase. In the training phase of the system, the process of database creation and storing the knowledge is done. Also the classification part of problem is done. And in testing phase, the system is tested. The details of the implementation is explained in step by steps in the following context:

**EXPERIMENT:**

The sample input is taken from the camera and is fed to the system. The steps of preprocessing are applied and the leaf part (which is object of interest) is segmented from the background. Then the features of are extracted from the sample image. These features are compared with the stored knowledge and a decision is made by the system that which type of leaf it is. In the experiment, a database of 10 class of leaf images is used. Sample from each class of image is shown in figure 2.

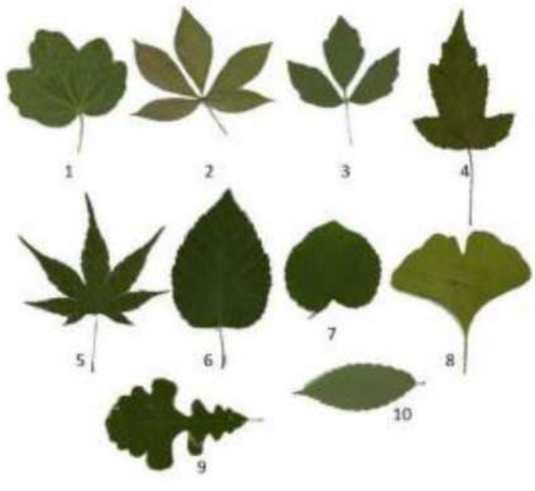


**Figure 2 : Shows the Leaf Samples from Each Class**

Each class of image, has 20-30 images. For the image belonging to kth, a set consisting of leaf boundary samples is stored as $QQk$. The shape matching cost for matching the shape of query image with the kth sample set is given as $Dk$. $FV1$ is the value of first component of feature vector F an is given as:

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$$FV_1 = class\ index\ (k)\ for\ which\ D_k\ is\ minimum.$$ Here $FV_1$ is of unit length.

Here $FV1$ is of unit length. For the texture matching, the image is scaled and zero padded so that each image has dimensions of 999x999 pixels without deforming the original shape of leaf. Each image was then divided into 9 block (each is of size 333x333). To each block of image uniform LBP operator was applied with pixel radius and neighborhood combination $(R, P) \in$ {(1,8), (2,12), (3,16)}. Hence for each block of image, histograms of length 59, 135 and 243 are obtained (since no. of bins of histogram= $P(P - 1) + 3$). All the three histograms are then concatenated for each block of image. Such histograms for all nine blocks are concatenated to form a feature length of 3933. This 3933 bins histogram is used as a feature vector $FV2$ = $hddstogram\ off$ 3933 $bddns$. $FV2$ is of 3933 length. The third feature vector is the original length of the leaf $FV3$ = $leaff\ length$. And last feature vector being $FV4$ = $leaff\ wdddth$.

The overall feature F vector is obtained by concatenating each feature

$$F = \{FV_1, FV_2, FV_3, FV_4\}$$

## V. RESULTS AND DISCUSSION

The implementation of the project starts with pre-processing of the leaf samples. The images of the sample are aligned in one direction. The alignment is based on the major axis of the leaf. A user interactive method of alignment is used. The original dimensions of the object of interest is also noted. The user roughly marks the tip of the leaf and base of the leaf. The horizontal axis is defined as the length from tip of the leaf to the base of the leaf. This horizontal axis is used for the alignment of the leaf. Once the leaf is aligned (with tip of leaf in upright direction), the image is segmented and the leaf area is extracted out form background. After segmentation, a bounding box is created around the leaf object. This gives the horizontal and vertical extent of the leaf (i.e. the length and the width of the leaf). Note, for the measurement of proper dimensions, of leaf two precautions are required to take, first the leaf stalk must be of standard size.

Secondly- while gathering the sample, the images must be taken form a fixed distance for all sample of leaf. This is in practice a difficult task, hence some method of relative measurement must be used (e.g. while capturing the image of sample, the image of some object with known dimensions such as a coin, can be used for comparison). In the training phase, the training of the system is done using the lab samples. These samples had clear background and in was in contrast with the leaf color. This helps in clear segmentation. Simple Otsu's method of segmentation can be used to separate out the foreground from background. The Otsu's method of segmentation is a global method of segmentation based on histogram thresholding. Thus the method of segmentation may consist of unconnected regions. As on fact, the images of leaf are connected and a healthy sample may have nearly no holes within the shape of the image, a morphological operation of opening can be used to connect any unconnected regions, keeping the structuring element small. The requirement of keeping a small structuring element is so because, large structuring element may cause the loss of information of shape blades which is a vital information in identifying the leaf.

After this to separate the noise which is unconnected to the central leaf portion, a largest blob (part which has the maximum area) can be found. This resulting area presents the geometrical shape of the object. The entire process is shown in the figure 3. It is to be noted that, in the testing phase, images are taken from the field samples. These images may not have a clear distinct background. Hence the Otsu's method of image segmentation is not suitable forsegmentation purpose. The more robust method of graph-cuts is used forsegmentation. This method is a user interactive method and produced far better results of

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segmentation than Otsu's method of segmentation. The method of graph-cuts is given in chapter-2 Figure 3(b). After the segmentation, the task is to extract the boundaries of the shape, from the binary segmented image. The four connected boundaries are traced by the method given in book Digital Image Processing [15]. These boundaries serves as input to the shape descriptor. The scatter plot of the sample leaf is shown in the figure 3(c).

**Figure 3 (a), (b) and (c); Segmentation of Image (a) is image in (b), and uniformly selected samples shown in figure (c)**

## VI. CONCLUSION AND FUTURE SCOPE

The experiments were conducted using various shape and texture descriptors. Various shape descriptors were used such as shape description using MPP (Minimum Perimeter Polygon), Shape Signatures, Shape contexts, Fourier Descriptors were used among which the Shape Context showed the most promising results. Identification of leaf was also done using the leaf tip and leaf bases, but it was observed that the matching was also not reliable because of the varying shapes of leaf tip and base for the same class of image. The shape alignment is also an image registration problem. The image alignment was at first done using Hough Transforms. But the image alignment for the leaves such as Acer Plantanum were not correctly aligned. Hence a more robust technique of alignment was done by estimating the parameters of the Affine Transform. This is a part of shape recognition using Shape Context hence the shape context produced the more promising results. A user interactive method for the alignment process is also implemented. Here the user marks roughly the major axis of plants, and then image is rotated in accordance with the axis. Segmentation also played an important role in the classification. As a wrongly segmented image disrupts the entire flow of identification. The segmentation process by using graph cuts produces more efficient results.

Though the results are promising yet there is always a way of improvement as no system is perfect. The efficiency of the system depends on the information supplied, which in turn depends on the number of features used in the classification of the system. Also for the improvement one need to constantly update the underlying technology. Various features were used and tested in the project and several others can also be included. One important feature that can also be used in classification problem is using the leaf blade patterns on the leaf. This can be achieved by increasing the number of sampling points used in the classification of the shapes using the shape context. This may create serious computational problems as processing a larger number of samples for each class of image increase the calculations required. Another way this information be included by using a shape descriptor that performs the computation based on the local information. Also to reduce the overall robustness of the system, better techniques of segmentation can be employed. As the current version of the Graph Cuts can be optimized. There are various papers that attempt to cut down the segmentation time are present. Also information such as color and the venation patterns can also increase the robustness of the system.

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