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Automated Tool for Plant Leaf Identification using Morphological Features

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Abstract -

It is well known that plants play a crucial role in preserving earth's ecology and also important for their medicinal properties, as alternative energy sources like bio-fuel. This is more important as many types of plants are now at the brink of extinction. In our day to day life herbal plays vital role on human physic maintenance. In recent times computer vision methodologies and pattern recognition techniques have been successfully applied towards automated systems of plant cataloguing. We are trying to bring atomization in this process such that without any previous knowledge of the leaf species to layman just using its image we are trying to get its name. This will help the botanists in their study and speed up the process of identifying the species of plant. India is enrich source of plant species which is the base of'Ayurveda' so there identification is must. Our idea is to develop an application which would detect the plant name after comparing with the trained sets.

Keywords- Image pre-processing, Edge Detection, Vein Detection, Artificial Neural Network, Experimental Result.

I. INTRODUCTION

Plants are vitally important for environmental protection, it is more important to identify and classify them properly [3]. World Health Organization estimates that 80% of people in Asia and Africa rely on herbal medicine due to the fact that they are gaining popularity worldwide as they are safe to human health and affordable. Many of them carry significant information for the development of human society [1]. Leaves of same species also have variation in there shapes and moreover leaves of different species may have a same size because of the complex nature of leaves. So we need some hierarchy in this process. India is full of variety of plant species, many of which are unknown at thus their identification is very important in the field of Ayurveda. One of the difficulty, in the field of Ayurveda is knowledge dies with the Expert, but keeping technology at the center they can last long for long time and also there is stress relief as we are not required to memorize all the different types of plant species. For retrieving target species name in the proposed system, modules designed will be Image pre-processing, Edge Detection, Vein Detection [3], Neural Network [2], Leaf Classification [4]. A leaf from an unknown species of plant will be the input to the proposed system. The system then segments the leaf image from its background, computes the morphological feature [1] representation used for matching, and then displays the similarity percentage as computed. The leaf image will be captured on a plain contrast background to reduce the complexity of the segmentation algorithm and give better performance.

II. PREVIOUS WORK

Many methodologies have been developed in automated fashion for plant leaf identification, most of them used shape modelling algorithm for contour detection. As contour detection is a heart of the object detection, It is the most important and preliminary phase in image processing so it, acts as a strong classifier. Moment invariant method uses 7 moments that describe shape, unchangeable to scaling, translation and rotation. This method needs more computation. Then Centroid-Radii method uses normalized radius and uniform distribution of angle at its center [6]. This method is faster as it uses predefined number for angle distribution and use simple radius calculation but, the method can fails to highly irregular leaf image. Adaptation in these methods is Binary Super-positioning method [6]. It is fast and easy from implementation point of view butit requires higher data set and moreover at the time of image capture, the image should be strictly at the center. Considering these features and constraint, we can use it for elimination of species which will not match with the proposed trained data set. Prewitt operator edge detection masks are the one of the oldest and best understood methods of detecting edges in images. Prewitt edge detection technique is selected due to efficiency and simplicity in the single mask [10]. Additionally, few techniques have used some texture based features and color based features as to improve the accuracy of the detection [1].

III. PROPOSED SYSTEM

Our system is based on image processing which finds an unknown leaf species without any previous knowledge, which is useful for any layman [1]. The basic factors for identification of species are Contour, Vein, and Neural Network as shown in Fig.1

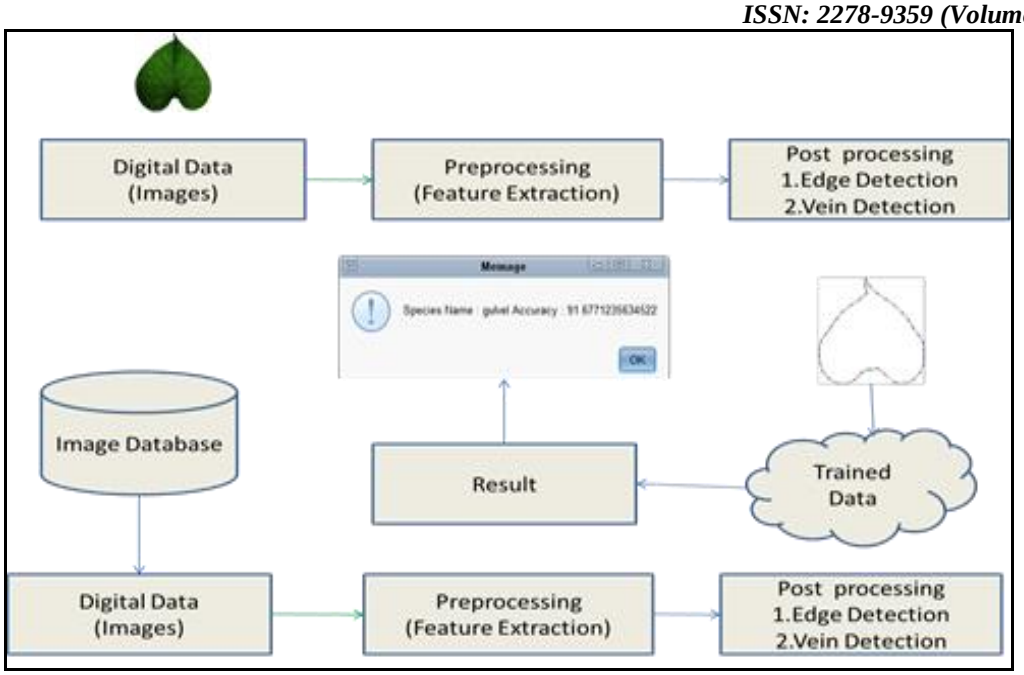

Fig 1.Architecture Diagram

Step 1: Image Acquisition

First we capture the leaf image by digital camera in RGB form on a white paper. We have ready dataset for comparing with that unknown image [1]. Image acquisition is done by camera with 18.3 Megapixel configurations.

Step 2: Image Preprocessing

Image processing is the enhancement of image i.e., processing an image so that the results are suitable for particular application [1]. Processing image involves operations for making the background white for removing unwanted noise. Because after capturing image on a white paper there may be noise in it. Preprocessing includes taking the part of our interestof the image as per our requirements. In our proposed system we used Photoshop tool in order to take out the portion of our interest using magnetic cutter tool and placing it on a blank white background in order to remove unwanted noise.

Step 3:Edge Detection

The proposed system finds the specific tokens which represents that portion of the image where transfer of lower to higher pixel intensity occurs. These tokens are used for neural network calculations. Edges are recognized by abrupt intensity variations in an image. The first gradient is typically calculated to locate the edges. The 3 * 3 masks are used to extract the edges from image and convolved them through it. Prewitt edge detection technique is selected due to efficiency and simplicity in single mask. In this technique, the edges are detected by convolving horizontal and vertical masks G_x and G_y respectively, through the images.

Gx

-1	0	1
-1	0	1
-1	0	1

Gy

-1	-1	-1
0	0	0
1	1	1

Above representation shows the horizontal and vertical Prewitt edge detection masks.

$|G|=|G_x|+|G_y|$

Now in edge detection technique, first we initialize token vector. After that we can start scanning the image pixel by pixel horizontally as well as vertically. Then calculate horizontal and vertical distances dx and dy respectively. Now we find gradient i.e., magnitude of the pixel intensity and direction by using root mean square. Gradient is nothing but strength of pixel which is used to find edge (token).Thinning process will be done on that image for removing unwanted points on the edge which make the edge thick. Because of that thinning process we can find sharp and thin edges lead to greater efficiency in object recognition. Draw the generated tokens, and also draw the edge or skeleton of leaf using well known Bresenham line drawing algorithm.

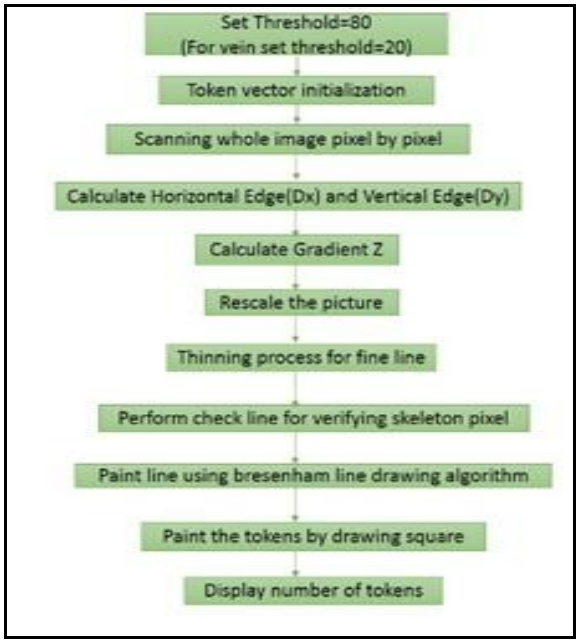

Fig 2. Flowchart for Edge Detection

Fig 2 shows the flowchart for edge detection also Fig 3 shows why we have selected Prewitt technique for implementation using comparison between Prewitt and Sobel Techniques based on number of tokens generated and number of calculations required for same.

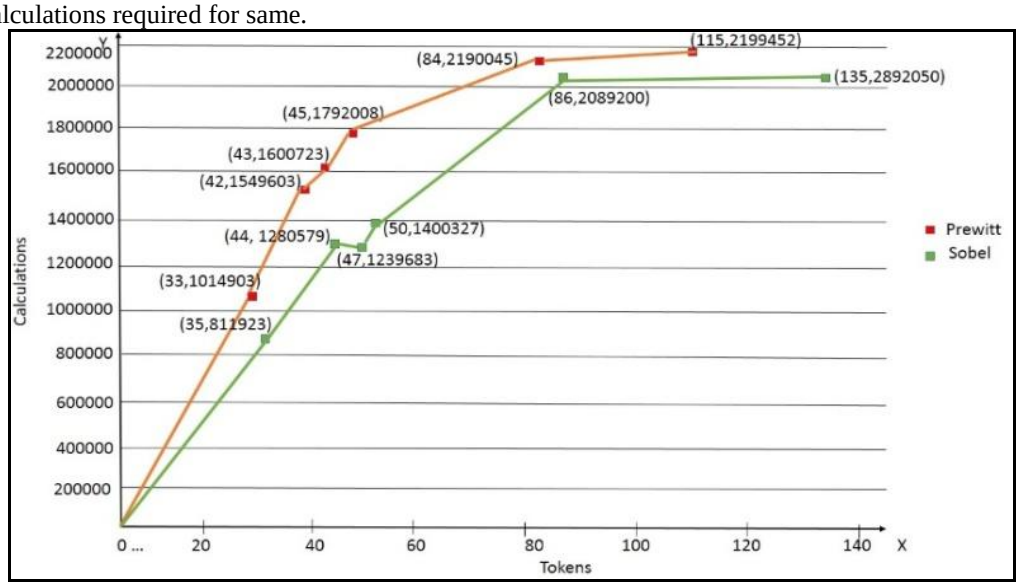

Fig 3. Comparison graph (Prewitt and Sobel)

Step 4: Vein Detection

After detecting edge we extract vein structure by setting proper threshold. We include this part because there is possibility of two leaf species having very much similar shape [3]. So to distinguish between them we consider veins part of the leaf. Threshold is considered in order to vary the intensity of the image. The lesser the threshold the higher is the number of tokens being generated. As there are no of pixel with little change in their intensity linearly [1].We pass this threshold value while detecting the edge due to which the veins pattern are detected because of very less change in the intensity value of the pixel we provide. Hence the tokens on the vein structure are detected by varying the threshold value.

Step 5: Neural Network

The human brain can be described as a biological **neural network** an interconnected web of neurons transmitting elaborate patterns of electrical signals. Dendrites receive input signals and, based on those inputs, fire an output signal via an axon. In short Neural Network is computer system modelled on the human brain and nervous system [1].

In our system we are using neural network with one hidden layer. Each hidden layer is associated with the sigmoid function. In other words neurons in a same layer have same activation function. Sigmoid function is an exponential function which is used for calculation and transfer of knowledge from input neurons to output neurons. The graph for sigmoid function can be shown as in Fig 4.

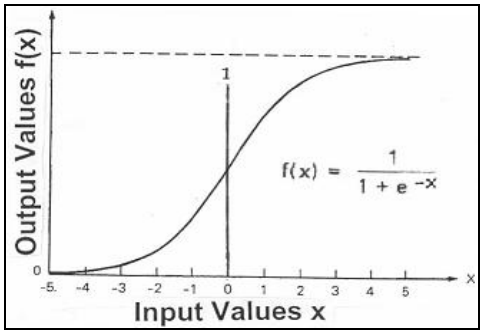

Fig 4. Sigmoid Function [11]

Sigmoid Function: f (x) = $1/(1+e^{-x})$ ... (1)
Sigmoid Derivative: f'(x) = f (x) * [1 - f (x)] ... (2)

Neurons are analogues to the processing units. Function associated with that neurons determine output of that neurons. Our application allows setting the no of input neurons, hidden neurons, and output neurons at run time. These neurons have activation signal in terms of integer value varying in the range of [-1.00, +1.00]. Nodes are connected with each other by links having weight for each link. Weight is information used by neural network to solve problem.

These weight values can be anything and need not to be lie between [-1.00, +1.00]. Along with this bias functions are used for accuracy which are again neurons with activation signal always set to one and they are connected to all neurons in the hidden layer[10]. Then we have learning rate i.e. alpha ideally set to 0.3. But for the proper learning of neural net and increasing the accuracy we are setting it to 0.1. Learning rate decide how faster the input pattern should be understand by the neural network. Lower the alpha i.e. learning rate more the accuracy we got. We can say that alpha is inversely proportional to the accuracy of the neural network. Then a main feature of Neural Network is learning process which is done by back propagation algorithm. This method is used for weight adjustment of link by going from output layer to input layer. This process is done no of times until error of neural network reduced. Error graph shows error no of steps. They are inversely proportional to each other.

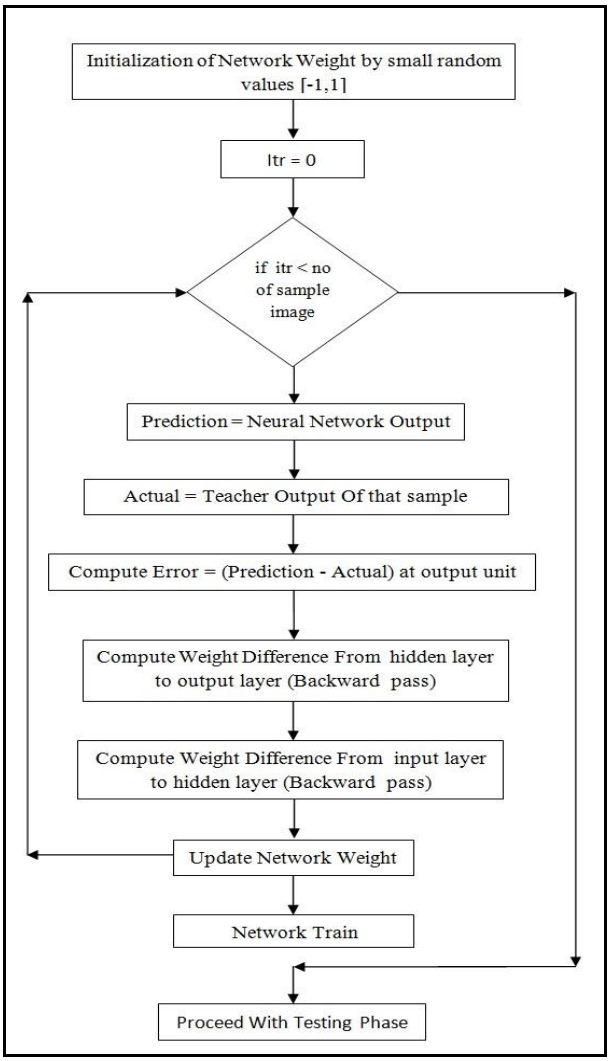

Fig 5. Flowchart of neural network

IV. EXPERIMENTAL RESULT

We have used the dataset for various leaf species like Tinospora Cordifolia (Gulvel), Ficus Religiosa (Peepal), Phyllanthus Emblica (Amla), Magnolia Champaca (Sonchafa). Here, Firstly we add new species then add images of the same species under it and find the tokens for each leaf image after that we proceed by training these tokens using neural network later in recognition panel we add the unknown leaf to be recognized. We get the result in terms of percentage match and the details of that species its uses and botanical names as shown in Fig 6.

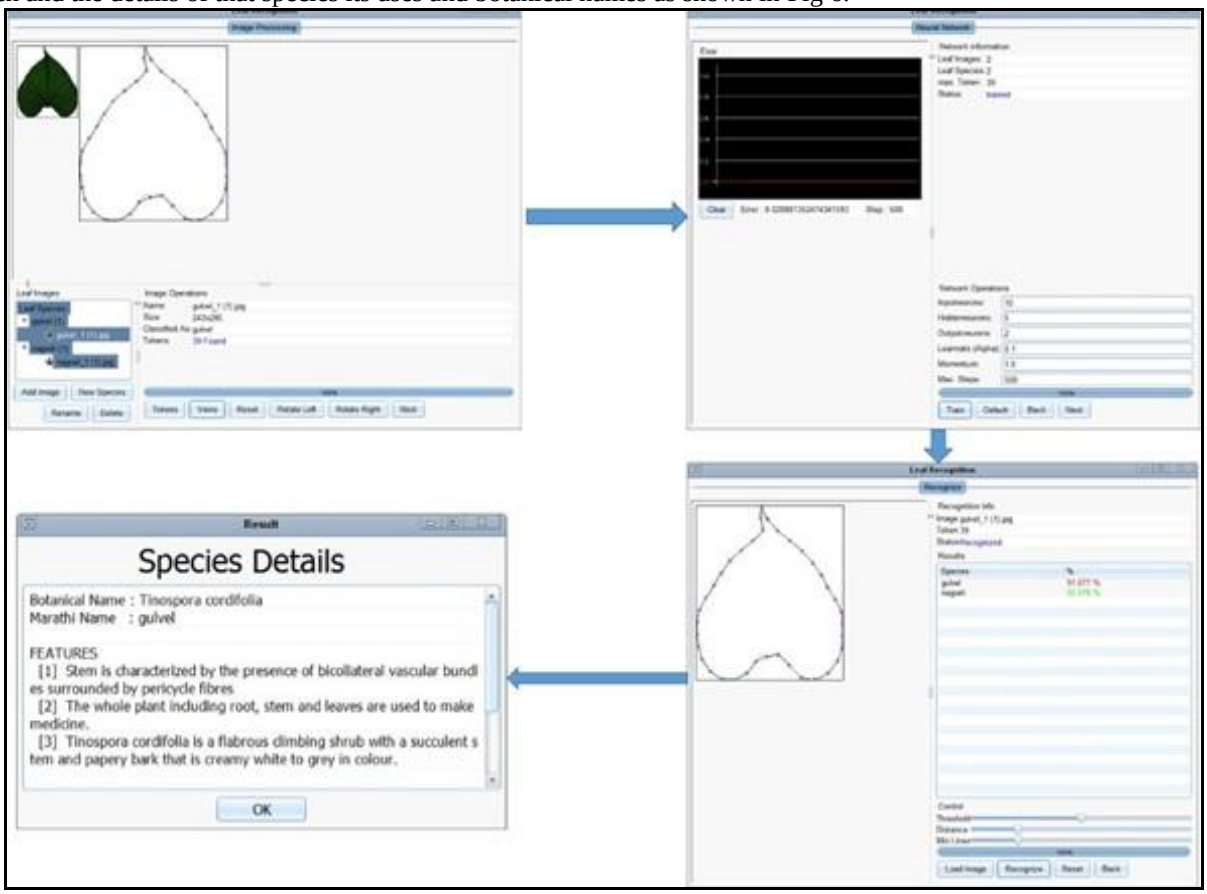

Fig 6.Experimental Results

V. ANALYSIS OF PROPOSED SYSTEM

The below Fig 7. Shows graph for two different leaf comparison. The parameters used for drawing the graph are the number of tokens generated across Y-axis and different threshold values set for gaining the tokens on X-axis. The below Fig 8. Shows graph for two similar leaf comparison. It takes the different leaf species to determine the accuracy with different threshold.

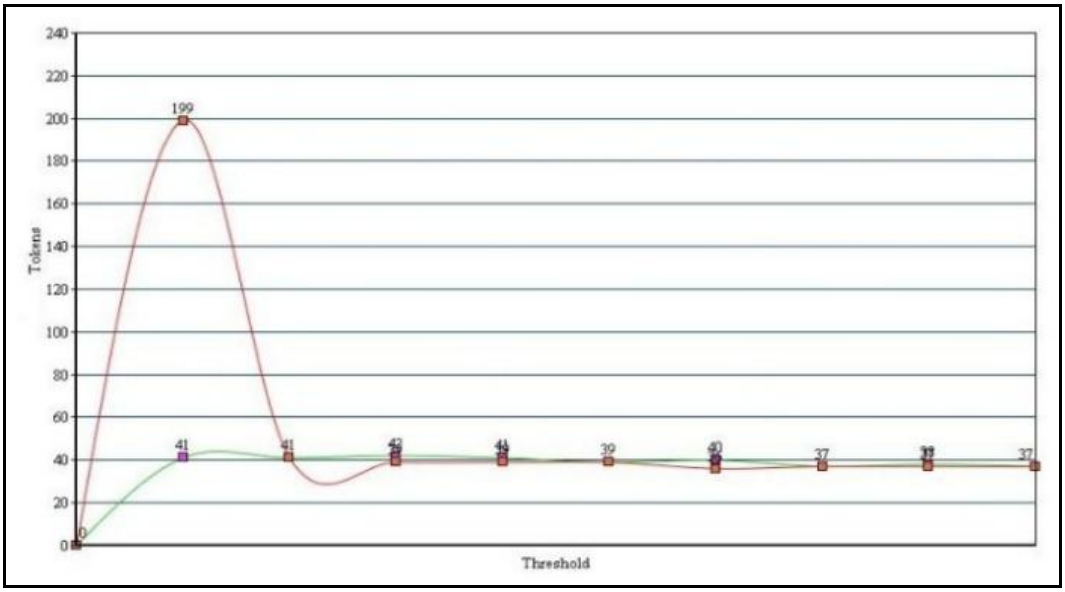

Fig 7. Graph for two different leafs

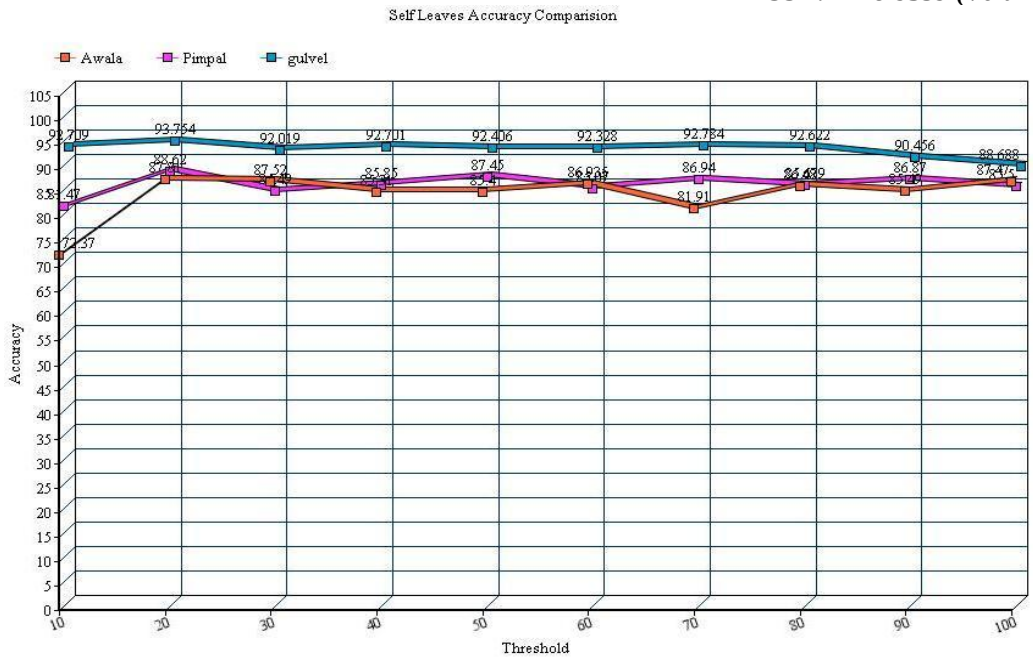

Fig 8. Graph for similar leaf

VI. CONCLUSION

From the above analysis and graphs we conclude that Sobel requires more number of calculations as compared to Prewitt Edge Detection. Also from graph we conclude that even if the calculations are more and the number of tokens generated by Sobel are less as compared to less computational and more token generated Prewitt Edge Detection. Therefore we have used Prewitt edge detection. According to graph for similar leaves and different leaves we conclude it by setting a static threshold value for both. Neural network trained the leaves and got the accurate results for different species.

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