World Wide Journal of Multidisciplinary Research and Development

WWJMRD 2017; 3(7): 162-165
www.wwjmrd.com
Impact Factor MJIF: 4.25
e-ISSN: 2454-6615

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Automated plant leaf recognition using metrics based approach

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Abstract
Plants are most important component for any life cycle. They contributes to the natural habitat is uncountable ways. Different types of plants contribute in different way. Automatic plant recognition of leaf is the current research issue. In current research automatic plant recognition based on metrics based approach is used. The inputted image of the plant leaf is subdivided into small cluster stored into metrics. Various features like average intensity, centroid, major axis length, minor axis length, solidity etc. are extracted from the image metrics. First dataset of different types of leaves belongs to the different plants of different categories are prepared. Each plant leaf taken from the database will be converted to small pixel clusters stored into metrics and will matched on the basis of various features like solidity, major axis etc. The result accuracy is about 96%. The result has been enhanced on the basis of increase in true positive and reduction in false negative.

Keywords: Major axis, Minor axis, morphological features.

Introduction

Plants are the major contributor of life on the earth. They are useful in different forms. They convert carbon dioxide to oxygen. This oxygen is most important component for human life. Plants are useful in generating a natural habitat for various types of animals. But now a days due to the over civilization the balance of animals and plants has been disturbed. There left hardly any green areas with natural environment near the human colonies. So large amount of works need to be performed in different areas to maintain the biodiversity [1].Plants are not only useful in generating oxygen but also has contribution in medicinal values. Various plants are useful in generating medicine which is lifesaving. Now day's large amount of doctors has given their consent about this ability of plants. China and Japan like countries believes that it is very important for human to protect the plants for their contribution towards the wellbeing of the humans on the earth.

Now days the field in this direction has emerged fastly. Automatic leaf recognition applications are available. Which has the ability to recognize the plant leafs. As each or species of plant has different physical and morphological features. Through which it is very easy to recognize the leaf and then corresponding to it plants. People now days have high quality cameras in their mobile phones. These cameras can take quality images. Which can be feed to the applications installed into the mobile sets? With the help of dataset stored either into the application or just online database the leaf species can be recognized. Which helps the user to select the required plant from the natural habitat. Otherwise without the application it is not possible. Because there is so large diversity on the earth, which makes it difficult to identify the right species.

Different techniques are available in this field to recognize the leaf based on extraction of various features. Typical plant leaf recognition application includes the standard path.

While recognition of the leaf name, different types of leaves shapes with different orientation are stored in the dataset shown on figure 1

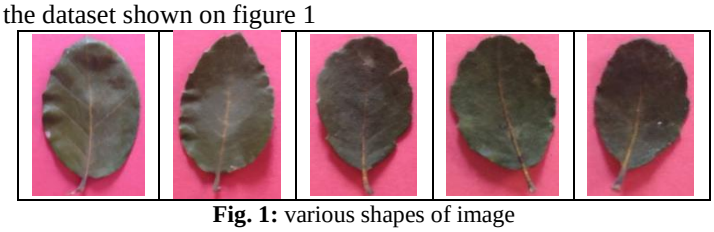

Fig. 1: various shapes of image

Related Work

Sapna Sharma (2015) various algorithms and methods that are taken in previous researches. This paper has considered various techniques, what their constraints are and what their conditions are. According to this morphology based features matching is the best techniques out of many. This technique has better success rate [1].Shyam Vijayrao Pundkar (2014) Various plants which are specifically useful for medicinal purpose. According to this paper when multiple techniques are applied simulteously the result success rate is increased [2].Anant Bhardwaj (2013) Automatic plant recognition is the done using various features extraction. This paper has given various algorithms which are based on morphological features. These features are used as inputs to the classifier system for discrimination as probabilistic neural network. The network was trained with leaves from different plant species[3].Jane Mangold (2013) Based on identifying the leaf of the plant using morphological features. These features are even used to narrow down to the genus and species level. It is used to identify the leafs to grow in garden. So that user knows whether the plant they are growing is beneficial to the health or not [4]. Shayan Hati (2013) Plant we are growing around us is having what type of advantages or disadvantages. For recognition of the plant there various feature are being extracted. And then based on artificial neural network the matching of the features are being taken place. This paper shows the result improvement of 92%.

III Features Extraction

Feature extraction phase is used to convert the information regarding the image in the form of metrics of pixels. These pixels are converted to useful information in terms of features namely morphological features, shape features etc. these features will extracts the useful information from the image and leave the un useful information. Features extraction generally decreases the dimensionality of the data space. In current paper we have considered various features like major axis length, Minor Axis length, solidity, perimeter and orientation.

A. **Major axis length:** The line connecting the one end called as base point to the tip of the leaf. For drawing the major axis two points are selected. Then line will be drawn on to the selected points. That represents the major perpendicular axis of the image. This major axis length measures the total length of the image in width wise.
   $Mal=(x1-xc)^2/rx^2+(y1-yc)^2/ry^2$
   X1,Y1 is the point along the major axis and xc and yc are the center point, rx, ry is the radius along x-axis and y-axis respectively. Mal is the major axis length.

B. **Minor axis length:** Max. width of the leaf. Minor axis is always perpendicular to the major axis. This length will denotes height of the image. When the line is drawn from the tip to the base of the image will be known as major axis. And the line drawn perpendicular to the major axis is called as minor axis.
   Mal= Sqrt(lx*lx-rx*rx)
   Mal is the minor axis length, lx is the length of major axis,rx is radius along x-axis.

C. **Centroid:** It is identified as the center of mass of the region. An image can be subdivided into various small regions. Each small region will be having its individual centroid point. When all the centroid points are connected will generate a clear drawn line. This line will be random and whole image center of mass stands around this centroid points.
   $$C_x = \frac{\sum C_{i_x} A_i}{\sum A_i}, C_y = \frac{\sum C_{i_y} A_i}{\sum A_i}$$
   cix if the centroid of the area Ai. Cx is the centroid of whole image along x-axis and Cy is the centroid long y-axis.

D. **Solidity:** the proportion of the pixels in the convex hull that are also in the region. It is computed as area/convex area. Generally there are two type of images one is hollow image and other is solidly filled image. The solidly filled image always consists of single color. All the pixels around the center of mass are filled with high intensity colors. In hollow image the pixels around the center of mass is less filled. That means small pixels are left empty.
   $$\frac{c}{s} = \frac{10}{(D_h/D_t)(N_s/1000)^{1.5}}$$
   S is the solidity, dh is the diameter, and ns is the pixel count in specific area.

E. **Perimeter:** the distance around the boundary of the region is called as perimeter. It is the total circumference around the image of the leaf. So that the total no. of pixels around the boundary points are calculated. This will gives the clear idea about the total amount of pixels that has been used to fill the boundary pixels.
   P = 2L + 2W
   P is the perimeter. where L is the length of major axis and W is the length of the minor axis.

F. **Orientation:** the angle between the x-axis and the major axis of the ellipse. It denotes the alignment of the image along major and minor axis. So that image major axis and minor axis length can be measured. Orientation along the coordinate axis will automatically shorten the length of major and minor axis.

O=cos(mj)+sin(mi)+sqrt(tan(mj*mi)

O is the orientation, mi is the length of minor axis and mj is the length of the major axis.

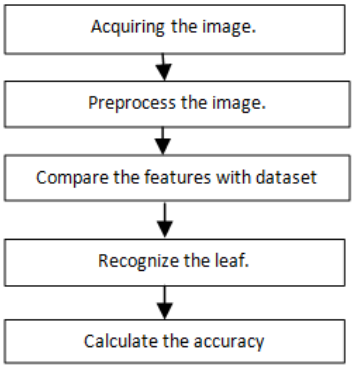

Fig. 2: Flow diagram

Block Diagram of Proposed System

Block diagram shows the proposed framework for leaf recognition is depicted in figure 2. The methodology is subdivided into two categories. One is training phase and second is testing phase.

1. **Training phase**
   a. Training phase consists of pre-process the image. Normalize the image.
   b. After preprocess the image convert the image into multiple rows and columns that is metric of pixels.
   c. Extract the features. That means leave the unnecessary pixels and take only the necessary pixels.
2. **Testing Phase**
   a. Compare the images of dataset features with the sample. It will recognize the plant with corresponding scientific name.
   b. Evaluate the true positive and false negative. It is in the form of confusion metrics.

Proposed Algorithm

Step1: input of the image taken any data source A, and S is the dataset source consisting of various images as (si, s2, s3, s4…)

Step2: preprocess the image A and S like converting the image S and A to grayscale, apply filters to smoothen the image of leaf.

Step3: extract morphological features of the leaf. Where each image represented as vector of weights(w1,w2..wn). considering the weight of pixel of each row of grid. These features are represented as (f1,f2,f3…fn);

Step4: load S having various images as (s1,s2,s3…sn) s are stored.

Step5: compare the images A features with the S(s1,s2,s3.. sn) set of images features.

Step6: match on the basis of features and extract its scientific name.

Experimental Results and Discussion

From the experimental work we have taken the standard dataset. This data set has images of different types of plants and also their respective scientific names. These images stored as part of the dataset are having different sizes. Single leaf image with their corresponding normalization will be converted to normal size of 256*256. Each leaf image is stored with different orientation and different levels of their degradation. The image after normalization will be converted to metrics of pixels. Where the features extraction will be done. Later on the basis of features the match will be performed.

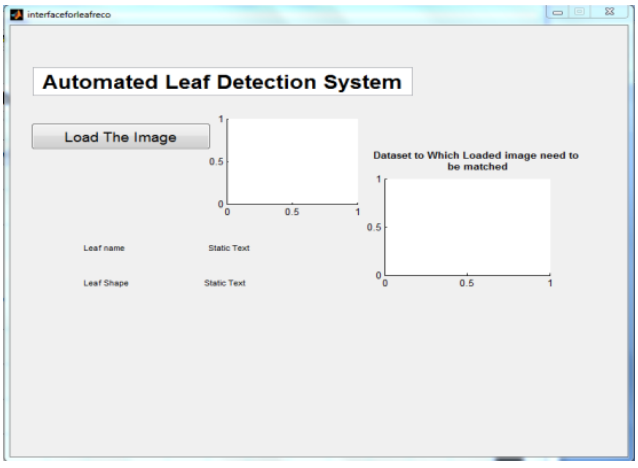

Fig. 3: Main control Panel of Leaf Matching

figure 4 shows the main control panel of the leaf matching. Through GUI interface it can be easy to interacts.

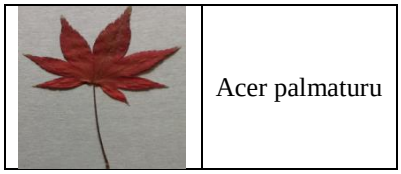

Fig. 5: processed image with its Name

Figure 5 shows the leaf image and its scientific name shown on to the interface after features match.

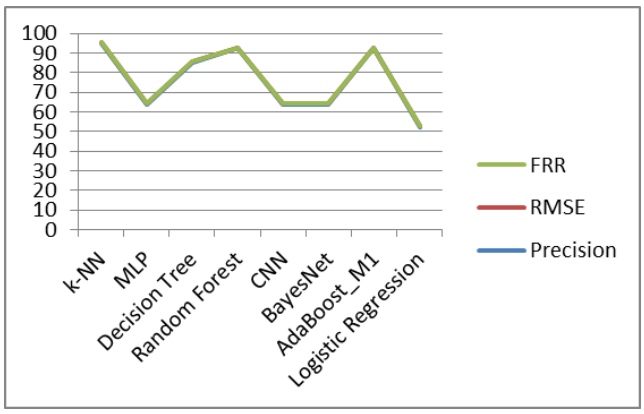

Fig. 6: 5 folds parameter comparison

Figure 6 shows the results on 5 fold cross validation of matched image graph with different parameters like FRR,RMSE and Precision. The max. precision shown is 96%.

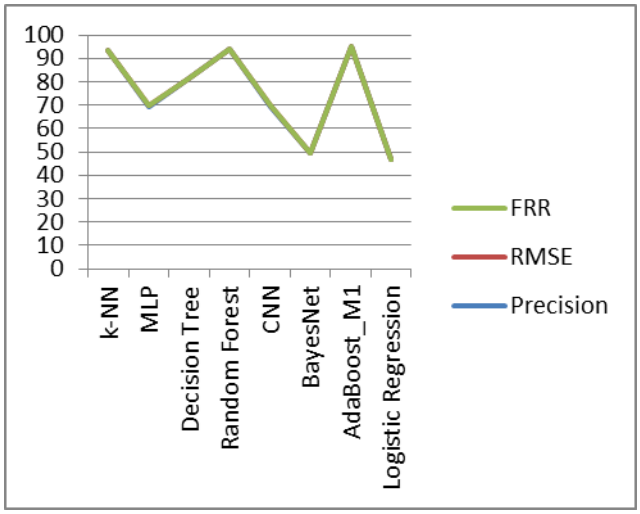

Fig. 6: 3 folds classification

Figure 7 shows the 3 fold classifier. Where the result for max. is shown as 94%.

Conclusion and Future Work

In current research the matching of leaf image with identification of its scientific name with identified optimized success rate. The inputted image though various phases being transformed to metrics of pixels. Features are extracted falls under the category of morphological features and shape features. In classification we have performed classification on various parameters like K-NN, MLP, Decision tree, Random Forest, CNN, BayesNet etc, each has shown the Precison, RMSE, FRR as 93.4%,0.105,0.006. The classification is performed with 3

fold and 5 fold. In case 5 fold the optimized result of 96% success rate is achieved. Which is optimized performance as far as leaf recognition is concerned. In future some enlargement of the dataset is to be taken place to improve the results further.

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