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Study of Various Techniques for Medicinal Plant Identification

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***Abstract*—** Ayurveda, the Indian ancient medicinal system, has gained importance because of its effectiveness in treating diseases. Medicinal plants are used in Ayurvedic medicines since ancient times. It is necessary to classify these plants so that it would be easy to select the right plant for the medicinal preparation or to study more about its characteristics. Identification is the pre-condition of classification of medicinal plant. In this paper, we have reviewed Image processing Near-Infrared Spectroscopy (NIRS), taxonomic key repository, neural network and DeoxyriboNucleic Acid (DNA) barcoding. The study shows that image processing is leading domain in identification of medicinal plant. The results are improved when multiple methods are used together in a sequence to identify a medicinal plant. Apart from that none of these methods are using geographical information to identify medicinal plants and we can use geographical Information System (GIS) information to improve its accuracy further.

Keywords*-Medicinal plan, Identification, classification, Image processing, Taxonomic Keys, DNA Barcoding, GIS, Neural Network*

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I. INTRODUCTION

Medicinal plants are of great importance to man-kind and animals. Botanists explore forest for finding rare species of plants. Understanding of Medicinal plants is essential for students of Ayurveda and Ayurveda researchers. Ayurveda Pharmacy companies also use medicinal plants to prepare medicine and study their characteristics.

Now days there are many applications for medicinal plant identification which identifies based on its characteristics and classify them into species and family. Most of the applications are mainly using image processing, then Near-Infrared Spectroscopy (NIRS), artificial neural network and DNA barcoding to name a few. Some of the application has also been done with the combination of various areas, such as image processing and artificial neural network. Each application has its own strength and weakness. None of the researcher has used the geographical information to identify the medicinal plant.

The rest of this paper is organized as follows: section II describes various methods of plant identification. And we conclude with conclusion Section III.

II. RELATED WORK

Most of the research work in the area of medicinal plant identification is done using Image processing, DNA barcoding, NIRS, Neural Network and combination of these.

A. Image Processing

Image processing is the most researched area in case of plant identification. Most of the plant identification applications take leaf as an input. The image processing algorithms then analyze the image of the leaf and extract its features to match it from the existing database of feature or the database of images. The challenge in image processing based application is that, firstly it needs to store lots of reference images per species if not then it needs more processing power to process image. The result also depends upon the quality of image and algorithm which process that image.

Sathwik, T. et al [13] use a texture analysis of leaf image method to identify and classify medicinal plants. The texture analysis generates a set feature which is used to query the image from the database.

Herdiyeni, Y. Kusmana, I [14]. use Local Binary Patterns (LBP) which is one of texture feature. It is use to identify the medicinal plant. The LBP is used in two ways, first is to calculate multiple histogram then joins those together. A second way is to classify medicinal plant based on LBP feaure of each histogram.

Gopal, A.; Prudhveeswar Reddy, S.; Gayatri, V [16] use images of leaf to identify medicinal plants. 10 for each species for total 10 species, that means 100 leaves are used to train the software. With 92% of accuracy it has been tested on 50 leaves.

Herdiyeni, Y.; Wahyuni, N.K.S. [18]use Fuzzy Local Binary Pattern (FLBP) and the Fuzzy Color Histogram (FCH) in order to identify medicinal plants. The accuracy of identification using fusion of FLBP and FCH is 74.51%.

Vinita Tajane,Prof. N.J.Janwe [5] use content based image retrieval (CBIR) where the plant disease is identified based on its leaf features such as color histogram and edge histogram

Bhandarkar, P et al [2] use Gray Level Co-occurrence Matrix and binary morphology for detection of the edges of plant leaves. The experiment is carried on 40 plant leaves belonging to 10 different species and it gives an accuracy rate of 67.5%.

Charters, J. et al [3] use the vascular structure of a leaf within a spatial context, where the edge patterns among neighboring regions characterize the overall venation structure and are represented in a histogram of angular relationships. They achieved a performance gain of 6%.

Harish, B.S. et al [6] use Morphological features and Zernike moments to classify plant leaves. The features extracted are not dependent on the scaling, leaf growth and image translation and rotation.

Prasad, S. et al [7] use a reduced shape and color feature extraction method is proposed for a mobile device based plant classification system. The original image is modified such that it does not affect the shape information and brings down processing cost by half of the total cost. Geometric feature and polar Fourier transform, trained using k-NN classifier is used along with the color feature using decision tree to identify the plant species.

Che Hussin, N.A et al [8] use Scale Invariant Feature Transform (SIFT) and Grid Based Colour Moment (GBCM) to identify plant species. The total number of plants species are 40 which are used as a set of sample data for the experiment and achieved 87.5% accuracy.

Prasad, S. et al [19] use a multi-resolution and multidirectional Curvelet transform on subdivided leaf images to extract leaf information. The system is trained using this parameter and obtain the accuracy of 95.6% on the set of 624 leaves for the result.

Almeida, J. et al [9] use a Phonological Visual Rhythms. Phenological patterns of species extracted from digital images of leaf. The time series needs to be encoded in visual rhythm to obtained the result, it is characterized by image description algorithms

Mouine, S. ; Yahiaoui, I. ; Verroust-Blondet A [10] use the leaf salient points and the leaf margin. Spatial correlation between leaf margin and salient points of the leaf used to obtain the results.

Quang-Khue Nguyen et al [11] use SURF features in combination with Bag of Words where frequency of words are used as a classifier and supervised learning. Speeded Up Robust Features (SURF) is a robust local feature detector that can be used in computer vision tasks like object recognition or 3D reconstruction.

B. DNA Barcoding

Apart from image processing DNA barcoding is an area of research that is being used to identify the medicinal plant based on its DNA. DNA barcoding is a method that uses a genetic marker in the plant's DNA to identify its species. The challenges in DNA barcoding is how fast and accurate the DNA of the plant on field can be acquired. The DNA obtaining is a lengthy process and does require work on laboratory to identify DNA of a plant. Apart from that it's also important to have access to several genomic regions were required for maximum identification success. Other challenge will be to provide sufficient storage.

Natascha Techen et al [4]has done review on DNA barcoding and found use of well-known genomic regions (matK, ITS, psbA-trnH, rbcL). Andrea Galimberti et al [1] use rbcL and trnH-psbA plastid regions as barcode markers. Different researchers are using different regions for barcode markers for experiments.

C. Near-Infrared Spectroscopy

Near-infrared Spectroscopy is not new for analyzing agriculture products. This technique has been used to identify medicinal plant based on the spectral signature of the leaves. Spectral signature is an output of analyzer which is actually an electromagnetic radiation that is emitted, reflected or absorbed by an object. The challenge here is obtaining spectral signature using analyzer when on field study. Apart from that an additional analyzer device is required to obtain the spectral signature which could be an overhead.

Kelina Sahaya Rajesh, P.[12] Use 5 different plant leaves to obtain spectral signature using XDS™ Optiprobe analyzer from NIR system under reflectance mode. This technique of NIRS can also be used to identify medicinal plant.

D. Neural Network

Artificial neural network is another approach used by researchers to identify the medicinal plants. It is used along with some other techniques such as image processing. The characteristics of leaf are extracted using image processing. These extracted features are the input to artificial neural network which is already trained to identify the medicinal plant based on the leaf characteristics. Before using any neural network it has to be trained first. The trainings quality and quantity decide the effectiveness and correctness of neural network result.

Janani, R. ; Gopal, A. [15] use the method of extraction of color, shape and texture features from leaf images and training an artificial neural network (ANN) classifier to identify the leaf class.

Herdiyeni, Y.; Santoni, M.M. [17] use texture, shape, and color. Local Binary Pattern Variance (LBPV) to extract leaf texture, morphological features is used to extract leaf shape, along with that the leaf color distribution will also be extracted, color moment are used. The experiment is performed on total 2448 images of 51 species each species with 48 images. Product Decision Rule (PDR) and Probabilistic Neural Network (PNN) are used to identify the plants.

Lei Zhang et al [22] use Self-organizing feature map (SOM) neural network along with image of leaf. It used geometrical features of shape and the texture features of venation. To extract leaf information, Wavelet statistical features 2-D and moment invariants are used.

Zulkifli, Z. et al [20] studied Zernike Moment Invariant (ZMI), Legendre Moment Invariant (LMI) and Tchebichef Moment Invariant (TMI) used in features extraction from leaf images. The General Regression Neural Network (GRNN) provides the classification functionality. The conclusion is that the TMI can able to extract the features with percentage of absolute error less than 10.38 %. Then the features are provided as an input to GRNN which achieved 100% classification rate. The neural network and image processing has its own set of challenges of storage and training.

E. Other Areas

Apart from different areas of research mentioned till now in this paper, there are some areas as well which deals with identification of medicinal plants

Lang, M. et al [23] use semi-automatic plant recognition system which uses number of petals, bloom color, inflorescences, shape of blooms, and shape of leaves to identify a plant. It also proposes a medicinal plant database for indexing and retrieving the medicinal plant characteristics.

Nordin, Sharifalillah et al [21] use taxonomic keys repository for better performance in the retrieval, visualization, and identification of plant species.

III. CONCLUSIONS

We studied various techniques for medicinal plant identification. The study shows that the research for identification of medicinal plant is done mainly in image processing domain. But we observed that single approach does not provide promising results. Most delighting results are obtained when various approaches are applied in sequence for identification.

Apart from that, most of the research used leaf image or leaf characteristics as an input for plant identification. But in practical scenario, the botanist or Ayurveda researcher may also want to identify the medicinal plant by other elements such as roots, seed, fruit, stem, flower and geographical location using GIS. None of the research has these together as an input for plant identification.

So more than one area can be combined together to predict, identify and classify the medicinal plant with accuracy.

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