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Deep Learning for Plant Species & Disease Identification

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ABSTRACT
This particular paper introduces a research on detection and classification of leaf species. The exactness of the particular leaf species cannot be identified by the naked eyes. Therefore, in order to identify the leaf species correctly, use of image processing and machine learning techniques can be of great help. All the images used for this particular work were acquired with the help digital camera. Removal of the background technique is needed to be applied on the given leaf image, in the pre-processing phase, to exclude the background from the chosen image. The method of image segmentation is then particularly applied on the processed background removed image. Extraction of many important features liketexture etc. is done by using; a wide range of segmented images is taken into consideration. In the end, these extracted features will be used as inputs for the classifier. The identification of the different plant species is the goal of our research, which is done using the image processing of plant leaf. A significantly compound leaf image is taken into use for the input. For the purpose of masking green pixels, threshold is used, and for the purpose of removing the possible noise, we process the image, basically using an isotropic diff usion. Image segmentation and classification is done by deploying a machine learning classifier that is used in the machine learning domain.It is necessary to structure an identification system, that determines the species of leaf and the particular disease associated with it.

Keywords– Artificial Intelligence, Feature Extraction, Image Segmentation, Machine Learning, Pre-processing

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I. INTRODUCTION

The overall environmental surrounding is composed of plants.The basic survivability of all humans depends upon the existence of plants. They are useful as foodstuff , as medicine and also in many industries. There are different variations in the species of plants, which ultimately leads to a wide range of plant species. It is estimated that the number of vascular plant species all around the world is 391,000 [1].The availability of leaves throughout the span of the entire year makes it the most desirable aspect for identification system, rather than any other parts, especially flowers that are present only for a shorter period of time.In the classification of plants through leaves, we have to take into account different features of leaf like colour, shape etc. Leaves can be classified based on colour that include similarity between two images with the help of colour histogram, but the colour based classification is depend on seasonal eff ect of sunlight. Therefore, by the use of classifier we can effectively classify the species of leaf.

There are many machine learning methods for the purpose of classification, such as k-nearest-neighbour (KNN), Artificial Neural Network (ANN), Naïve Bayes, Support Vector Machines (SVM), Convolutional Neural Network (CNN) [2]. Artificial Intelligence (AI), in general is a very popular thing around the world, and is being used extensively around the world, in various fields, such as medical, natural language processing, robotics etc. [3]. A subdomain of Artificial Intelligence (AI), called the Deep Learning (DL), is very much preferred and use for supervised learning [4].

In this particular research we have used, CNN for the extraction of the features from the given leaf image of chosen plant species. As a benchmark, we have used Canny Edge Detection (CED) methodology for segmenting the leaf veins and effectively performing the leaf vein morphology, to really understand and identify the diseases associated with it.

II. BACKGROUND STUDY

Originally, the leaf images will be acquired with the help of digital camera, or some other equipment. After this the preprocessing of the image takes place. To highlight the features of the image it is required to be enhanced. The enhancement of the image can be effectively done if we simply try and

remove the noise out of it,it will also improve the visibility of the image features. Once we are done with the image segmentation step, it is imperative to identify the region of interest. Once ROI is being recognised we can do the process of feature extraction. The classification is done on the extracted features.

For the purpose of plant identification system many of the common features are used, such as shape, texture & colour. Shape can be used to effectively distinguish between the various leaf images. Texture also plays a very important role where different leaf images have different textures, on the basis of which the various leafs can be accurately differentiated. Leaf colour is one of the major features, as on the basis of colour many of the leaf or plant species in general can be distinguished effectively. Moreover, leaf vein morphological structure is equally important.

A research work on the cotton plant species specifically had been presented by P. Revathi et al. [5]. A computing system was developed to successfully identify the disease and the affected portion of the given cotton leaf image. The end result was to predict the disease and display it in three particular languages.

Another research work, particularly on the grape plant species was conducted by N. Krithika et al. [6]. A KNN based approach was used to identify the disease associated with the chosen grape leaf image. KNN had resulted into effective classification of the diseases present on the grape leaf images.

A different research work, particularly on the cotton plant species was done by Pawan et al. [7]. A particular method of k-means clustering was used where the processing of image was done with the help of MATLAB. The differentiation on the basis of variation in colour was effectively done using MATLAB.

A separate research work on plant disease identification was done using image processing techniques by Vishnu et al. [8]. In this research work four major processing techniques were used for the detection of plant leaf diseases effectively.

III. METHODOLOGY

This is classified as a very basic practice to do the preprocessing of the leaf images before it is extracted and classified for further process.

Generally there are six steps, which we have used in order to accurately determine the plant species and disease associated with it. The processing mechanism usually consists of image acquisition with the help of digital camera or internet, process of image pre-processing includes image enhancement and image segmentation, wherein the affected and most useful area are basically segmented, and then classification and feature extraction is done. Finally, presence of the diseases on the plant leaf is identified. The following written steps are involved in this particular research work:

a. Database Selection
b. Image Pre-processing
c. Edge Detection Method – Canny
d. Image Segmentation
e. Feature Extraction
f. Deep Learning – CNN

III.I Database Selection

For this particular research, we have used Plant Village Dataset. Images of leaf of multiple various varieties of plant species make up the content of this particular dataset. Different species like tomato, pepper bell etc. are present in this particular dataset.

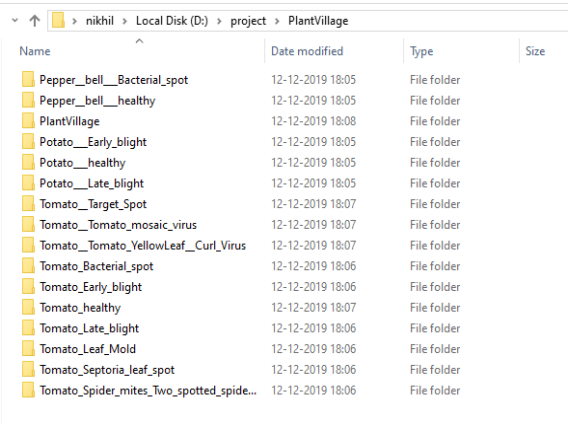

Fig. 1: Species in Database

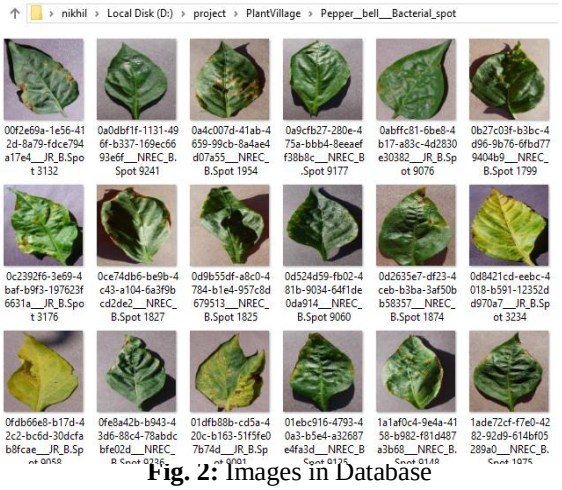

Fig. 2: Images in Database

III.II Image Pre-processing

The input image is required to be preprocessed, because images are very much corrupted by a type of multiplicative noise like intensity of light and shadow on a leaf images which may possibly possess a lot of other imperative information. When we are doing the process of

preprocessing the image, it is also required to focus on image enhancement.The leaf images that have been collected and gathered are generally very raw, and it cannot be used directly for analysis.Also, the images needs to be converted into an acceptable and standard format like jpg etc.

III.III Edge Detection Method - Canny

In this research we have incorporated the use of Canny Edge Detection Algorithm (CEDA). The application of CEDA is not considered as a very tedious or complex task rather is widely considered as an easily understandable algorithm. It is also called as a multi-stage algorithm, which is useful in detecting a huge range of edges from the given images.

Basically, all the images are converted from RGB to grey-scale images, and then canny edge detection is applied. It also takes care of noise reduction, gradient calculation and edge tracking.

III.IVImage Segmentation

The leaf spot in the given image basically contains reflection from the source, that forms some intense spot in the leaf, but pixel value within the leaf is over a particular threshold (20) and then it is generally replaced by pixel value of some neighborhood pixel. This particular operation fills all the intense leaf spot that are present in the cotton leaf area as shown in the figure below.

Fig. 3: Image before Segmentation

Fig. 4: Image after Segmentation

III.V Feature Extraction

The most important stage in any research is the feature extraction stage. Feature extraction helps in the extraction of most important feature from the given leaf images. The process of feature extraction is generally the process of the transformation of raw pixel values, from the given image, to a more useful, instrumental and meaningful information that can be effectively used in other techniques, like point matching or machine learning.

The features of the leaf like texture, color, vein, shape, are most commonly used for the sole purpose of plant identification system. Multiple methods can be employed for the process of feature extraction like Histogram of Oriented Gradient (HOG), Zernike Moments, Hu's Moment and others. In Canny Edge Detection Algorithm (CEDA), where CEDA is used for feature extraction of leaf.

III.VIDeep Learning - CNN

Out of the may deep learning methods out there, one that is extensively used around the globe for feature extraction is Convolutional Neural Network (CNN).

The Convolutional Neural Network(CNN) is identified as a type of multilayer perceptron, as it basically deploys more than one layer of perceptron for the intention of learning more about the image deeply and also substantially acquire the important features out of it. Any basic Convolutional Neural Network is generally composed of three layers.
Convolutional layer is identified as the primary layer of the CNN. A first layer operation is being performed on the image, to gather all the required imperative information about the image. In the secondary layer, Rectified Linear Unit, a non-linear activation function is done in all feature maps. Finally, for the purpose of simplification and summarization of the information the third layer is used, which is known as the pooling stage, that basically deploys a function to do so.

IV. RESULTS

This particular section comprehensively presents the end result of our research. The following is the GUI where input operation is being performed:

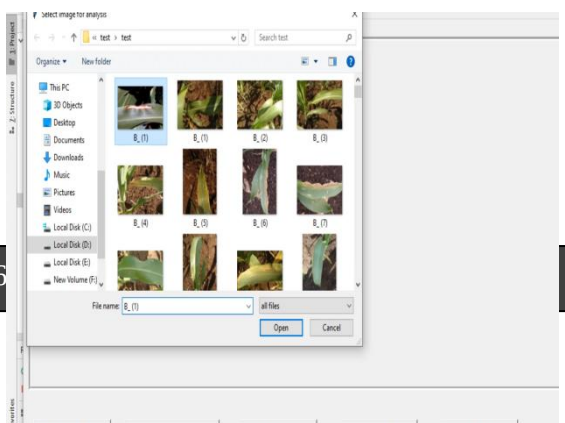

Fig. 5: Input Operation

In the input operation we basically browse the image from the system and present it to our GUI.

The following is the GUI where we successfully display the required output:

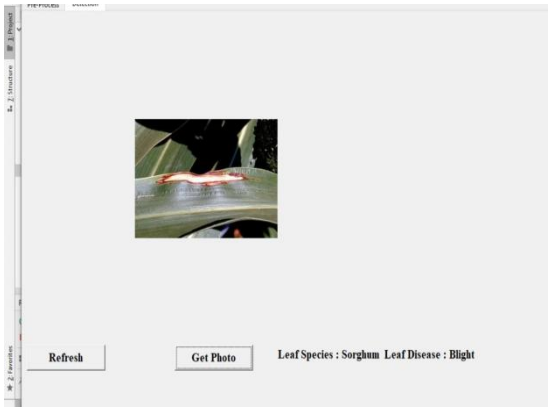

Fig. 6: Output Operation

Here, after browsing in the image, the GUI, using the convolutional neural network, successfully displays the species as well as the particular disease associated with it.

V. CONCLUSION

The entire existence of human life is premised upon the humans' interdependency on plants, therefore it become extensively imperative on our front to provide the kind of protection that this vital source of life requires.

In this particular research work, we have found out that for the interest of feature extraction Convolutional Neural Network (CNN), is much largely effective than any other conventional method. Feature extraction can be successfully done with the help of CNN and that too with a great ease.

Furthermore, for successfully understanding the outer edges of the vein morphologywe have used canny edge detection algorithm. The process of image segmentation is done thereafter, which provides a much wider view to the user in terms of detail. The process of feature extraction is done thereafter where necessary features are extracted for the purpose of disease identification with greater amount of accuracy. Finally, after going through all the processes successfully we effectively perform the process of convolutional neural network (CNN).

The pairing up of canny edge detection algorithm with the convolutional neural network provides a significantly greater amount of correctness in terms of identifying the plant species and the associated disease with it. This therefore establishes a development of a computing system that displays a great amount of effectiveness.

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