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Indian Plant Recognition System Using Convolutional Neural Network

Deepali Naglot[1*], Prachi Sandeep Kasliwal[2], Swati Jayaji Gaikwad[3], Nisha Deepak Agrawal[4]

[1,2,3,4]Department of Computer Science & Engineering, Jawaharlal Nehru Engineering College, Aurangabad, India

Corresponding Author: dnaglot1711@gmail.com

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***Abstract*—** Plants plays important role in our lives, as it provides us food and oxygen which is needed by all living things. There are thousands of kinds of trees in this world, and it is very difficult to distinguish between them. Experts can however identify by using characteristics of leaves but a common man cannot. Recognition of Plant from images is a challenging computer vision task. Proposed System is deployed to classify Indian local leaves automatically using deep learning. Deep Learning is a self-learning technique used for massive data and recent development in hardware and big data have turned out as a blessing. We have considered 10 different Indian plants leaves. Recognition rate of proposed system is 93%.

Keywords— Indian leaf, Plant Recognition, Machine Learning, Deep Learning, and VGG 16

I. INTRODUCTION

Plants play a very vital role in our life as they provide us food and oxygen. We require a good understanding and knowledge about plants and identify new and rare species to increase the agricultural productivity and also to support drug industry [1]

We employ machine learning because some plants cannot be identified or are not distinguishable except for sometimes when they bloom flowers or bear fruit. Also a lot of work has been done in identifying plants mainly in computer vision [2] by using features of leaf such as color, diameter, physiological width, physiological length, perimeter ratio, aspect ratio, rectangularity but it is not up to the mark because leaves can be very same in all these features like lemon and sweet lime or peach and plum leaves. Hence, deep learning is used to fulfil our purpose as it can work with large number of images and produces precise and reliable output. We have developed a model in VGG16 for regional leaves which are found in Maharashtra. We use VGG16 to get better results. [3]

We have prepared our own dataset with full annotation which contains the images of the following plants like arahar, brinjal, cotton , chilly, custard apple, lemon, peanut, mango, tomato, sweet lime etc. Figure 1 shows some sample images of leaves.
The of rest the paper is organized as follows, Section I contains the introduction of the importance and use of recognition of a plant, Section II contains the Related work carried out so far, Section III explains the flow and methodology used in the proposed system, Section IV explains the results and discussion, Section V concludes the work with future work to be carried out.

Figure 1: Sample Leaves

II. RELATED WORK

JyotismitaChaki, Ranjan Parekh and Samar Bhattacharya used multi layered approach to identify the plant leaf. This paper represents methods of recognizing heterogeneous leaves by different visual properties. They have used color based modelling for the colored or non-green leaves and shape based modelling simple green and compound green leaves[4].

Aparajita Sahay and Min Chen presented a Windows phone application for the identification of leaf species. They worked on a data set of labelled images using weighted KNN.In their application, user can photograph of a single leaf on only white colored background and submit it to the system as an input image. Application will analyze the features of leaf and identify species of the plant at realtime [5].

W.H.Rankothge and D.M.S.B Dissanayake presented a plant identification system which is based on image processing and neural network techniques. Image processing techniques including removing noise of image, to normalize leaf area, to reduce the unwanted white background and to scale up image of leaf. Image extraction process is includes RGB color extraction, leaf shape extraction and the leaf vein pattern extraction. They have an accuracy of 95% and they gives results within fewminutes [6].

Bin Wang and Douglas Brown presented a novel shape descriptor for more accuracy and fast plant leaf identification. They have used well-known Swedish leaf dataset and their Leaf100 dataset. Their proposed method can achieve more accuracy than state-of-the-art methods and 170 times faster speed than this [7].

III. PROPOSED SYSTEM ARCHITECTURE

A. Data Collection

The proposed system will take leaf images as input. In proposed system, data is collected using mobile phone cameras. Dataset of total 10 samples (consisting of 400 samples of each alphabet) i.e. 4000 are taken from which 1943 used for training and remaining samples used for testing. Dataset is normalized before providing for training and testing.

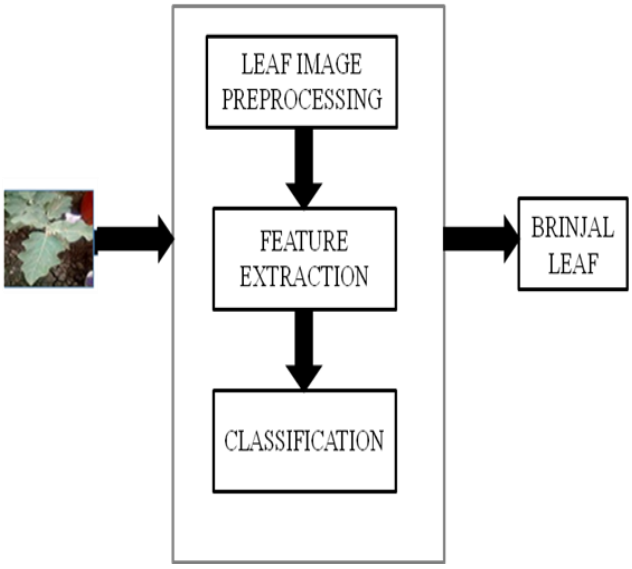

Figure 2: Architecture of Proposed System

B. PREPROCESSING AND FEATURE EXTRACTION

We remove unwanted noise from the image so as to reduce false positive regions from the leaf images. The leaf images contain only one object, the leaf. Since all leaves are not perfectly flat, image capturing would always cast a shadow underneath the leaf. The shadow would disrupt the edge detection as it has a huge contrast with the background, confusing the algorithms to draw the boundary based on shadow instead of on the leaf. Thus, it should be removed before image segmentation. The image RGB value was changed to HSV value. Then, the channel with the clearest contrast between object and shadow was selected and used to identify the object boundary. As HSV value conversion alters the original color, this step serves as guidance for the subsequent edge detection of RGB value leaf images, rather than producing a final image for feature extraction. Cropping is done as it reduces GPU computation and gives faster and better results. Hence the image is rescaled and cropped out for the central 256×256 patch from the resulting image. Multiscaling is performed as it prevents overfitting yielding better results [8].The colors of plants are usually green. Moreover, the shades and the variety of changes of water, nutrient, atmosphere and season can cause change of the color, so the color feature has low reliability. Thus, we decided to recognize various plants by the gray-level image of plant leaf, over the color information [8]. As a result, gray component for each pixel is computed from the color image by applying the equation (1) shown below [9]

$$Grau=0.299\times Ir+0.587\times I0+0.114\times I. \quad (1)$$

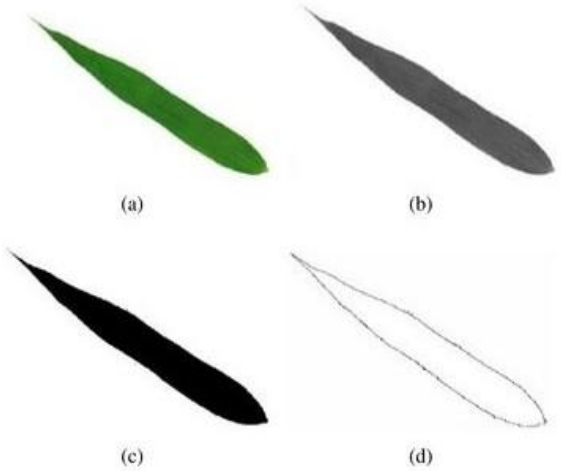

Figure. 3: Example of leaf contour extraction.
(a) Input image (b) gray scale image (c) binary image, and (d) contour extraction.

C. Classification

a. VGG16

Visual Geometry Group model is used here for classification. It is convolutional network used for classification and detection. Its architecture is shown below the input to cov1 layer is of fixed size 224 x 224 image. The image is passed through a series of convolutional (conv.) layers, where the filters were used with small receptive fields.non-linearity) layers. Spatial pooling is carried out by five max-pooling layers, which follow some of the conv. layers Max-pooling is performed over a 2×2 pixel window, with stride 2.

Three Fully-Connected (FC) layers follow a stack of convolutional layers. The final layer is the soft-max layer. All hidden layers have the rectification (ReLU) non-linearity.

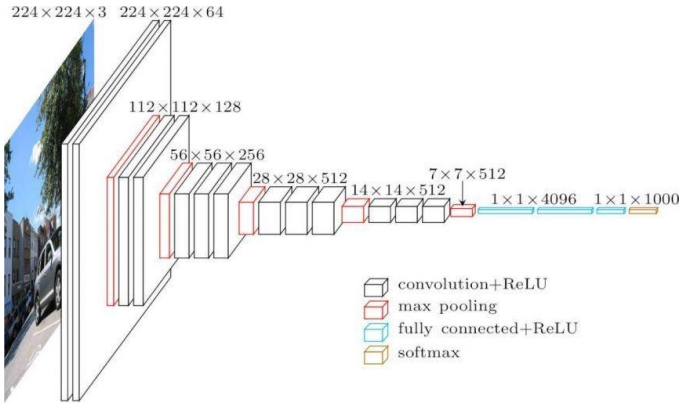

Figure. 4: VGG 16 Architecture

IV. Results and Discussion

The proposed system was implemented using Intel(R) Core(TM) i7 processor at 2.20 GHZ speed and the code was written using Python. Data is collected by 2 people by mobile phone cameras by visiting different farms and nurseries in Maharashtra. Total 4000 (400 samples of each leaf) input samples collected. The leaves which are common to this belt arahar ,brinjal , cotton , chilly, custard apple, lemon , peanut, mango , tomato ,sweet lime were taken. Out of these 1943 images used for training and remaining for testing. Output of the feature extraction step is feature set. It is used as input of the classifier to recognize the leaf.VGG 16 model was used for training. Proposed system contains single input layer, hidden layers and output layer. Confusion matrix is used for analyzing how well our classifier can recognize samples of different class. A confusion matrix of size k x k associated with a classifier, demonstrates the predicted and actual/target classification, where k is the number of different classes.[10] Table 1.presents confusion matrix, where TP stands for True Positive, FN stands for False Negative, FP stands for True Positive and TN stands for True Negative. In confusion matrix we consider only 10 images of each leaves. Accuracy is the percentage of test samples that are correctly recognized by the classifier. Precision is measure of exactness. Recall is measure of completeness.

Accuracy=TP+TN/P+N (2)
Precision=TP/TP+FP (3)
Recall=TP/TP+FN (4)

As shown in result, some samples of the leaves lemon and sweet lime were misclassified during testing as they belong to the same family. The leaf cotton was confused to brinjal, since they are identical to each other. Table.1 shows the confusion matrix of proposed system.

Table.1 Confusion Matrix of Proposed System

Actual Class	Plant	Predicted Class															
		Arahar	Brinjal	Cotton	Chilly	Custard Apple	Lemon	Peanut	Sweet Lime	Tomato	Mango	Total	TP	FN	FP	Precision	Recall
	Arahar	10	0	0	0	0	0	0	0	0	0	10	10	0	0	100%	100%
	Brinjal	0	8	2	0	0	0	0	0	0	0	10	8	2	1	88.89%	80%
	Cotton	0	1	9	0	0	0	0	0	0	0	10	9	1	2	81.82%	90%
	Chilly	0	0	0	9	0	1	0	0	0	0	10	9	1	0	100%	100%
	Custard Apple	0	0	0	0	10	0	0	0	0	0	10	10	0	0	100%	100%
	Lemon	0	0	0	0	0	9	0	1	0	0	10	9	1	3	75%	90%
	Peanut	0	0	0	0	0	0	10	0	0	0	10	10	0	0	100%	100%
	Sweet Lime	0	0	0	0	0	2	0	8	0	0	10	8	2	1	88.89%	80%
	Tomato	0	0	0	0	0	0	0	0	10	0	10	10	0	0	100%	100%
	Mango	0	0	0	0	0	0	0	0	0	10	10	10	0	0	100%	100%
	Total	10	10	10	10	10	10	10	10	10	10	10	93	7	7	93%	93%
Recognition rate = 93%																	

V. CONCLUSION AND FUTURE SCOPE

Leaf recognition is important for plant identification. We have studied various plant recognition techniques and identified the issues in existing plant recognition techniques. This paper presents method for Leaf recognition using VGG16 model. Some of the advantages of VGG16 are it can handle large number of complex data in less time. Proposed system does not require any specific background and environmental condition. It can give output in any season and weather conditions. Proposed system can recognize 10 regional Indian plants with accuracy of 93%. The performance of the proposed system is improved in terms of accuracy and time to build the model using above approach. Some leaves are not recognized correctly due to the similarity between them as well as orientation of the image in front of the camera. In future we can predict which soil is suitable for the plant, we can suggest the suitable weather conditions and we can suggest suitable fertilizers once the leaf is identified.

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Authors Profile

Ms.Deepali Naglot is a Assistant Professor at MGM's Jawaharlal Nehru Engineering College, Aurangabad, India. She pursed Bachelor of Engineering in Computer Engineering from Savitribai Phule Pune University, Pune in year 2014 and Master of Technology in Computer Science and Engineering from Savitribai Phule Pune University, Pune in year 2016. Her Area of Interest is Data Mining & Machine Learning.

Ms.Prachi Kasliwal is currently pursuing her bachelor in Computer Science & Engineering from MGM's Jawaharlal Nehru Engineering College, Aurangabad, India. Her research area of interest includes Machine Learning and Artificial Intelligence.

Ms. Swati Gaikwad is currently pursuing her bachelor in Computer Science & Engineering from MGM's Jawaharlal Nehru Engineering College, Aurangabad, India. Her research area of interest includes Machine Learning.

Ms. Nisha Agrawal is currently pursuing her bachelor in Computer Science & Engineering from MGM's Jawaharlal Nehru Engineering College, Aurangabad, India. Her research area of interest includes Machine Learning.

