Crop Disease Detection Using Deep Learning

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Abstract: Identification of the plant diseases is the key to preventing the losses in the yield and quantity of the agricultural product. Automatic and accurate estimation of disease severity is essential for food security, disease management, and yield loss prediction. We propose and experimentally evaluate a software solution for automatic detection and classification of plant leaf diseases. The latest generation of convolutional neural networks (CNNs) has achieved impressive results in the field of image classification. This paper is concerned with a new approach to the development of plant disease recognition model, based on leaf image classification, by the use of deep convolutional networks. The developed model is able to recognize 8 different types of plant diseases out of healthy leaves, with the ability to distinguish plant leaves from their surroundings. The experimental results on the developed model achieved precision between 85% and 90%.

Keywords: CNN, SVM, down sampling, neural networks

1. INTRODUCTION

Backbone of economy is agriculture in most of the developing countries, especially in India. In India large number of population lives in rural areas where livelihood of people depends mostly on agriculture. The crop production quantity and quality depends on the plant growth. Therefore, plant leaf disease detection is very essential in earlier stage and take necessary steps prevent it from spreading to others parts of the field. Normally, the farmer identifies the disease by observe the color and shape of the leaves. This method needs long time experience and lots of regular efforts. This is practically not possible for the large fields. For every farmer it is not possible to have Expert advice for detecting diseases. This paper presents, inclusive review of leaf disease detection system using Deep learning and machine learning techniques. The basic steps to implement Deep learning techniques to detect the leaf diseases are explained. An overview of recently used techniques as well as traditional methods in this field is described in section 2. Proposed approach is described in section 3. Our recent work is on 3 plants i.e. Apple, Potato, Grapes. We are using convolutional neural network in our approach.

2. LITERATURE SURVEY

H. Al-Hairy, S. Bani-Ahmad, M.Revalat, M. Braik and Z ALRahmneh proposed, “Fast and Accurate Detection and Classification of Plant Diseases”[1]. In this paper, the applications of k-means clustering and neural network have been formulated for clustering and classification of diseases that affect on plant leaves. The proposed algorithm was tested on five diseases which influence on the plants; they are: Early scorch, Cottony mold, ashen mold, late scorch, tiny whiteness.

Shivani K. Tichkule and Dhanashri. H. Gawali proposed “Plant Diseases Detection Using Image Processing Techniques”[2]. Here they used different classifiers for different plants. They worked for Soyabean, Cotton, Grapes, Wheat having accuracies 93.79%, 95%, 96.7%, 76.6% respectively. They used K-means Clustering to detect infected objects and Neural Networks are thus commonly used for obtaining accuracy in detecting and classifying diseases. They basically created Agrobot. But the main disadvantage is that they used different models for different crops.

Jitesh P. Shah, Harshadkumar B. Prajapati , Vipul K. Dabhi Proposed “A Survey on Detection and Classification of Rice Plant Diseases”[3]. They also used machine learning techniques. K-means clustering used for segmentation, For feature extraction gray level co-occurrence matrix is used. SVM for image Classification. They obtained different accuracy for different diseases of rice plant. Average of those accuracy is about 85 %. Disadvantage of this proposed work is they focused only on single rice plant.

Rajleen Kaur ,Sandeep Singh Kang, "An Enhancement in classifier support vector machine to improve plant disease detection"[4]. This paper contain the study of detection of plant diseases and detection of infected part of plants. It is done with advancement of computer technology which helps in farming to increase the production.

Sachin D. Khirade and A.B. Patil proposed "Plant Disease Detection Using Image Processing"[5] which mainly uses basic image processing steps such as image acquisition, image preprocessing, image segmentation using otsu' method, k-means clustering, feature extraction using Color Co-Occurrence Method. Here they used ANN classifier for classification of plant disease.

Shiv Ram Dubey, Anand Singh Jalal, propsed "Detection and Classification of Apple Fruit Diseases Using Complete Loacal Binary Patterns"[6]. They have used k-means clustering for image processing. They have done feature extraction by Complete Local Binary Pattern technique. And for image classification they followed SVM.

Aditya Parikh , Mehul S. Raval , Chandrasinh Parmar and Sanjay Chaudhary, proposed "Disease Detection and Severity Estimation in Cotton Plant from Unconstrained Images". This paper is a part of ongoing research for development of agro-advisory open architecture. It showcase Grey Mildew detection which is one of the prominent disease in the northern part of Gujarat state. They have used KNN classifiers for image classification[7].

3. IMPLEMENTATION

Convolutional Neural Networks (CNNs) are particular types of artificial neural network which are biologically inspired by the visual cortex. They are supervised feature learner able to learn complex invariances and patterns with extreme variability, with robustness scaling, shifting, translation, rotation and distortion of the input. Their particular architecture was designed to recognize visual patterns directly from pixel images with minimal preprocessing. CNN consists of a sequence of layers, each of which make use of a differentiable function to transform one volume of activations to another. Typically three main types of layers are used to build CNN architectures: Convolutional Layers, Pooling Layers, and Fully-Connected Layers.

Convolutional layers can be seen as sets of filters which are able to extract some specific patterns and particular features from an image. The output of a convolutional layer is a feature map which describes particular characteristics of the image. All neurons in a feature map share the same set of weights and the same bias, so neurons in a feature map are able to detect the same feature. The other feature maps in this layer use different sets of weights and biases, also reducing the number of free parameters, so different types of local features are extracted. Pooling layers work as a feature selection layers. They progressively reduce the spatial resolution of each feature map in order to reduce the amount of parameters and the computation in the net by means of local averaging and a subsampling, hence controlling overfitting. Fully-connected layers are usually placed at the end of the structure to perform high-level reasoning. They take a vector of neurons from the previous layer as input, and connects it to all its neurons, actually producing a one-dimensional vector. This structure makes CNNs particularly well suited for image recognition and object detection tasks[8].

Convolutional layers, which apply a specified number of convolution filters to the image. For each subregion, the layer performs a set of mathematical operations to produce a single value in the output feature map. Convolutional layers then typically apply a ReLU activation function to the output to introduce nonlinearities into the model. We have used 2 convolutional layers having 32 filters of size 3 x 3.

The ReLu, refers to the Rectifier Unit, the most commonly deployed activation function for the outputs of the CNN neurons. Mathematically, it's described as:

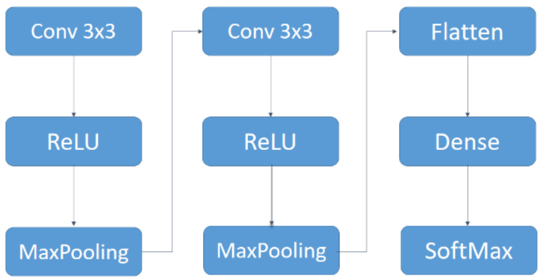
$$\text{Eq.3} : \max(0,x)$$

Unfortunately, the ReLu function is not differentiable at the origin, which makes it hard to use with backpropa- gation training. Instead, a smoothed version called the Softplus function is used in practice:

$$\text{Eq.4} : f(x)=\ln(1+e^{x})$$

Pooling layers, which downsample the image data extracted by the convolutional layers to reduce the dimensionality of the feature map in order to decrease processing time. A commonly used pooling algorithm is max pooling, which extracts sub regions of the feature map (e.g., 2x2-pixel tiles), keeps their maximum value, and discards all other values and strides size is 2 x 2.

Dense (fully connected) layers, which perform classification on the features extracted by the convolutional layers and down sampled by the pooling layers. In dense layer, every node in the layer is connected to every node in the preceding layer. The Fully Connected layer is configured exactly the way its name implies: it is fully connected with the output of the previous layer. Fully-connected layers are typically used in the last stages of the CNN to connect to the output layer and construct the desired number of outputs.



Typically, a CNN is composed of a stack of convolutional modules that perform feature extraction. Each module consists of a convolutional layer followed by a pooling layer. The last convolutional module is followed by one or more dense layers that perform classification. The final dense layer in a CNN contains a single node for each target class in the model (all the possible classes the model may predict), with a softmax activation function to generate a value between 0–1 for each node (the sum of all these softmax values is equal to 1). We can interpret the softmax values for a given image as relative measurements of how likely it is that the image falls into each target class.

4. EXPERIMENTAL RESULTS

We trained our model for total 3 plants that are grapes, apple, potato having 3, 3, 2 diseases respectively. The results for CNN classification for given testing sample are given in following table. We achieved accuracy 87% for Grapes, 90% for Apple, 86% for Potato. This approach gives correct prediction.

Plant Name	Disease Name	Data Set Size	Accuracy
Apple	Apple_Scab	504	90%
	Black_Rot	496	
	Cedar_Apple_Rust	220	
Grapes	Black_Rot	944	87%
	Black_Measles(Esca)	1107	
	Leaf_Blight	861	
Potato	Early_Blight	800	86%
	Late_Blight	800	

5. CONCLUSION

The accurately detection and classification of the plant disease is very important for the successful cultivation of crop and this can be done using image processing. The use of CNN layers for classification of disease in plants such as convolution, relu, maxpooling, flattening, dense, softmax are efficiently used. From these layers, we can accurately identify and classify various plant diseases using image processing techniques. This approach gives the 86% to 90% accuracy in predicting plant diseases. Extension to this work is to improve accuracy.

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