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CNN based Plant Leaf Disease Detection using Machine Learning and Image Processing

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***Abstract*: The early detection of diseases is important in agriculture for a crop yield, Agriculture is one of the main factor that decides the growth of any country. Improper management leads to loss in agricultural products. Farmers lack the knowledge of disease and hence they produce less production. Customer centers are available but do not offer service 24*7 and sometimes communication too fail.**

Farmers are unable to explain disease properly on call need to analysis the image of affected area of disease. Though, images and videos of crops provide better view and agro scientists can provide a better solution to resolve the issues related to healthy crop yet it not been informed to farmers.

Detection of plant disease through some automatic technique is beneficial as it reduces a large work of monitoring in big farms of crops, and at very early stage itself it detects the symptoms of disease.

This paper focus on plant disease detection using image processing approach this work utilizes an open dataset of 5000 pictures of unhealthy and solid plants, where convolution system and semi supervised techniques are used to characterize crop species and detect the sickness.

Key words: CNN, leaf disease, Classification

I. Introduction

India is well known for agricultural country where in about 70% of the population depends on agriculture. Farmers have wide range of multiplicity to select suitable crops for their farm. However, the cultivation of these crops for optimum yield and quality produce is mostly technical. It can be improved by the aid of technological support. The management of perennial crops requires close controlling especially for the management of diseases that can affect production significantly and afterword the post-harvest life.

The image processing is best technique used in agricultural applications for following purposes. Predict plant disease from image of plants. The plant disease is limited by human visual capabilities because most of the first symptoms are microscopic. This process is tedious, time consuming. There is need for design system that automatically recognizes, classifies and quantitatively detects plant disease symptoms. In case of plant disease, the disease is as any impairment of normal physiological function of plants, producing characteristic symptoms. A symptom is a reality accompanying something and is observed as evidence of its existence. Disease is caused by pathogen which is any agent causing disease.

The camera deployed in the agricultural field is used to capture the leaves periodically or whenever the change in color of the leaf is detected. The segmentation process is carried out on the captured leaves to segment the affected area. The segmented image is uploaded to the cloud for further classification. To reduce the amount of data to be stored in the cloud, the concept of compressed sensing is used. CS is applied to the segmented image to reduce the amount of data to be uploaded to the cloud. Very few measurements are uploaded rather than all samples of the segmented image.

The development of an automated system also helps farmers avoid consulting divine. Automatic detection of leaf diseases is most important research topic as it may prove gain in monitoring large fields of crops, and thus automatically detect the diseases from the symptoms that present on the plant leaves. This enables machine vision that is to provide image based and image processing plays important role.

We will provide a result within fraction of seconds and guided you throughout the project. We briefly explain about the experimental analysis of our methodology. Samples of 75 images are collected that comprised of different plant diseases like Alter aria Alternate, Anthracnose, Bacterial Blight, leaf spot and Healthy Leaves.

Different number of images is collected for each disease that was classified into database images and input images. The primary attributes of the image are relied upon the shape and texture oriented features. The sample screenshots displays the plant disease detection using color based segmentation model.

II. SYSTEM DESIGN AND ARCHITECTURE

1. SYSTEM ARCHITECTURE

System Architecture design-identifies the overall hypermedia structure for the Web App. Architecture design is tied to the goals establish for a Web App, the content to be presented, the users who will visit, and the navigation philosophy that has been established. Content architecture, focuses on the manner in which content objects and structured for presentation and navigation. Web App architecture, addresses the manner in which the application is structure to manage user interaction, handle internal processing tasks, effect navigation, and present content. Web App architecture is defined within the context of the development environment in which the application is to be implemented

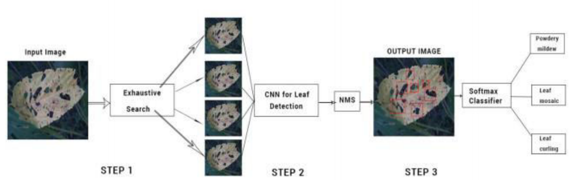


Fig1: System Architecture

2. CNN Algorithm:

A vision subsystem requires a lot of image processing in addition to a CNN. In order to run CNNs on a power-constrained system that supports image processing, it should fulfill the following requirements:

1. Availability of high computational performance: For a typical CNN implementation, billions of MACs per second is the requirement.

2. Larger load/store bandwidth: In the case of a fully

3. Connected layer used for classification purpose, each co-efficient gets used in multiplication only once. So, the load-store bandwidth requirement is greater than the number of MACs performed by the processor.

4. Low dynamic power requirement: The system should consume less power. To address this issue, fixed-point implementation is required, which imposes the requirement of meeting the performance requirements using the minimum possible finite number of bits.

4 Flexibility: It should be possible to easily upgrade the existing design to new better performing design.

5 Since computational resources are always a constraint in embedded systems, if the use case allows a small degradation in performance, it is helpful to have an algorithm that can achieve huge savings in computational complexity at the cost of a controlled small degradation in performance

3. De-Convolution

In order to analyze the network that we trained on Image Net – and get a first impression of how well the model without pooling lends itself to approximate inversion – we use a 'DE convolution' approach. We start from the idea of using a DE convolutional network for visualizing the parts of an image that are most discriminative for a given unit in a network, an approach recently proposed by Zeiler & Fergus (2014). Following this initial attempt – and observing that it does not always work well without max-pooling layers – we propose a new and efficient way of visualizing the concepts learned by higher network layers. The DE convolutional network ('deconvnet') approach to visualizing concepts learned by neurons in higher layers of a CNN can be summarized as follows. Given a high-level feature map,'deconvnet' which can be able to compete and inverts the data flow through the sacristy of CNN, going from neuron activations in the given layer down to an image.
This way we get insight into what lower layers of the network learn.
Visualizations of

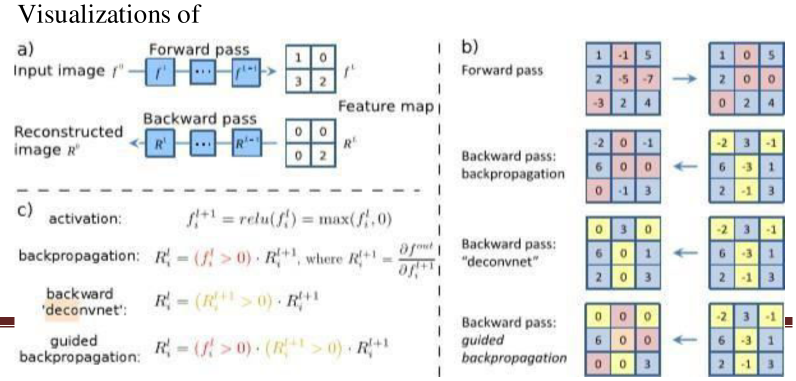


Fig 2: Schematic of visualizing the activation so high layer neurons

a) Given an input image, we perform the forward pass to the layer we are interested in, then set to zero all activations except one and propagate back to the image to get a reconstruction.

b) Different methods of propagating back through a ReLU nonlinearity.

c) Formal definition of different methods for propagating a output activation out back through a ReLU unit in layer l; note that the 'deconvnet' approach and guided back propagation do not compute a true gradient but rather an imputed version.

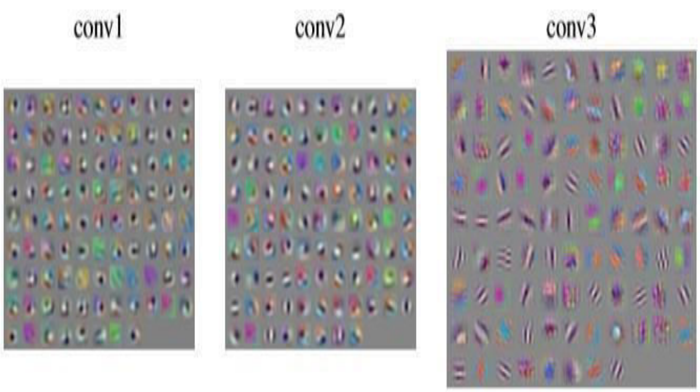
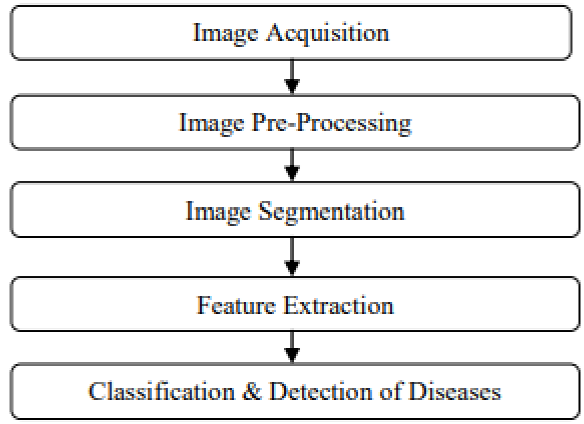


Fig 3: Visualizations of patterns learned by the lower layers (conv1-conv3) of the network trained on Image Net. Each single patch corresponds to one filter. Interestingly, Gabor filters only appear in the third layer

Approach were recently discussed in Simonyanetal. (2014). In short the both methods differ mainly in the way they handle back propagation through the rectified linear (ReLU) nonlinearity. In order to obtain are construction conditioned on an input image from our network without pooling layers we propose a modification of the 'deconvnet', which makes reconstructions significantly more accurate, especially when reconstructing from higher layers of the network.

III. BASIC CONCEPT OF LEAF DISEASE DETECTION

Basic step of image processing to detect & classify plant leaf disease. These steps are image acquisition, image pre-processing, image segmentation, feature extraction, classification and leaf disease detection. These steps are described as below in figure.



A. Image Acquisition

The image is captured, scanned and converted into a manageable entity. This process is known as image acquisition. During a test-phase, we acquire a series of color images using a digital scanner so as to acquire a single image of leaf. The color images were digitized to produce RGB digital color images.

Images are captured from the farm using a digital camera to get them directly in digital form with numerical values so that digital image processing operations can be applied.

B. Image Pre-Processing

The main aim of Pre-processing is to suppress unwanted image data and to enhance some important image features. It includes RGB to Gray conversion, image resizing and median filtering. Here color image is converted to gray scale image to make the image device independent. The image is then resized to a size of 256*256. Then median filtering is performed on the image to remove the noise. The digital version of the rotten leaf sample consists of about 30% of leaf area and rest 70% is the background.

C. Image Segmentation

Image segmentation is the process of separating the objects present in the image. The preprocessed image is now subjected to the segmentation processing stage. Very often we find a situation in which the acquired rotted leaf image at this stage under observation is surrounded by its petiole, stem, or neighboring leaf images and image background. The color feature of the sample image is used to distinguish rotted leaf area form healthy leaf area.
The machine vision can identify a very wide range of color spectrum as compared to human vision. Color has been successfully applied to

retrieve images because, it has very strong correlations with the underlying objects in an image. The color feature is robust to background complications, scaling, orientation, perspective, and the size of an image. The color of the image is represented through some color model. The commonly used color models are RGB (red, green, blue), and HSV (hue, saturation, value).

D. Feature Extraction

Feature extraction is a method in which both the color and texture of an image are taken into account to arrive at unique features. The feature vectors such as color, morphology, texture, shape, edges, are used as learning database images for extracting the features. Four feature vectors are considered namely color, texture and morphology of the leaf. Algorithm used for extracting the features is as follow: SURF (Speed up Robust Feature) algorithm is applied for extracting the features. SURF algorithm used as local descriptor and blob detector.

E. Classification & Detection of Diseases

Classifiers are used for the training and testing of the datasets. These classifiers may be support vector machine (SVM), k-nearest neighbor, neural network etc. These methods are used to classify and detect the leaf diseases.

II. CONCLUSION

There are many methods in automated or computer vision plant disease detection and classification process, but still, this research field is lacking. In addition, there are still no commercial solutions on the market, except those dealing with plant species recognition based on the leaves images. In this paper, a new approach of using deep learning method was explored in order to automatically classify and detect plant diseases from leaf images. The developed model was able to detect leaf presence and distinguish between healthy leaves and 13 different diseases, which can be visually diagnosed. The complete procedure was described, respectively, from collecting the images used for training and validation to image preprocessing and augmentation and finally the procedure of training the deep CNN.

The experimental results achieved precision between 90% and 97%, for separate class tests. The final overall accuracy of the trained model was 95.3%. Fine-tuning has not shown significant changes in the overall accuracy, but augmentation process had greater influence to achieve respectable results.

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