Chapter 19
Application of Convoluted Neural Network and Its Architectures for Fungal Plant Disease Detection

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ABSTRACT

Eighty-five percent of the plants are affected by diseases caused by organisms like fungus, bacteria, and virus, which devastate the natural ecosystem. The most common clues provided by the plants affected by fungal diseases are defaming of the plant color. In literature, several traditional rule-based algorithms and normal image processing techniques are used to identify the fungal plant diseases. However, the traditional approach suffers from poor disease identification accuracy. Convoluted neural network (CNN) is one of the potential deep learning neural networks used for image recognition and classification in plant pathology. In this chapter, some of the potential CNN architectures used for plant disease detection like LeNet, AlexNet, VGGNet, GoogLeNet, ResNet, and ZFnet are discussed with the architecture and advantages. The efficiencies achieved by ResNet and ZFNet are found to be good in terms of accuracy and error rate.

1.0. INTRODUCTION

Around 85 percentage of the plants are affected by diseases caused by fungal organisms which devastate the natural ecosystem. The microorganisms which commonly cause fungal diseases in plants are fungus, bacteria, and virus. By paying careful attention to the appearance of the plant, the diseases can be suspected at the early stage itself. The most common clues provided by the plants affected by fungal

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diseases are defaming of the plant color, deterioration of the leafs shape, yellowing of the stems, rusting of branches, damping of seedlings, formation of white molds, crooked stem edges, crinkling of leaves, and so on Larkin, and Fravel (1998).

The fungus in fungi affected plants absorbs all energy and vitamins from the plants causing a great deal of damage to the plants and its byproducts. The damage causes stress to the plants by destroying the cells and tissues of the plants. Some of the sources of fungal diseases are animal, soil, tools used, human workers, weeds, seeds, and so on. From these sources the fungus are generated and they enter the plant through their natural opening i.e. stomata or through any holes created over the plant due to insects or any other mechanical device usage while planting. Most commonly occurring fungal plant diseases are sclerotium rots, leaf blight, powdery mildews, anthracnose, rusts, and so on Xavier and Boyetchko, (2004).

In literature several traditional rule based algorithms and normal image processing techniques are used identify the fungal plant diseases. However the traditional approach suffer from several limitations like poor disease identification accuracy, improper preprocessing of data, repetition of laborious tasks, unable manage uncontrolled data capturing conditions, bottlenecks during segmentation, lack of scalability, cannot handle data transition, and so on. This lead to the application of automated algorithms based on artificial intelligence for identifying pathogenic fungal plant diseases. Some of the popularly used artificial intelligence approaches for fungal plant disease identification are in e backpropogation neural network, deep learning, supervised learning, reinforcement learning, unsupervised learning, convoluted neural network, recurrent network, and so on. The automated approaches either uses numerical data or images gathered over the wide variety of fungi affected plants to train the algorithms for disease identification. The automated artificial intelligence approaches does precise operation by efficiently handling the problems related to real time operation, computational resources, insufficient gathering of data, distribution of training data, side effects during computation, data transition, and so on Khirade and Patil, (2015), Petrellis, (2017), Barbedo, Koenigkan, and Santos, (2016).

Among all forms of automated approaches, image based approaches achieves superior quality of output compared to all other approaches while identifying the fungal plant diseases. CNN is one of the potential deep learning neural networks used for image recognition and classification in plant pathology. CNN is composed of three layers i.e. convolutional, pooling, and fully connected with learnable weights and bias which can successfully the dependencies related to spatial and temporal properties of images. Some of the powerful architectures of CNN used for image analysis are LeNet, AlexNet, VGGNet, GoogLeNet, ResNet, and ZFnet Wu, (2017), O'Shea and Nash, (2015).

2.0. LeNet

LeNet stands for Lenet-5 composed of two sets of convolutional layers and pooling layer invented by Yann LeCun in the year 1998 at Bell lab. It is one of the oldest CNN model invented for the sake of deep learning being first applied to the backpropogation based learning algorithm. The very first application of LeNet was to classify the handwritten digit or character recognition problem. LeNet-5 is composed of six layers in addition to input and output layers where the parameters of one layer are used to train the parameters of other layers. First layer is C1 consisting of six convolutional kernels of size 5*5 and the feature mapping is performed with the size 28*28. Second layer is S2 which perform subsampling and features in each layer are of size 14*14. Third layer is C3 which is a convolutional layer consisting of kernels of size 16*5*5. Fourth layer is S4 which is similar to S2 of size 2*2 and generates 16 samples