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CONVOLUTIONAL NEURAL NETWORK (CNN) APPLIED TO PLANT LEAF DISEASE CLASSIFICATION

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ABSTRACT

Crop production can be greatly reduced due to various diseases, which seriously endangers food security. Thus, detecting plant diseases accurately is necessary and urgent. Traditional classification methods, such as naked-eye observation and laboratory tests, have many limitations, such as being time consuming and subjective. Currently, deep learning (DL) methods, especially those based on convolutional neural network (CNN), have gained widespread application in plant disease

1. INTRODUCTION

More than 90% of people in the world rely on agriculture. Farmers produce 80% of the world's food , however, more than 50% of crop production is lost due to plant diseases and pests. Thus, recognizing and detecting plant disease accurately is necessary and urgent.

Plant diseases can be systematically divided into fungal, oomycete, hyphomycete, bacterial, and viral types**.**

We have shown some pictures of plant disease in table 1. Researchers and farmers have never stopped exploring how to develop an intelligent and effective method for plant disease classification.

Conventional field scouting for diseases in crops still relies primarily on visual inspection of the leaf color patterns and crown structures.

2. DESCRIPTION

The disease characteristics among different crops are also different due to the variety of plants.

Many studies have focused on the classification of plant diseases based on machine learning. Using machine learning methods to detect plant diseases.

DL is a branch of machine learning and is mainly used for image classification, object detection , and natural language processing

The main types of networks are multilayer perceptron, CNN, and recurrent neural network (RNN).

CNN is the most widely used for plant leaf disease classification.

CNN usually consists of convolutional, pooling, and fully connected layers.

The convolutional layer uses the local correlation of the information in the image to extract features.

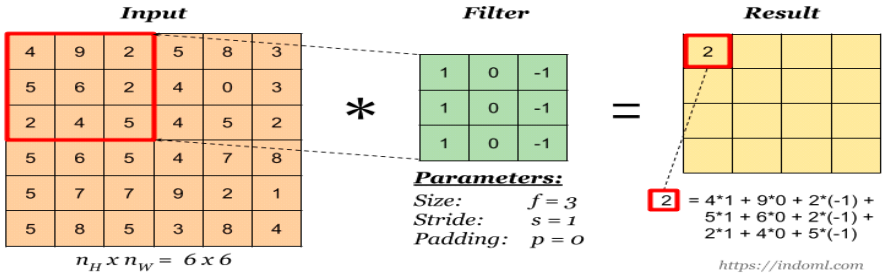
3. WORKING PRINCIPLE OF (CNN) APPLIED TO PLANT LEAF DISEASE:

A kernel is placed in the top-left corner of the image. The pixel values covered by the kernel are multiplied with the corresponding kernel values, and then the products are summated, and the bias is added at the end.

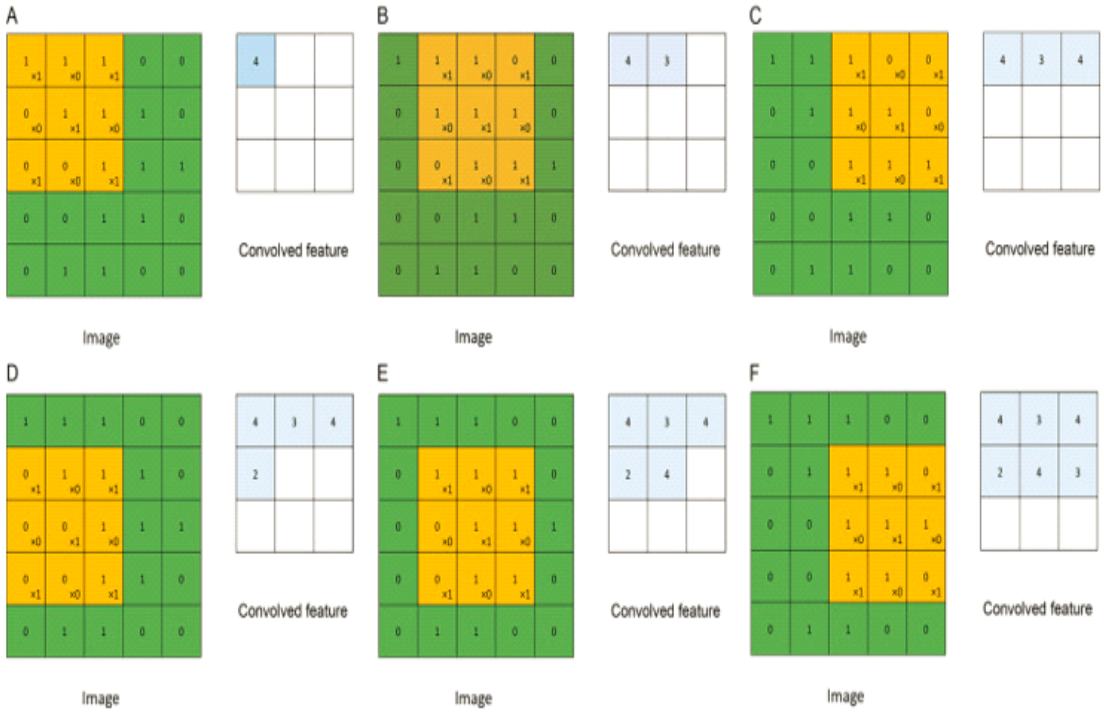
The kernel is moved over by one pixel, and the process is repeated until all possible locations in the image are filtered.

Maximum pooling is to divide the input image into several rectangular regions based on the size of the filter and output the maximum value for each region.

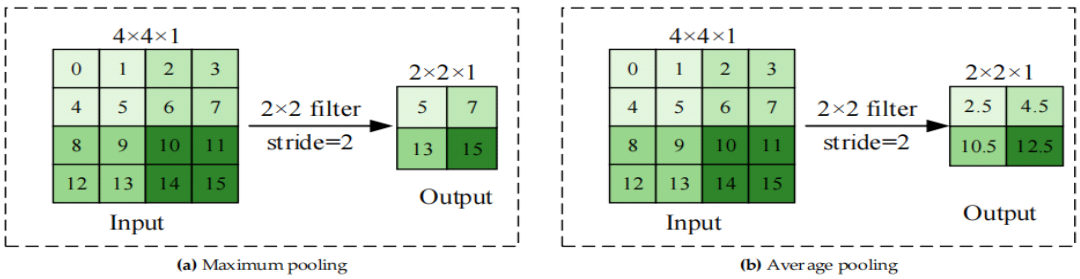
Step 1: Overlay the filter to the input, perform element wise multiplication, and add the result.



Step 2: move the overlay right one position (or according to the **stride** setting), and do the same calculation above to get the next result. And so on.



MAXIMUM POOLLING:



4. LITERATURE REVIEW

S. S. Sannakki and V. S. Rajpurohit, proposed a "Classification of Pomegranate Diseases Based on Back Propagation Neural Network" which mainly works on the method of Segment the defected area and color and texture are used as the features. Here they used neural network classifier for the classification.

[1] The main advantage is it Converts to L*a*b to extract chromaticity layers of the image and Categorisation is found to be 97.30% accurate. The main disadvantage is that it is used only for the limited crops.

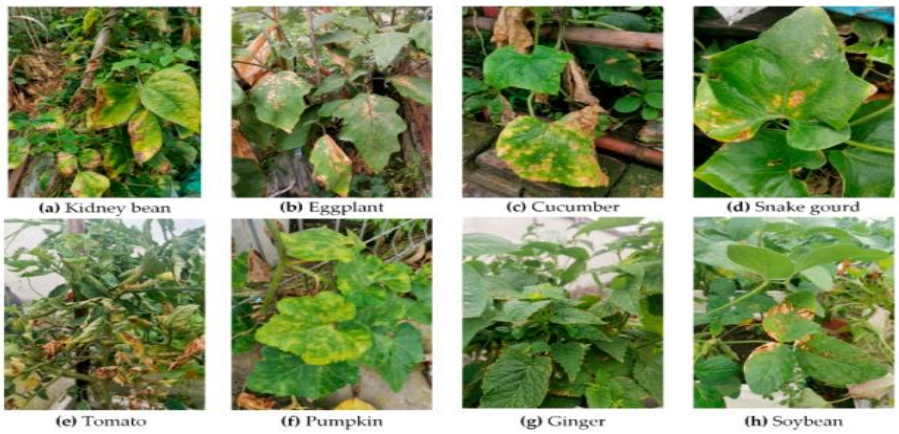
[2] P. R. Rothe and R. V. Kshirsagar introduced a" Cotton Leaf Disease Identification using Pattern Recognition Techniques" which Uses snake segmentation, here Hu's moments are used as distinctive attribute. Active contour model used to limit the vitality inside the infection spot, BPNN classifier tackles the numerous class problems. The average classification is found to be 85.52%.

[3] Aakanksha Rastogi, Ritika Arora and Shanu Sharma," Leaf Disease Detection and Grading using Computer Vision Technology &Fuzzy Logic". K-means clustering used to segment the defected area; GLCM is used for the extraction of texture features, Fuzzy logic is used for disease grading. They used artificial neural network (ANN) as a classifier which mainly helps to check the severity of the diseased leaf.

5. PROBLEM DEFINITION

Table 1. Common diseases of several common plants.

Plant	Major Types of Disease		
	Fungal	Bacterial	Viral
Cucumber	Downy mildew, powdery mildew, gray mold, black spot, anthracnose	Angular spot, brown spot, target spot	Mosaic virus, yellow spot virus
Rice	Rice stripe blight, false smut, rice blast	Bacterial leaf blight, bacterial leaf streak	Rice leaf smut, rice black-streaked dwarf virus
Maize	Leaf spot disease, rust disease, gray leaf spot	Bacterial stalk rot, bacterial leaf streak	Rough dwarf disease, crimson leaf disease
Tomato	Early blight, late blight, leaf mold	Bacterial wilt, soft rot, canker	Tomato yellow leaf curl virus



1) **Insufficient Datasets:**-The most important problem of CNN-based DL's application of plant disease classifification is insuffificient The most important problem of CNN-based DL's application of plant disease classifification is insuffificient datasets in size and diversity.

2) **Nonideal Robustness:**-This nonideal robustness problem was confifirmed by Mohanty, who trained and tested deep CNN (DCNN) models with the PlantVillage dataset; the top accuracy they obtained was 99.35%. However, when the DCNN models were tested on a set of images taken under conditions that were different from the training set, the accuracy dropped to 31% .

3) **Symptom Variations:**-When detecting plant diseases, we usually assume that the symptoms of the disease will not change. The symptoms of plant diseases are the results of the interaction of diseases, plants, and the environment [2]. Changes in any one of the three may lead to changes in disease symptoms

6. OBJECTIVE

Before 2015, no notable breakthrough was obtained in plant disease classifification. With the fast development of DL since 2015, DL has been widely used in plant disease detection and classifification and represents state-of-the-art technology in this fifield.

For plant leaf disease classifification, CNN-based models are the most used. We introduce and summarize the problems and solutions existing in the development of CNN based DL methods applied to plant disease detection and classifification.

7. RESEARCH METHODOLOGY

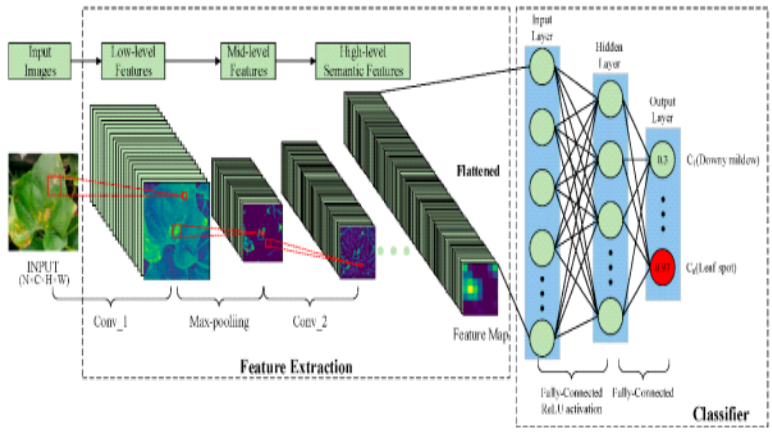
This research is all about the whole concept of CNN classification used for plant disease, The aim of this research is to collect the information about the CNN classification actual concept and how it is working. We use a CNN-based architecture to extract features, which mainly include convolutional, max-pooling, and full connection layers.

Concept of CNN Classification:

The convolutional layer is mainly used to extract features of snake gourd plant leaf images.

The shallow convolutional layer is used to extract some edge and texture information.the middle layer is used to extract complex texture and part of semantic information, and the deep layer is used to extract high-level semantic features.

The convolutional layer is followed by a max-pooling layer, which is used to retain the important information in the image.



8. ANALYSIS FINDINGS

In classic DL problems, we often assume that the training and test sets have the same distribution. Usually, we train the model on the training set and test the model on the test set. However, the test scenario is often uncontrollable in actual application.

The distribution of the test set is really different from the training set due to various factors, such as the inflfluence of season and climate. Under the circumstances, the overfifitting problem appears, that is, the trained model does not work well in practical application.

This nonideal robustness problem was confifirmed by Mohanty et al. [4], who trained and tested deep CNN (DCNN) models with the PlantVillage dataset the top accuracy they obtained was 99.35%.

However, when the DCNN models were tested on a set of images taken under conditions that were different from the training set, the accuracy dropped to 31% [4]. Similarly, Ferentinos used CNN models (i.e., AlexNet, GoogLeNet, and VGG) to detect and recognize plant diseases with a public dataset PlantVillage.

When the model was trained and tested with PlantVillage, the best success was 99.53% with the VGG model. However, when they trained the VGG model with laboratory images and tested it with fifield images, the success rate was only up to 33.27% [5].

Limitation:

Using the cloud platform, it can easily realize the functions of taking photos to identity pests and counting insects.

With the quick development of intelligent devices, the application of deep learning in daily life will

9. FUTURE SCOPE

The quick development of intelligent devices, such as smart phones, personal computers, affixed cameras, and UAV, is making image classifification projects more convenient and intelligent.

The scheme consists of two parts:

1) Mobile phone client, through which users can upload the collected images to the server

2) Server-side program, which processes the images and returns the classifification results to the user. Meanwhile, the server also needs to store the relevant results in the database to facilitate the query of users Using the cloud platform, it can easily realize the functions of taking photos to identity pests and counting insects.

With the quick development of intelligent devices, the application of deep learning in daily life will become more and more extensive.

10. CONCLUSION

DL, which is a branch of machine learning, is mainly used for image classifification, target detection, and image segmentation. In this paper, we reviewed the latest CNN networks pertinent to plant leaf disease classifification.

We introduce the process of CNN methods applied to plant disease classifification and summarize DL principles involved in plant disease classifification.

We also summarize some problems and corresponding solutions of DL used for plant disease classifification with extrinsic and intrinsic factors

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