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Disease Detection in the Leaves of Multiple Plants

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Abstract - *Diseases in plants are one of the major challenge in the agriculture sector. Pathogens such as fungi, bacteria and viruses causes different types of infections in plants leading to its damage. An early information about the crop health and detection of diseases can control loss in production to a large extend. The deep algorithms can be made useful in plant disease diagnosis. This paper proposes a deep learning based method for the detection of diseases effected in the leaves of plants. Here the deep Convolutional Neural Network (CNN) technique is used for the detection and classification of different types of diseases effected to the plant leaves. The CNN network is trained with 5 varieties of diseases effected to different plant leaves. Data base for this work has been collected from various agricultural fields and also through online sources. The dataset containing 1222 diseased images of plant leaves were made used. The architecture used is the RESNET – 50. The proposed CNN model acquires a classification accuracy in the range above 96%, which is accurate than the conventional machine learning techniques.*

Key Words: Disease detection, Pathogens, Deep learning, Sigatoka, Anthracnose, Convolutional Neural Network…

1. INTRODUCTION

The Indian economy is highly depended on the agriculture sector which is considered as the main source of income. India has a second position in the global production of vegetables and fruits. Infectious disease in plants is one of the few reasons authorized by the World Trade Organization for blocking imports of agricultural products. Commercialization has created many negative effects in agricultural fields which involved the increased use of pesticides, pollution in soil, air, water etc. Always there is a balance between the global food production and the growing food demand. Reports infer that more than 80% of agricultural production is done by the smallholder farmers, in that 50% loss in the yield is due to the attack of pest and diseases.

The increased use of pesticides, climatic changes, attack of pathogens lead to the loss in production of crops. The farmer's livelihoods depend on the agriculture so diseases in plant can not only effect the food security but also the famers. Most of the diseases in plants are affected by pathogens. The pathogens may be fungi, bacteria or virus. Most of the diseases caused in plants are in the leaf parts rather than the stem, roots etc. and also symptoms of diseases occurs in the leaf portions in its preliminary stage. From the leaf portion these diseases get spread to the other parts causing to the damage of the whole plant. And also there are some diseases which is affected throughout the leaf and it may fall off. So plant protection plays a major role in the growing demand of food production.

For the efficient eradication of diseases in plants, they must be detected in an early stage. Several methods are available for disease detection. One such method is the optical observation which requires expert people for the field visit to identify the diseases and also all the diseases cannot be identified with naked eyes. So there arises the need for an automated method for the detection of the diseases. Diagnosis of diseases at an early stage can help to provide treatments as soon as possible. The image processing technologies have provided significant development in the field of agriculture. The introduction of Deep learning techniques in agriculture has made drastic developments in plant disease detection. In this paper we address the detection of diseases caused in the plant leaves using the Deep learning architecture called RESNET – 50.

2. LITERATURE REVIEW'

The major loss due to the Plant viruses is caused to the agricultural and horticultural crops all around the world. The damage caused to the plants by the pests and pathogens plays a significant role in crop losses. Detection and identification of diseases in crops could be realized via direct and indirect methods, these are the primitive techniques. The current methods for plant disease detection involves the

imaging techniques using machine learning and deep learning.

2.1 Primitive Methods

The primitive methods of plant disease detection consist of both the direct and indirect methods [3]. The Direct method for the detection of diseases includes the molecular and serological methods. This could be used for high-throughput analysis when large numbers of samples need to be analyzed. In these methods, the disease causing pathogens such as bacteria, fungi and viruses are detected directly to provide accurate identification of the disease/pathogen. On the other hand, indirect methods are used identify the plant diseases through various parameters such as morphological change, temperature change, transpiration rate change and volatile organic compounds released by infected plants.

2.2 Machine Learning Techniques

Machine learning is a technique of training a machine to do some work by providing a set of training data's. it uses various models or architectures in order to provide better image processing. There are various steps involved in machine learning, they are image preprocessing, segmentation, feature extraction and pattern recognition. The image processing and machine learning techniques have been extensively explored for plant disease study [4]. Different types of classifiers can be used, like Support Vector Machine, K- Nearest Neighbor etc. the feature extraction in machine learning is carried out manually and theses features used for the classification process. The limitation of this technique is that, it can be used for only limited dataset. For a large dataset the machine learning techniques fail in the case of accuracy.

1. PROPOSED APPROACH

The initial step of project is the data acquisition. Images of the disease affected leaves of four varieties of plants are collected. And these images were divided into two sets. 90% of images where taken for the training process, these set of data are called the training dataset. The images in these dataset are trained by preprocessing and by feature extraction.

The deep learning algorithm provides an automatic feature extraction. This is the first phase of the proposed system. The second phase consist of a testing dataset. It may also contain images of disease affected leaves, that is the remaining 10% of the overall dataset. The difference is that these images may or may not be trained.

3.1 Plant Diseases

The disease effected leaf images of 4 varieties of plants such as banana, mango, grape and beans are classified here. Mainly four types of diseases are taken into considered.

- **Sigatoka leaf spot – Plantain**

This disease is a leaf spot disease which is also called as leaf streak disease. It a fungal disease which causes drying of leaves. It may appear in both yellow and black color, hence called yellow sigatoka and black sigatoka. Black sigatoka is caused by the fungus called *Mycosphaerella fijiensis* and yellow sigatoka is caused by *Mycosphaerella musicola* [5]. Black sigatoka is more virulent than the yellow sigatoka. Their symptoms appear on younger leaves causing to its damage. Their symptoms appear on the younger leaf parts. The lesions are in reddish-rusty brown and they are most evident on the underside of leaves.

(a) (b)

Figure 1. (a) Black sigatoka and (b) Yellow sigatoka

As the disease progresses, these spots form narrow brown streaks along the veins. Leaf margin can become water – soaked and black. In yellow sigatoka light green specks on upper leaf side. Large brown to black dead areas along leaf margin occurs.

- **Anthracnose - Mango**

Anthracnose is caused by the fungal infection made by the fungus *colletotrichum gloeosporioides* [6]. the spore production by this fungus is favored by wet or humid weather. The dispersal of these spores occurs by rain and wind. This enables the spread of disease over relatively short

Figure 2. Anthracnose in mango leaf.

distances. This disease occurs both in leaf parts and in fruits. The symptoms first occur on the leaves, spots from commonly towards the margins. They are tan to dark brown in color with a darker border. Infection of young leaf may occur when their emergence coincides with rainy weather.

- **Powdery Mildew – Grape**

The fungus called *Erysiphe necator* causes the powdery mildew disease in grapes. This fungus does not require free water on plant tissue surface to infect. Powdery mildew can result in a reduced vine growth, fruit quality and yield [7].

Figure 3. Powdery mildew in grape leaf

The fungus will infect to all green tissues. It appears as Ash – gray to white powdery spots in the leaves and fruit and on veins and shoots it appears as brown or black patches. The ash – gray to white powdery fungal growth in spots may gradually develops. As the disease progresses, the spots enlarge and merge to cover the whole leaf causing to the deformation, dry up and shed.

- **Rust - Beans**

Rust in beans leaf is also a fungal disease caused by the fungus called *Uromyces appendiculatus.* These fungal spores spread quickly in beans [8]. The symptoms are seen in the leaves, which becomes covered in a mix of yellow, brown and red. A minute brown to yellow pustules rupture the epidermis of older leaves, mainly on the underside. The spots begin as a tiny, white, slightly raised spots and these

Figure 4. Rust in beans leaf

will break open to become distinct round reddish brown spots. When touched, the rust – like reddish brown spores brushes off. If the leaves are covered severely, they may fall off. Bean rust may kill young plants. On older plants the fungus has less effect on yield.

- **Tapioca - Cassava Mosaic**

This is virus disease which effects on the leaves of tapioca plant. It appears with pale yellow to white chlorosis developing at the early stage. The distortion and the reduction in leaflet size depends on severity of the disease. The plant will have stunted growth and tuber size will be reduced. The main symptom is the appearance of mosaic

Figure 5. Cassava mosaic disease in tapioca

patterns in the leaves. The mosaic pattern may be uniformly distributed in the leaf surface. The symptoms of cassava mosaic disease are caused by a group of viruses that often co-infect cassava plants, that is tapioca plant. The distribution of the virus is greatly dependent on the population of this insect, which in turn is conditioned to the prevailing weather conditions.

3.2 Training and Testing dataset

The images of the disease affected leaves of 5 varieties of plants are grouped together to form a dataset which is called as the training dataset. The training dataset consist of 1222 images of leaves. The images are collected from various agricultural fields and also from some online agricultural portals. The database includes 5 different classes, where each class is defined as a plant type with a disease. These images are used for the training process hence they are called training dataset. That is from total number of images 90% is used as testing images. Another set of dataset is the testing dataset. It consists of images similar to the images in the training dataset, i.e. images of disease effected leaves of plants. Remaining 10% is used as testing images. Then the preprocessing of images is carried out, that is all the images are resized to 224*224-pixel size.

4. EXPERIMENTAL RESULTS

Images of the diseased leaves of plantain, mango, grape and beans was given as the training images. The training dataset consist of the 90% of overall diseased images and the remaining belongs to the testing dataset. So in a total of 1222 images, around 1099 are the training images and remaining 123 belongs to testing images (which may or may not be trained). The training is proceeded with the training set, and the convolution based automatic feature extraction is carried out. Then the evaluation is done with the testing data (unknown data). The result of the image taken for testing will be as follows.

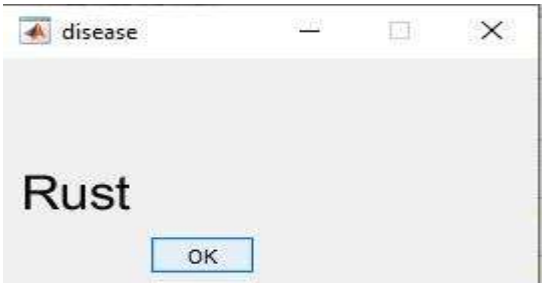

Figure 6. Test result of disease affected beans leaf

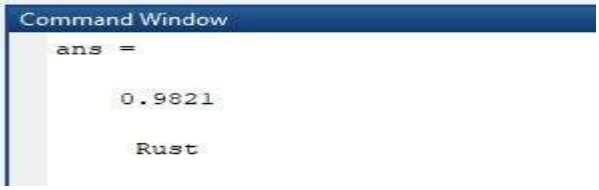

Figure 7. Accuracy of class rust

4.1 Result Analysis

Classification of four diseases of four different plants was done. And also the mean accuracy of all the diseases was also obtained. Each disease was classified in to different class. The class denote the type of the disease caused in that particular plant leaf.

Table 1. Classification table showing different classes and its classification accuracy.

Plant Type	No: of Images	Class (Disease)	Classification accuracy (percentage)
Banana	432	Sigatoka	98.81
Mango	204	Anthracnose	97.68
Grape	158	Powdery Mildew	96.52
Beans	248	Rust	98.21
Tapioca	180	Cassava Mosaic	97.14

The highest accuracy is for the sigatoka class since the number of images taken for training is more and low accuracy is for the class powdery mildew.

5. CONCLUSION

Disease detection in plants is a key method for the reduction of agricultural losses. An early stage detection of diseases is very useful in preventing the growth of the pests and also the spread of diseases. This also reduces the usage of pesticides in the agricultural field. So an automatic method is required to identify diseases through simple leaves images. Dataset containing thousands of images are collected and they are divided into testing and training sets of images. Convolution Neural Network is used for the disease detection and classification process. The architecture used is the ResNet – 50. This architecture has the ability to classify images into thousands of categories. The proposed method provides a classification accuracy in the range of 96 to 98% which is better efficient than the traditional machine learning methods.

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BIOGRAPHIES

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