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Crop Disease Detection using Image Classification based on Deep Learning

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Abstract - Crop diseases affect farmers worldwide, reducing crop yields and coming about in critical financial misfortunes.For effective disease management, early detection and accurate diagnosis of crop diseases are crucial, but traditional methods of disease identification can be labor-intensive and time-consuming. Recent developments in deep learning and computer vision have shown great potential for automating the detection and diagnosis of crop diseases. Deep learning models can analyze large volumes of image data and automatically learn to identify symptoms of the disease, to diagnose crop diseases in the field in a timely and accurate manner. Developing a deep learning model for crop disease detection, an extensive set of tagged image data of healthy and sick plants needs to be collected.

The dataset is utilized to prepare a deep learning demonstration, such as a convolutional neural network (CNN), to consequently extricate highlights from pictures and classify them as solid or unhealthy. Once the demonstration has been prepared, it can be utilized to classify unused pictures of plants as healthy or infected and recognize the particular illness influencing an unhealthy plant. This could offer assistance to agriculturists and rural specialists to rapidly and precisely distinguish trim diseases and take suitable activities to oversee them. In conclusion, deep learning-based crop illness discovery may be a promising range of investigation with the potential to essentially move forward the productivity and viability of crop disease administration. With advanced inquire about and advancement, it may be conceivable to make vigorous and solid deep learning models that can be conveyed in real-world agrarian settings, giving agriculturists with the instruments they got to secure their crops and jobs.

1.INTRODUCTION

India is growing quickly, and farming is very important for its early development. Farms are having a hard time keeping up with the increasing number of people in the world. In addition, teaching young people that growing things is important. Changes in weather, decrease in helpful insects, damage to crops by bugs, not enough water, and other things still cause problems. Ensuring there is enough food for everyone to have access to. Crop sickness makes less food and lowers its quality. Crop diseases are a problem. Changes in global agriculture not only affect the world's food supply, but also harm small farmers. Whose way of making a living relies on growing things without danger. Farmers can keep an eye on plant diseases with this technology. Finding them as soon as they show up on the plants. We figured out a good way to solve the problem. This problem got solved because of the internet and computer vision. Misidentifying a plant disease can lead to reduced crop yield, longer growth periods and altered cultivation practices. Make the products good. It is important to know the condition of a plant to grow it well. Different kinds of stuff. Issues with the environment, like mold, not enough water, bugs, and unwanted plants, can harm crops. Farmers need to do things beforehand to improve how much they can grow. This study helps to focus on how crops look. Artificial intelligence is getting better and smarter. It's now possible to detect plant diseases just by looking at pictures of plants using technology. Deep learning is a form of learning. A system that works using brain-like networks. important patterns and features from large amounts of data, without the need for explicit programming by humans. Photographs contain diverse objects and subjects to look at. When getting ready, the computer brain learns how to find important parts. CNN is an improvised machine learning technique that emulates the human brain by having multiple layers.

2. RELATED WORK

Wallelign, S., et al. in 2018 [1] discussed the viability of convolutional neural network architecture for the classification of various plant diseases with the aid of leaf images. The mentioned framework is implemented by utilizing the LeNet, one of the popular CNN architectures, for disease classification in the aspect of soybean plants. The soybean plant leaf images of 12,763 samples are obtained from the standard database called PlantVillage. The mentioned framework is able to achieve an accuracy of 99.32% indicating the viability of CNN with plant disease classification utilizing the leaf images.

Arivazhagan, S. and Ligi, S. V. in 2018 [2] proposed a framework based on automated deep learning for the recognition and classification of various diseases in mango plants. The dataset utilized for this framework consists of 1200 images which include both diseased and healthy leaves of mango. The accuracy obtained from the proposed framework is 96.67%. Oppenheim.

Fuentes, A., et al. in 2017 [3] proposed a framework and can be applied in two stages. At first, the meta architectures of Faster R-CNN, R-FCN, and SSD will be combined to form a single meta-architecture. Lastly, certain methodologies such as VGG16, VGG-19, and ResNet50 will be attached to extract the features from more depth and these models' efficiency was estimated. When compared to many other models, the proposed framework efficiency is better.

Sladojevic, S., et al. in 2016 [4] concerned the generation of the new-age model for the identification of various diseases of 13 plant diseases out of the healthier plant leaf images. The deep learning architecture called Caffe was utilized for training the data. The results were obtained from the mentioned framework with a precision of 91 percent to 98 percent.

"Plant disease detection based on deep learning" by Sardogan, M., et al. in 2018 [5] presented a model with a combination of convolutional neural networks (CNN) along with learning vector quantization(LVQ) for the identification and categorization of diseases of tomato plant leaves. The presented framework was implemented on the data size of 500 images with the four categories of diseases considered for tomato plant leaves. The convolutional neural network is utilized for the extraction of vital attributes from the images as well as for the classification.

3. OUR APPROACH

This study is concentrated on the identification of plant conditions. The segmentation, attribute extraction, and classification approaches are used to determine plant conditions. Snapshots of leaves from varied plants are taken with a digital camera or resembling unit, and the pictures are used to categorize the affected area in the leaves. To determine plant condition, we use a Convolution neural network in the proposed architecture. This paper proposes an architecture that employs low- cost, open- source software to achieve the task of reliably detecting plant disorder.

3.1 Convolutional Neural Network

A Convolutional Neural Network, is a category of neural networks that makes a speciality of processing information that has a grid-like topology. A digital picture is a binary representation of visual records. It contains a chain of pixels organized in a grid-like fashion that includes pixel values to indicate how brilliant and what coloration every pixel ought to be. Convolutional Neural Network is a Deep Learning classification algorithm that takes an image as an input, extracts the features and assigns importance to various objects in the picture.

3.2 Keras Layer

The fundamental component of Keras models is the layer. Each layer gets information as input, processes it, and then outputs the updated data. The output of one layer will serve as the input for the following layer.

3.3 Flatten Layer

The input is flattened using a flatten layer. Flatten makes the following defense.

keras.layers.Flatten(data_format = None)

3.4 Dense Layer

The dense layer is the typical layer of a neural network with many connections. It is the most typical and regularly utilized layer. Dense layer performs the operation below on the input and then returns the result.

output = activation(dot(input, kernel) + bias)

3.5 Dropout Layer

One of the key ideas in machine learning is dropout. It is applied to address the overfitting problem. Input data may contain some undesirable information, commonly referred to as noise. Dropout will attempt to exclude the noisy data in order to avoid overfitting the model.

The three main defenses of Dropout are as follows.

keras.layers.Dropout(rate, noise_shape = None, seed = None)

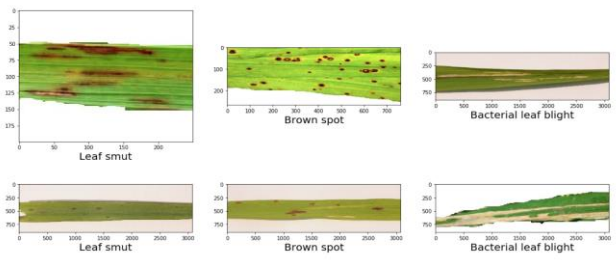
3.6 Rice Disease Dataset

This dataset consists of 241 images of disease infected rice leaves. The images are grouped into 3 classes based on the type of disease, namely Leaf smut, Brown spot and Bacterial leaf blight, Ref. Figure -1.

3.7 Image Segmentation

A photograph is a set or set of different pixels. We group collectively the pixels that have comparable attributes the usage of image segmentation. Image segmentation is the technique of filtering or categorizing a database of snap shots into instructions, subsets, or regions primarily based on precise functions or characteristics. Photograph segmentation creates a pixel-clever mask for each object in the image. This method gives us a miles more granular knowledge of the item(s) within the photograph.

Figure -1: Sample Dataset



3.8 Feature Extraction

Feature extraction refers back to the technique of remodeling raw records into numerical functions that can be processed even as retaining the information within the authentic facts set. It yields higher effects than applying devices to get to know immediately the uncooked facts.

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4. RESULTS

4.1 Training and Validation datasets

We analyzed 241 RGB images of three common diseases, namely Leaf smut, Brown spot and Bacterial leaf blight. Validation data is recommended to be used for optimal hyper-parameters to prevent the overfitting of the model.

4.2 Model Summary

Building CNN model using Keras layer, Flatten layer, Dense layer, Dropout layer, Ref. Figure -2.

Layer (type)	Output Shape	Param #
keras_layer_5 (KerasLayer)	(None, 2048)	21802784
flatten (Flatten)	(None, 2048)	0
dense (Dense)	(None, 512)	1049088
dropout (Dropout)	(None, 512)	0
dense_1 (Dense)	(None, 3)	1539

Total params: 22,853,411
Trainable params: 1,050,627
Non-trainable params: 21,802,784

Figure -2: Model Summary

4.3 Effect of epochs

The epochs up to 30 are used to train the CNN model. The best tuned epoch is 30, since there are no further improvements in training and validation accuracies found. Figure -4 refers to the Training and Validation Accuracies and Training and Validation Losses, resulting in 96.77% accuracy.

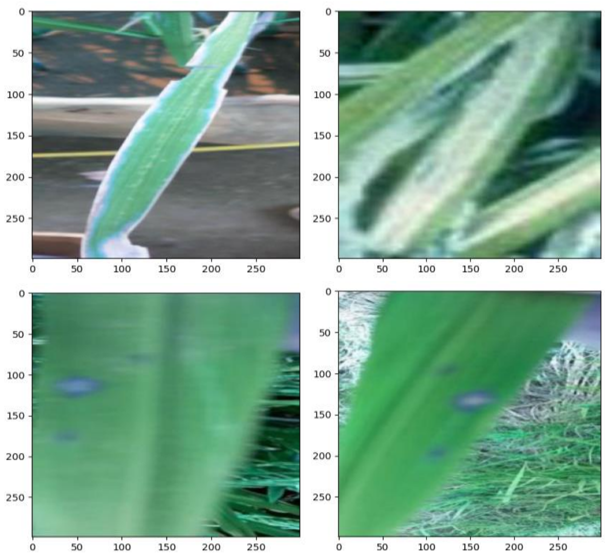

Figure -3: Sample Outcomes

Figure -3 refers to a few examples of misclassified images found by our CNN-based model.

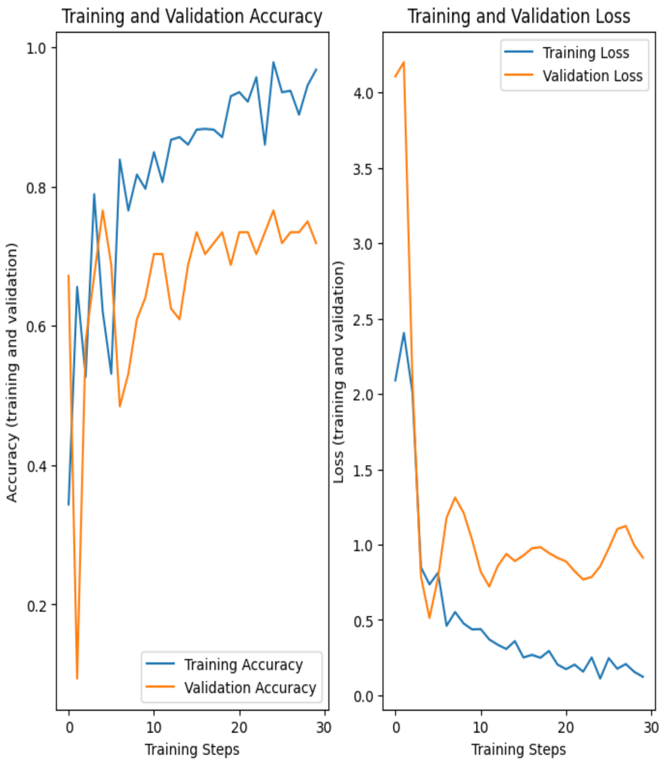

Figure -4: Graphs

5. CONCLUSIONS

Here in this paper, we have developed a custom CNN model that can identify three common rice leaf diseases that are commonly found. Our model is trained to classify the rice leaf diseases in different backgrounds. Our model achieves 96.77% accuracy, additionally we aim to improve the robustness of our model by testing on different datasets from across the world. In conclusion, the proposed model identifies the cultivated field on a regular basis. The CNN-based model is used to identify crop diseases at an early stage.

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