Indian Journal of Ecology (2020) 47 Special Issue (11): 197-201

Manuscript Number: S-413
NAAS Rating: 4.96

Detection Process for Disease Recognition of Paddy Crop using Deep Learning

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Abstract: Paddy is one of the focal farming produces in India. But, various diseases on paddy crop are decreasing the amount of production and its eminence. The early exposure of diseases on paddy crop will help in preventing severe crop loss and also severe spread of the diseases. Recently, drones technologies have been used in agriculture with the camera and sensors for monitoring and collecting the information regarding crops. Most recent advancements in the field of deep learning techniques helps in detecting and diagnosing diseases in crops with the help of images which were taken using a high digital camera for identifying and distinguishing numerous categories of crop diseases. This paper offers a proficient elucidation for identifying various paddy crop diseases. The system was designed in a way that it can help to identify and distinguish several diseases of paddy crop. The designed system accomplished the deep learning models to identify and distinguish various diseases in paddy crop. The deep learning model has attained a precision amount of 93.65% and the system was able to catalogue 94% precision in identifying and recognizing the variety of diseases by which the crop was infested.

Keywords: Paddy crop, Deep learning, Convolutional neural network, Pooling layer, Image processing, Disease identification, Disease cataloguing

In India nearly 70% of the residents makes livelihood based on the farming practices. Numerous technologies and studies were urbanized to deliver smart agricultural systems and enrich the quantity and quality of productivity. In order to overcome the requirement of growing population, it is required to create a major advancement in agricultural productiveness. Rice is the most common vital food for the people in India. Aiming on paddy crop disease management is important to analyze the occurrence of paddy crop diseases such as Brown spot, Sheath blight, Leaf smut and Bacterial leaf blight.

These diseases terminates 10 to 12 % of production in India. So early detection of these diseases is very important to achieve a proficient production. The existing method of disease detection is a manual approach which takes a lot of time. Apprehending the images of infested leaves and process those by using an automated system could be a smart solution for farmers. Many number of Image processing techniques are regularly using in agricultural sector for the exposure, detecting and analyzing disease invasions of plants. At present, deep learning methods are becoming popular in this area.

Deep learning is a subclass of Artificial Intelligence. It is a progressive and innovative technique which makes use of a popular mechanism called neural networks. A neural network is popular among various deep learning modules which are extensively using with the combination of image processing technique. A CNN with minimal procedure will identify as well as catalogue. It is proficient in assessing images and the features needed by using its layered structure. The CNN comprises of 4 layers which are images as input, convolutional and pooling layers, fully connected layer and finally the required output image.

MATERIAL AND METHODS

Convolutional layer: Convolutional layers are dissimilar which contains a stable number of weights directed by the optimal number of filters but not dependent on the size of input. For each filter there is an individual weight for each position of its shape. So using 2 - 3x3x3 filters, have 54 weights in total without counting the bias again. Figure 2 and Figure 3 shows convolution layer operation for an input image (5x5) with a resulted filter (3x3) which will be comprised into a smaller size by varying the higher left corner filter of the given image. Then the acquired values are multiplied by the values of filter which will be the final result. Finally, a new compact sized matrix is designed based on the input image.

Pooling layer: A pooling layer is one of the significant building blocks of a Convolutional Neural Network. The focal objective of this pooling layer is to gradually decrease the spatial size of the image to reduce the quantity of parameters and computation work within the network. Pooling layer works on each feature map unconventionally. Figure 4 elucidates the max pooling operation and Figure 5 represents the inception module.

Activation layer: The activation Layer is in charge for

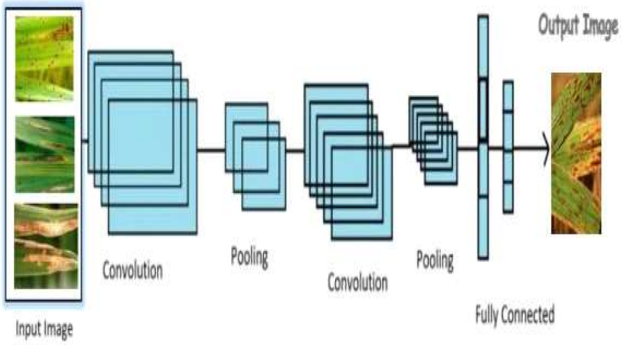

Fig. 1. CNN architecture

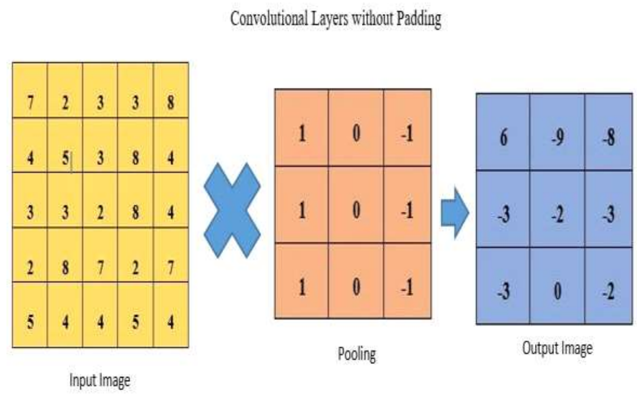

Fig. 2. Operation of convolution layer without padding

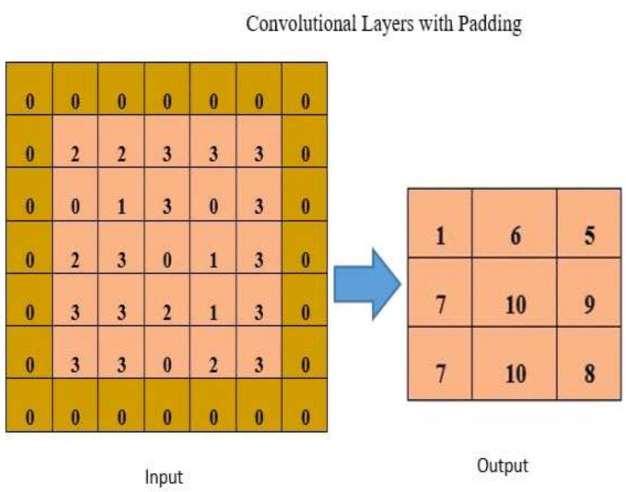

Fig. 3. Operation of convolution layer with padding

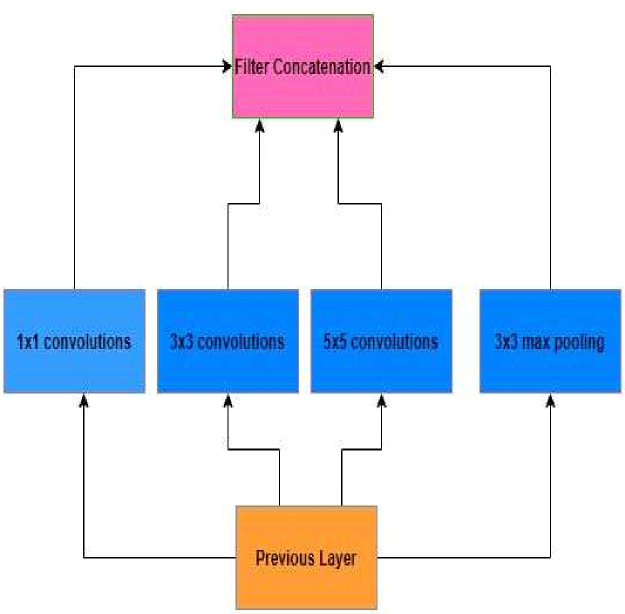

Fig. 4. Pooling operation

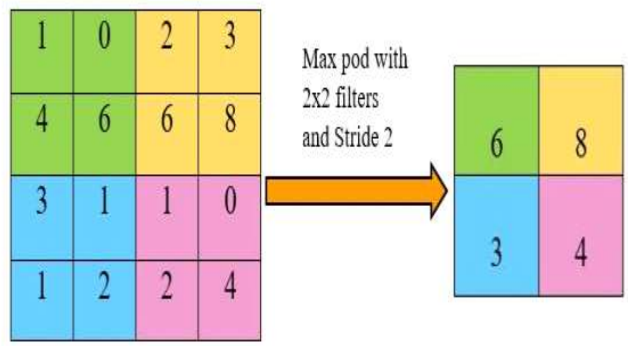

Fig. 5. Naïve inception module

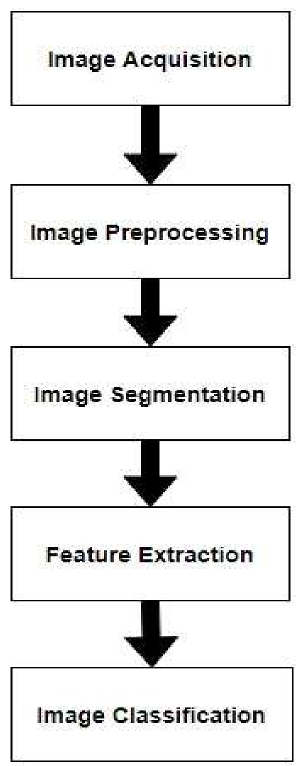

Fig. 6. Paddy crop leaf detection process and disease recognition

converting the summed weighted input from the node into the stimulation of the node or output for that input.

Fully connected layer: The input for this fully connected layer will be the output from the final pooling operation or convolutional layer, which is compacted and then fed into the fully connected layer.

APPROACH

A block diagram in Figure 6 represents Acquisition of Images, Image process and disease recognition

Image Processing

Image acquisition: A dataset is prepared based on our own image database, which involves image acquirement from different farms along with some available datasets.

Image preprocessing: For best results, image preprocessing is essential for the reason that dirt, pest's mucks on the leaves which falls under the category of image noise. Moreover, the images which we captured may have some distortion of shadow effect, lighting problems and water droplets will generate complications in the process of segmentation and required feature extraction. We can remove such types of distortion with the help of different noise removal filters and for the captured images which are of low contrast can be improved by using image contrast enhancement algorithms. All of this Pre-processing enhances the image to its desirable color scale.

Image segmentation: Image segmentation is very much essential in detecting plant diseases. In this, the main task is to split the image into individual regions for analyzing the data for extracting the required features. The image segmentation is constructed on either discontinuities or similarities.

Feature extraction: In this extraction, the main focus is to identify features of objects present within an image based on color, shape, texture and contrast. Based on the color and contrast it will be easy to distinguish one disease from other. Moreover, these diseases have dissimilar shape which helps the system to segregate diseases using shape features and different color patterns.

Image classification: Classification makes use of a fully connected layers for extracting the required features with the help of convolutional and pooling layers. In this classification process, we can able to classify the rice plant leaf whether it is infected with the disease or not and also recognizes the disease type.

The dataset be made up of nearly 3,000 images containing 4 types of paddy crop diseases. An Interface is designed using Python and Keras CNN. Image augmentation techniques for Deep Learning using pyTorch were incorporated with the application to enrich the image dataset by cropping, flipping and rotating them horizontally and vertically while keeping our original dataset.

RESULTS AND DISCUSSION

An accuracy rate of 92.5% was achieved while training our model. It also attained a 96% determined precision rate when testing the diseased paddy crop leaves.

The dataset has 3000 images in which around 2500 were used for training the model and remaining were used for

Fig. 7. Different types of paddy crop diseases

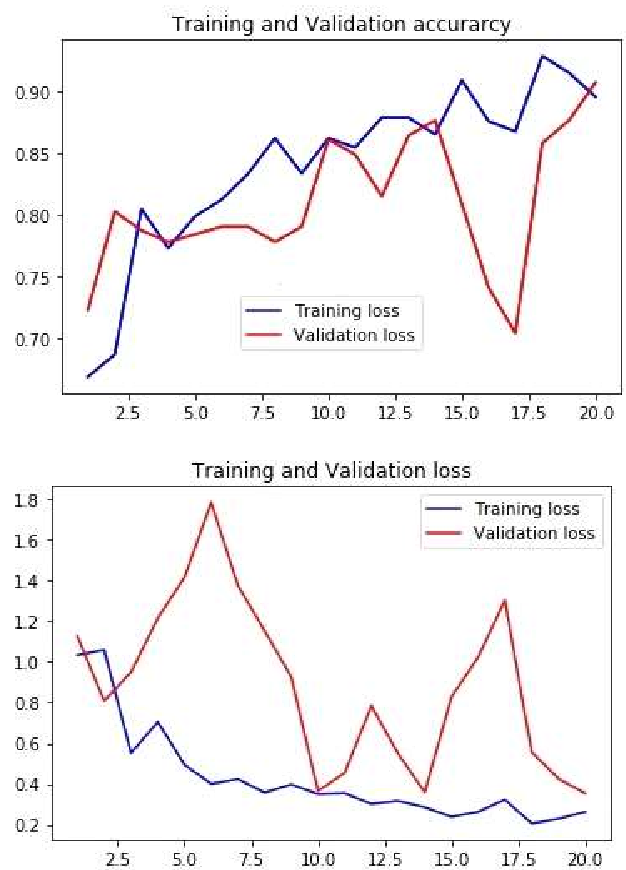

Fig. 8. Training and validation Accuracy & loss

validating the model. The training and validation accuracy along with loss (Fig. 6) illustrates that the designed model was trained for about 20 epoch and how the accuracy varies within each epoch. At epoch 18, we observed that the model has its best accuracy with 91%. We save and use the model at its best epoch point.

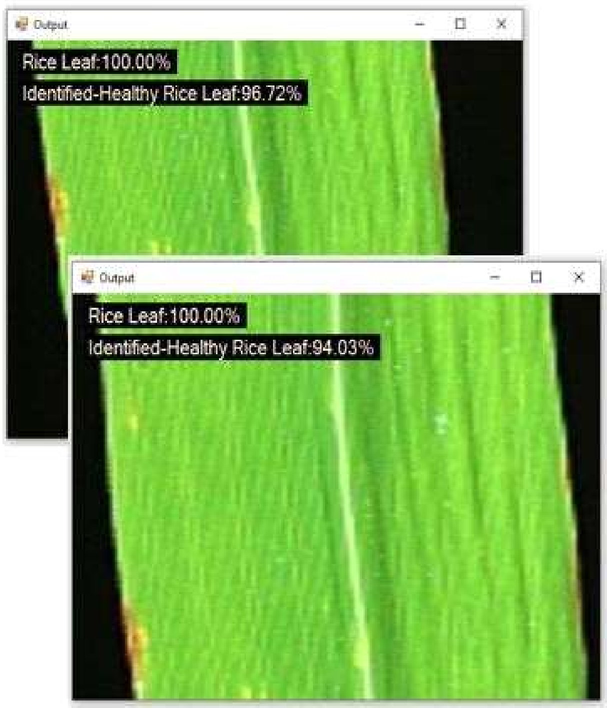

Fig. 9. Identification of a paddy crop leaf

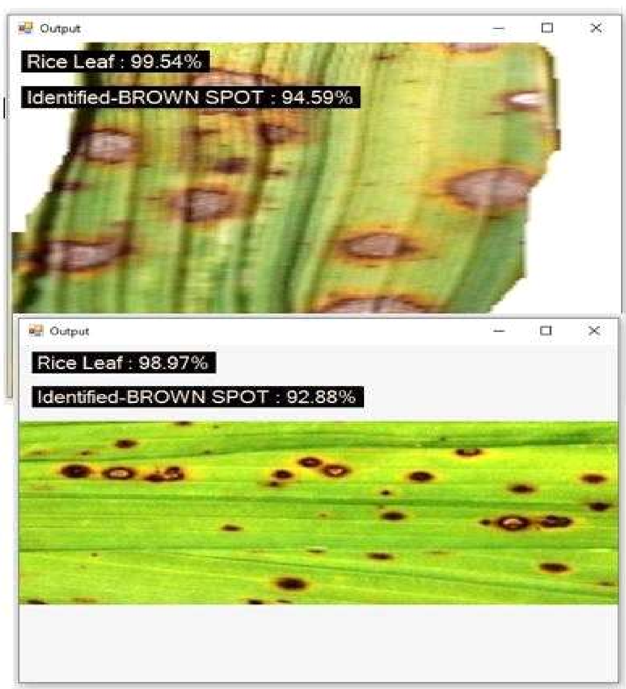

Fig. 10. Identification of brown spot disease

The designed model is efficient in identifying the paddy crop diseases with an accuracy rate as follows:

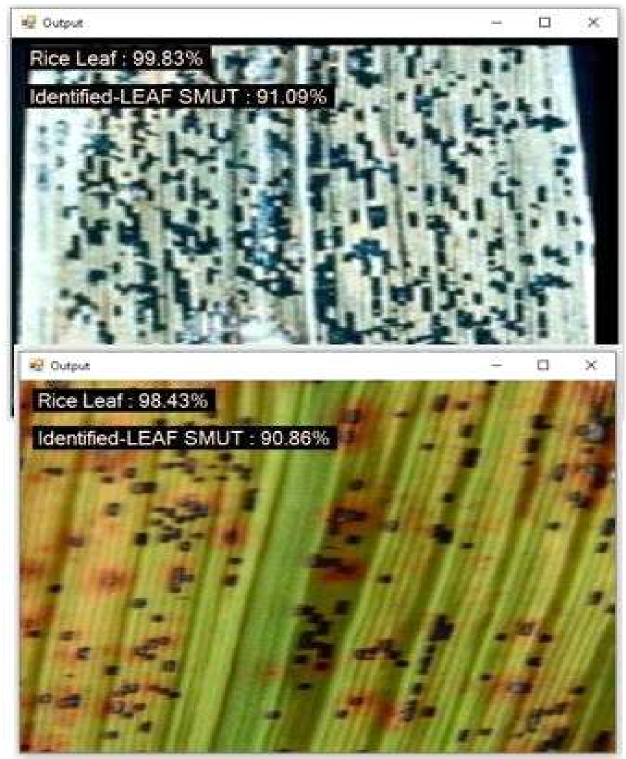

Fig. 11. Identification of leaf smut disease

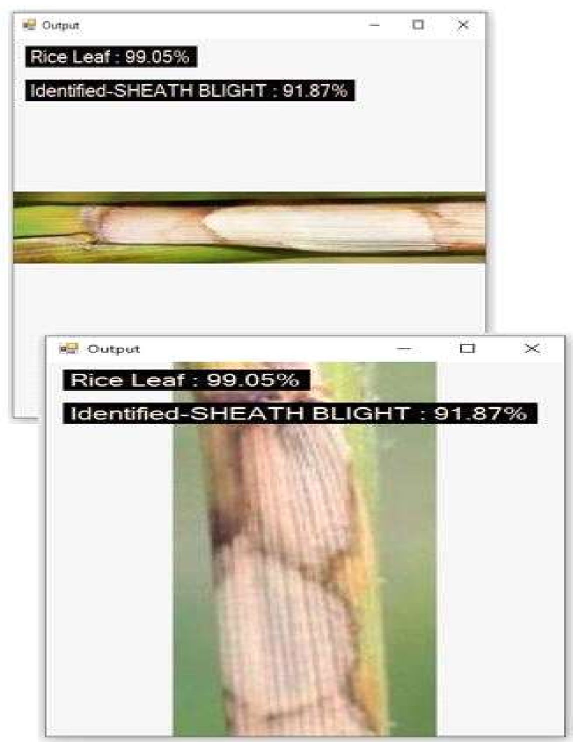

Fig. 12. Identification of sheath blight disease

Table 1. Accuracy rate results

Figure	Sample	Identification of paddy crop leaf with accuracy rate (%)	Identification of disease with accuracy rate (%)
Figure 9	Sample 1	100.00	96.72
	Sample 2	100.00	94.03
Figure 10	Sample 3	99.54	94.59
	Sample 4	98.97	92.88
Figure 11	Sample 5	99.83	91.09
	Sample 6	98.43	90.86
Figure 12	Sample 7	99.05	91.87
	Sample 8	99.05	91.87
Figure 13	Sample 9	99.78	91.87
	Sample 10	97.65	92.06

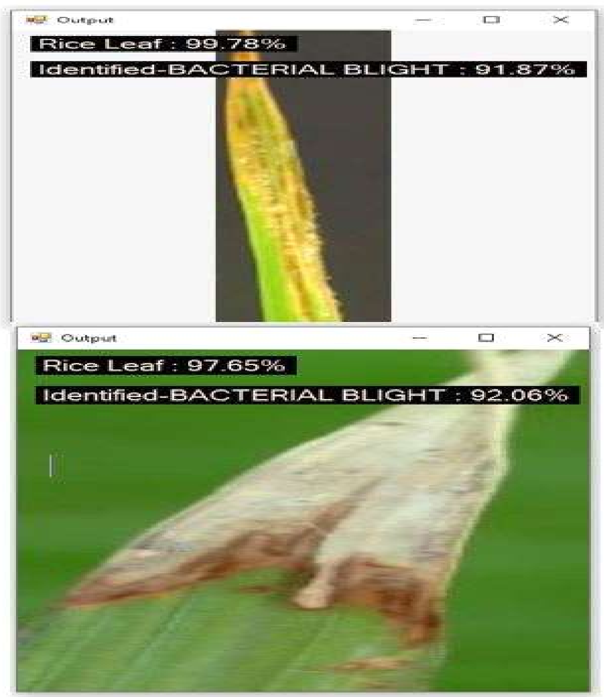

Fig. 13. Identification of bacterial leaf disease

CONCLUSION

This System has accomplished its objective to detect and recognize paddy crop and their major diseases using CNN which helps for testing the real-time paddy crop leaf images to identify and distinguish the diseases. For the forthcoming work, same system can be implemented for various plants and diverse types of diseases by including the data into current dataset to escalate the trained models. With the achieved accuracy rate of 92.5% for detecting and recognizing the diseases, the projected model can support and assist the farmers to identify and recognize the paddy crop diseases.

Received 28 March, 2020; Accepted 30 June, 2020

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