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CNN based Crop Leaf Disease Detection

Gitanjali Yadav, Ashwini Nawadkar, Prema Desai

Assistant Professor, Dept. of AI & DS, VIIT, SPPU University, Pune, Maharashtra, India

Assistant Professor, Dept. of AI & DS, VIIT, SPPU University, Pune, Maharashtra, India

Assistant Professor, Dept. of AI & DS, VIIT, SPPU University, Pune, Maharashtra, India

ABSTRACT: Agricultural countries like India the manifestation and dominance of plant disease varies periodically depending upon the environmental conditions, the types of plants and the variations grown. Increase in pollution, climate change causes the contamination to crops which leads to reduction in productivity. The crop infection detection needs deep acquaintance of disease and its resolutions. The Convolutional Neural Network with different layers is used to train the model and Android application is designed for easy and early infection detection for farmers as a user interface. The contaminated crop leaf will be captured and that captured image will be compared with the pre-defined database or trained datasets. The evaluation will give accuracy of the model nearly 95 %. The infection detection is evaluated and crop infection is shown in the results.

KEYWORDS: CNN;ReLU; Convolution; Crop leaf Disease.

I. INTRODUCTION

India is known as emergent economic colossal but the profit of this growth are mostly restricted to urban or semi-urban areas. More that 65% of population of India lives in rural areas and the earning source is agriculture. As we know, because of escalation in pollution the crops gets infected which leads to decrease in productivity. The pollution affect the crop leaves with different diseases and it is quite difficult for farmers to detect it and do some remedies at earlier stage of it. India's weather varies and there is great variety in ecosystem. India is the leading producer of the Banana in the world. The yearly production of Banana is nearly 11 million tons a year. But now a days the production rate decreases day by day because of infection.

In this paper, we presented the research work on a tomato and banana crop leaves. Mostly the typical weather affects the tomato crop leaf and banana so we hope that this research will help a farmer. This research work will help a farmer to increase the growth rate of crops without any infection by detecting it at earlier stage. This will in turn also help to increase the production rate and profit. This android application interface is very user friendly and easy to handle, as no prior technology knowledge is required to use the system.

II. RELATED WORK

Though there are abundant number of researches has been done for detecting plant diseases using CNN, Computer Vision and image processing and computer vision most of them have failed to detect the crop leaf diseases efficiently. In this reference research paper, they did the detection of stem disease of jute plant which is the India's top cash crop. In this work they used the Hue based segmentation for image processing and did classification using SVM algorithm. Their system works for disease detection of stem of plant, but not tried for leaves. [1]

The system by Pranali K. Kosamkar, used Convolutional Neural Network algorithm for classification of crop leaf image. And also recommending pesticides using Tensor flow. They built a system with android application using Web services and deep neural network. [2]

In this review paper we studied that the plant image processing is used for the detection of plant diseases. For disease detection different processes like image acquisition, image pre-processing. This paper also discussed some segmentation and feature extraction algorithm used in the plant disease detection. [3]

In this research paper, different algorithms are discussed for detection of object, like R-CNN is applied to the candidate box for feature vector extraction. SPP-Net removes the restriction on network fixed size. Fast R-CNN and Faster R-CNN improves the speed of training deeper neural network as compared to R-CNN. [4]

III. PROPOSED SYSTEM OVERVIEW

The system is designed by keeping in mind that the client may not have a technical knowledge to operate it. The system will capture the image of infected crop plant leaf and gives the result to client as is it infected and which disease is this.

This process involves the following steps:

1. Image Acquisition:

The system is trained by using images stored in the database. Once the model is built it is ready for testing the images. For testing the model one can capture the image of the leaf using mobile camera.

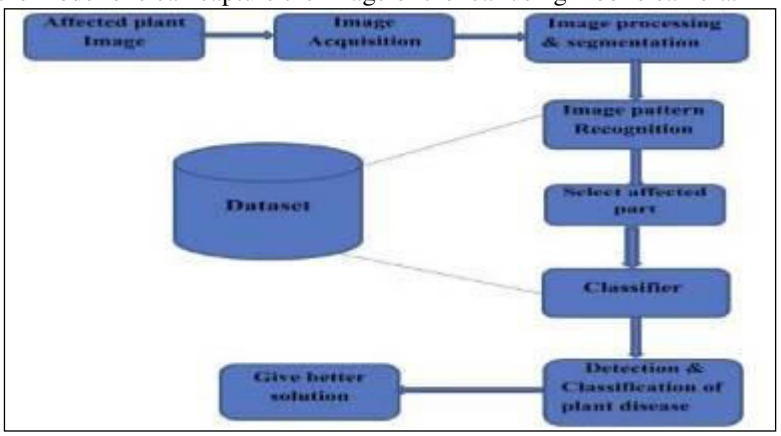


Fig.1:-System Overview

2. Image preprocessing and segmentation:

To prepare image data for system model data preprocessing of image is necessary. Image preprocessing helps us to remove unwanted deformation and improve specific qualities that are important for our system. For example, in convolutional neural networks fully connected layers need all images in array of same size. Also preprocessing causes speed up of model performance.

3. Image pattern recognition:

This is also called as feature engineering in machine learning. To recognize any image, system must learn their features as well as patterns present in image. Patterns means the repeated trends in various types id data. Such patterns can be identified by applying some statistical methods. Image recognition algorithms use neural networks to label the images, so that user can easily search and compare the images.

4. Select the affected part:

After recognizing the patterns of crop leaf, the infected part of leaf is detected by system.

5. Classifier:

Basically Convolutional neural network (CNN) is used for image classification. With traditional Artificial Neural network(ANN) it is very expensive in terms of computation. For example suppose we have 50x50 pixel image to classify. Now the trainable parameters become (50*50) * 100 image pixels multiplied by hidden layer + 100 bias + 2 * 100 output neurons + 2 bias = 2,50,302. So comparing to this CNN gives better performance by using the filters.

IV. SYSTEM IMPLEMENTATION

The proposed system is developed for two particular crops that is Banana and Tomato. The process starts with the capturing the affected image of crop leaf. It is a first phase of image acquisition. That captured image is then passed for the image segmentation and processing. The captured image is compared with pre-trained dataset of images. The affected image is then processed and gives the result as a class of disease provided with its solution. For training the model multiple numbers of images of affected crop leaf and a healthy plant. In testing phase, the one affected image

is given as input for classification and the test is done properly. When the affected image is tested, if such disease is present in the dataset it returns the label of that disease. We get the result after that the disease solution recommendation is done.

1. CNN Algorithm:

CNN as a machine learning algorithm takes the images of Banana and Tomato , assign the learnable weights and

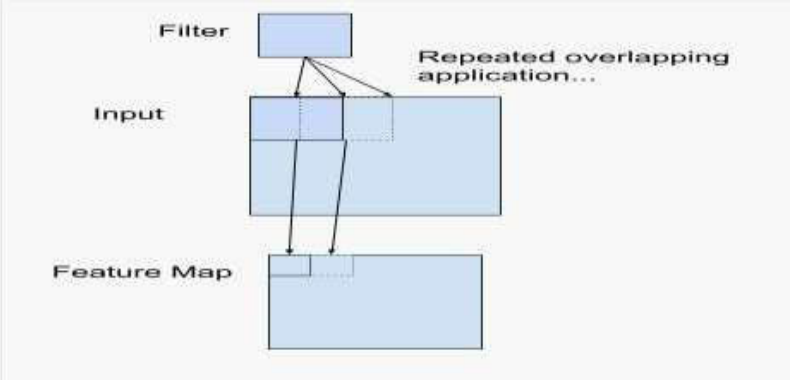
Fig.2:-Sample image from dataset.

biases to various aspects of the image and differentiate it from the other.

I] The first step of CNN is to extract the features of images.

Ii] The input to CNN is a gray scale image.

Iii] The output of the network is the multiclass output (i.e types of diseases).



.

Fig.3:-Convolution layer filter.

Basically Convolutional neural network is thesimple feed forward network. It has two or more hidden layers. It works with two dimensional as well as three dimensional data. The image given as an input is passed through a sequence of convolution layers along with pooling and fully connected layers called as filters or the kernels. Every image in CNN is represented as an array of pixels.

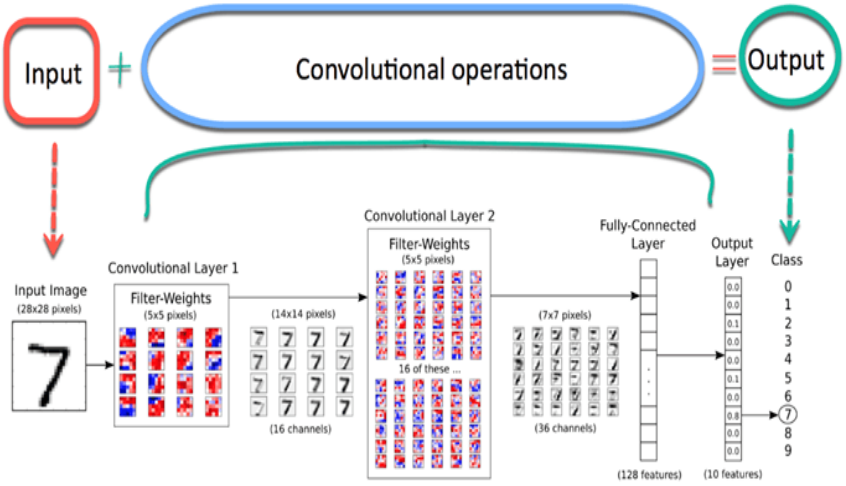


Fig4. Convolutional operations

2. Convolution:

In the process ofconvolution the features of an input object are extracted on the image locally. That is, the network will learn exact patterns within the picture and will be able to recognize it everywhere in the picture. Element-wise multiplication is done in Convolution. The system will scan a part of the image, typically with a dimension of 3×3 and multiplies it to a filter. The output of this element-wise multiplication is called a feature map. Until all the image is scanned, the step is repeated. Thus convolution reduces the size of image.

The output will be of different size than the input, so here you need to do padding. Due to this padding you will get right number of rows and columns in each matrix.

Convolution takes three parameters as given below:

i. Depth: It is the number of filters used in convolution.

ii. Stride: It gives the number of pixel jumps between two slices. If it is 2 means, window will jump by 2-pixels.

iii. Zero-padding: Padding concept is used to match the number of rows and columns of input and output convolved images. If the dimensions are same , then no padding is required.

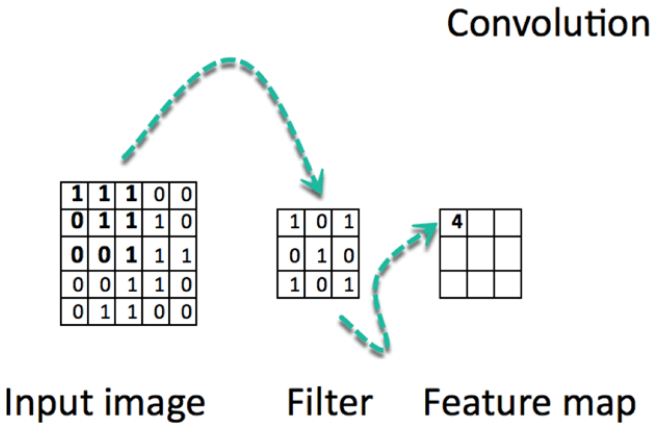


Fig5. Filter map generation

3. ReLU:

Generally, in neural networks the activation function is used for summing up the weighted input from the node into the activation of node or output of that node. So the output may be positive or negative.

But in ReLU (Rectified linear activation function) every negative value from the filtered images is replaced with zero. This is done to avoid the values from summing up to zero.

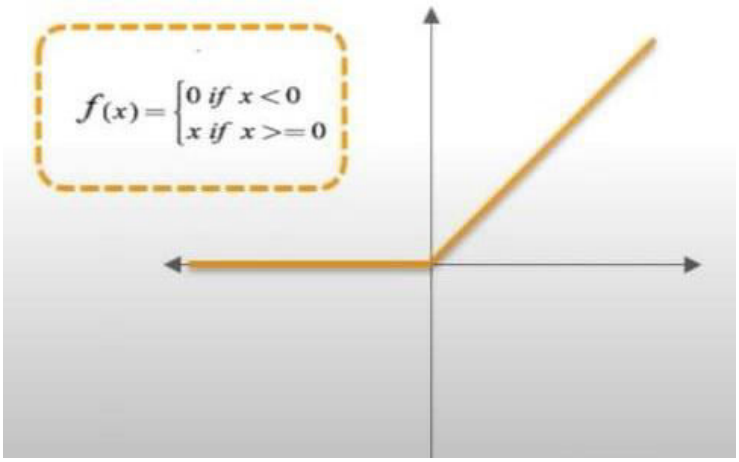


Fig.6. ReLU function

4. Pooling Layer:

The Pooling process allows us to introduce spatial variance. There are different types of pooling like sum pooling and mean pooling but we have used the max pooling in our system.

Pooling actually helps to transform a feature map into a pooled feature map, which is smaller in size and is calculated based on the original feature map .

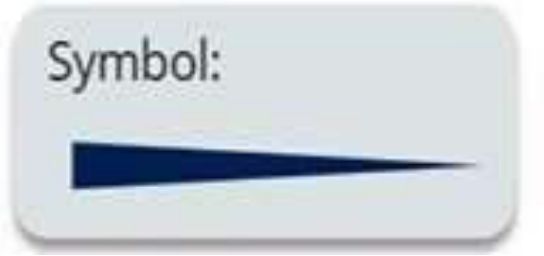


Fig7. Shrinking symbol

Stacking up the layers got the 5*5 matrix and adding one more time that here layer than got the 3*3 matrix it shrink that image from 5*5 to 3*3 matrix.

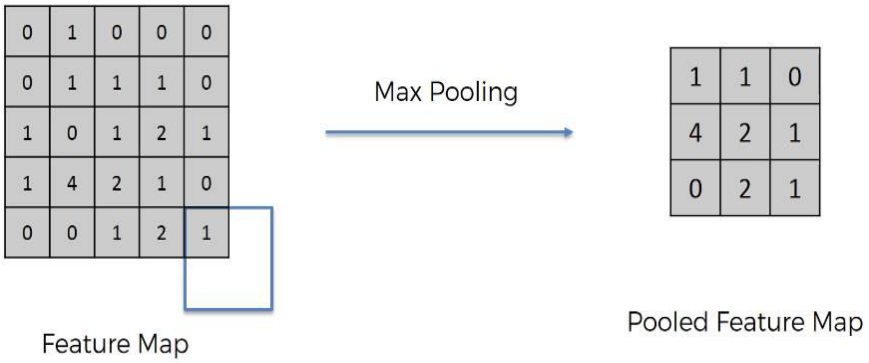


Fig8. Max pooling

5. Fully Connected Layer:

This is the final layer where the actual calculation is done. Here we took the shrink image and put it into a single list which is a 12 element vector. The output is same as we get while training phase.
Whenever new image is input the comparison is done with trained values.

6. Mathematical Model for system:

Let,S={I,F,O,F',S}.
S be Closed system defined as, S = I, F, O,F',S.
To select the input from the system which is{I} and perform various actions.
Function={F1,F2,F3,F4,F5}
Where,

- F1-Image Acquisition
- F2-Image Processing and Segment.
- F3-Pattern Recognition
- F4-Classification of plant disease
- F5-Result Output= {O1, O2}

1. O1-Classification of disease of captured crop leaf.
2. O2-Solution of disease ofcaptured plant leaf if disease is detected on leaf.

V. CONCLUSION

In this work we developed the android application achieve to find out the banana and the tomato crop leaf disease with the help of CNN algorithm. Also we are providing the solution for disease. Here, the user can check itself whether a crop leaf is healthy or not and achieve the good food. So that user can take preliminary actions for the infection.

VI. FUTURE SCOPE

Our system is limited for only two crop leaves. In future we will try for the more crop leaves disease detection with solution. Also can give the explanation for the result of system, using explainable AI concept, so that more users can trust on the system.

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