ISSN: 2455 - 1597

ijergs
Open Access

International Journal of Engineering Research and Generic Science (IJERGS)
Available online at: https://www.ijergs.in

Volume - 7, Issue - 4, July - August - 2021, Page No. 01 - 11

Automated Disease Detection in Crops Using Convolutional Neural Network

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Abstract

The automated disease detection in crops using convolutional neural network is useful to detect and identify infected or diseased leaves of crops. This is a technique that widely useful detect diseased crops to increase the productivity of crops and efficiently detect infected or diseased leaves. The convolution neural network and artificial neural network process captured image and it take captured image as an input then, it create featured mapping of image and subsampling of image and at last it's process by output layer. ANNs is the combination of three layers to process and detect disease in crops like input layer, hidden layer and output layer. It is also cover different classification of neural networks and it's different processing types like SLP, MLP, RBF, SOM and CNN. After that there is used different classifiers to generate classification of infected images of leaves. Image segmentation and image enhancement which is play very efficient role to detect and identify disease in cropsandleaves diseases, is processed by using convolution neural networks.

Keywords: Convolution, Neural networks, Image processing, ANN, Deep learning

Introduction

To increase economy of the country agricultural productivity plays an important role. To increasing the productivity of crops it is necessary that crops are not affected any disease. That's why to detect diseases in crops automated disease detection technique is useful. A disease detection techniques very useful to detect disease in crops using convolution neural network and image processing techniques [2].Anconvolution neural networks are efficient technique to process crops leaves and detect diseases of crops. Images of leaves are taken by digital device like cameras and other digital device for detection disease in crops. The infected or diseased leaf further processed by image processing and then by convolutional neural network. This technique is useful for continuously observing crops to analyse diseased crops and healthy crops. For the processing of this system, it is trained using dataset that contain the different class of leaves and infected images of leaves and after that model is ready to detect disease in crops [4],[5].Crops leaves disease detection by visual and digital way is accurate and meaningful but it is useful in limited areas because neural network is developed using dataset data. The data can be area oriented that's why to developed efficient model and technique that can access and more accurate for any area. Whereas if automated disease identification techniques is taken to detect crops infected leaves it would more efficient in efforts, timing and identify more precisely. In crops, several commondiseases that not area specific it could seen every area and every season. These diseaseseen are brownish and yellowish marks, early and late scorch, and other are bacterial infected diseases. Image processing and convolution neural networks are in process for identifying infected area of disease and to gather information about differences in the infected crops of the affected

areas[1],[6].Artificial neural network have three layer. These layer are used to detect and process the captured images of diseased crops. After the processing of infected leaves, identify diseased leaves and it's diseased type like bacterial, fungal, scorch etc. The image processing is used to detect infected leaves and it perform image segmentation and image enhancement to identify diseased leaves.Many system proposed or developed to process to detect disease in crops using image processing and other models. These technique is efficient to reduce the task and problems that faces during detection of diseased crops. But, now classification tools are developed like neural classifiers that efficient and more accurate to identify and detect diseased crops that reduce productivity of crops and infect other plants or crops.

Datasets And Techniques

The whole process of designing the model for crops leaves disease or infection identification or detection using convolution neural network is explained. The whole process for detection of crops disease is divided into several necessary stages that classified various sections and subsection, to gathering various infected images for detection or classification process using convolutional neural networks [17].

Dataset

The appropriate dataset is required for detection or classification disease in crops using convolution neural network and ANN techniques. All the images is collected from download data from internet sources and other predefine datasets that used for other disease detection techniques that can be in different languages. The collected images that form a dataset were combined into 15 different categories. 13 categoriesrepresent crops disease that normally occurs in leaves, due to fungal and bacterial disease [17].In that order to collect or detect healthy leaves from diseased leaves of crops, that's why one extra category was combined in the dataset to detect healthy leaf. That category that contain images of healthy leaves for identification. One more category in the dataset that contain surrounding images which is favourable to obtain more precise information for classification and detection diseased leaves. Thus Artificial and convolution neural network trained using leaves images and identify healthy and infected leaves. Thecategory for surrounding pictures were collected from the Stanford background image dataset. After that in next phase, all the duplicate images are collected to detect and classify disease leaves develop python scripts and modules applying the comparing procedure. The scripts and modules that used to remove the duplicate images by contrasting the images data like naming, area, colour, infected part. At the last automatic model is easy to use for human being and other that can detect infected leaves easily.

In next phasecreate a dataset that contain segmented and augmented images of leaves. The trained model is used for detection and classification different features and extract information from dataset that contain all images of crops leaves. Therefore, to use augmented and segmented images increase the efficiency of neural network that extract features more accurately. Finally, a dataset that carrying 30880 picture data for training of neural network and 2589 images for extraction and authorization of leaves is produced [17].

Table 2.1 that contain all classes of images of leaves and diseases that normally occur in crops put jointly with the Number of original images and number of original or augment images for each category used to trained and validate data for the disease detection and identification model.

Table 1

Dataset for image classification and detection of leaf disease [17]

Class	Number of original images	Total number of images: original and augmented	Number of images from the dataset used for validation
(1) Healthy leaf	565	4523	331
(2) Pear, cherry, and peach, porosity	265	2124	152
(3) Peach, powdery mildew	108	1296	90
(4) Peach, Taphrinadeformans	152	1552	156
(5) Apple, pear, Erwiniaamylovora	232	2368	205
(6) Apple, pear, Venturia	183	2200	151
(7) Apple, powdery mildew	120	1440	118
(8) Apple, Rust	163	1960	163
(9)Pair, Gymnosporangiumsabinae	267	2142	185
(10) Pair, gray leaf spot	122	1464	198
(11) Grapevine, wilt	287	2300	114
(12) Grapevine, mites	250	2000	230
(13) Grapevine, powdery mildew	237	1900	183
(14) Grapevine, downy mildew	297	2376	201
(15) Background images	1235	1235	112
	4483	**30880**	**2589**

Processing Model Identify Disease In Crops

To detect the disease in crops, artificial neural network and convolution neural network is design to process leaves of the crops and identify the diseases into the crops. The neural network consist different neural network classifiers like BP

classifier, CP classifier, MLP classifier that used to classify and detect the disease into the crops. There are different mechanism to classify the neural network and it's processing ofHyperspectral data, which is given as follows:

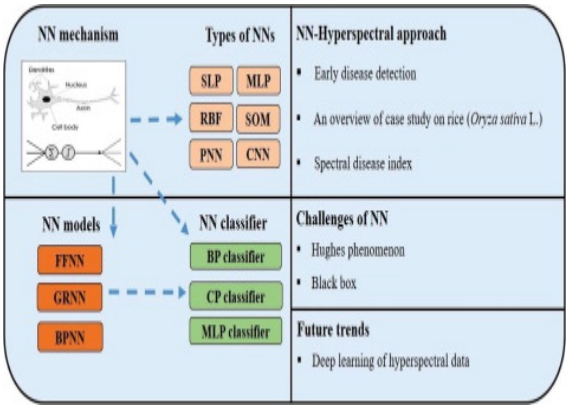


Fig 1: Neural network in crops disease detection

Procedure of neural network

Neural Networks (NNs) are mathematic classification based models which isused in data processing and data mining. According to fundamentals, Neural Networks are an interrelated networks of forks and it work aligned to the network of nerve cells in the human brain.In ANNs, every node which is allocated to the network act like a nerve cell like human brain.Normally, nerve cell of human brain collect the signals from other nerve cells via synapse link between these neurons.An artificial neural network has biological synapses and neurons that can be used to solve complex datasets. In neural networks, the nerve cells and synapses playsan major part, they receive and operate the input signal and generate the output [8], [9].An ANN is a feed-forwarding mechanism that contain input, hidden and output nodes. It is an input-process-output mechanism that use to solve or predict complex problems.

The first Time delay neural network (TDNN) developed in 1987 by Alex Waibel and it was the first Convolution neural network (CNN). This model was based on a "Back propagation" and it is achieved by shift invariance. Since, that model has motivate many developers and researcher to research and design fastest processing models and with greater efficiency that has the great performing potential like a humans and human brain. That's why model is known as CNNs.

An Artificial neural networks (ANNS) design and process in a feed-forward way from the input layer to output layers through the hidden layer [11]. The hidden layer of ANN behave suchas"black box" which can periodically manage convolution of the human brain. The disadvantage of neural networks, it include "Black box" nature, greater computation which increase burden of networks [12].

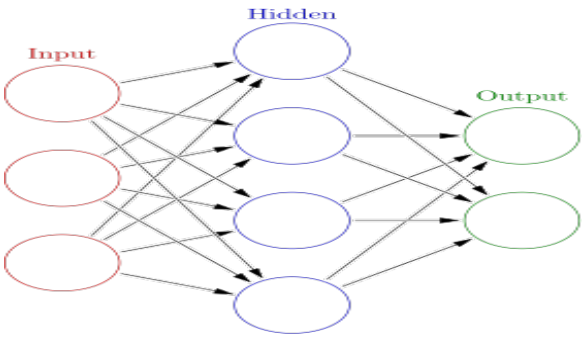


Fig 2: Artificial neural network

Type of Neural Networks

There is we explain the brief description about types of the neural networks. The several types of neural networks is Single Layer Perceptron (SLP) networks, Multi-Layer Perceptron (MLP)networks, Kohonen's Self Organising Map network (SOM), Probabilistic Neural Networks (PNN),Radial Basis Function (RBF) network and Convolutional Neural Networks (CNN). There is explain functions of these types of neural network below.

Single-Layer Perceptron (SLP)

Single layer perceptron (SLP) is the type of feed forward neural network. In 1958, Rosenblatt developed Rosenblatt's perceptron theorem for neural networks and the theory of SLP, which is form using threshold transfer function. It is the easiest type of neural network and detect the binary values (0, 1). In 1961, Rosenblatt derived the perceptron theoremfor neural network for optimal weight values as a substitute of starting weighted values. In single layer perceptron does not have a priority knowledge to input values to the network. That's why only initial weighted values is assign to randomly [7]. The SLP algorithm sum all the input weighted values and if sum of input values is larger than threshold value then SLP is called Activated means output = 1. In SLP, if predicted output is same as the desired result then performance of SLP is considered satisfactory. If predicted output doesn't equivalent with the required output then initial weighted values need to change and reduce the error. SLP is a linear classifier that's why if the cases not linearly separated then learning process of neural network not reach a point where all the input weighted or cases classify properly.

Multi-Layer Perceptron (MLP)

The multi -layer perceptron (MLP) has same structure like single layer perceptron but it contain one more hidden layer with SLP. The MLP algorithm is based on the sigmoid threshold. The multi-layer perceptron uses the back propagation algorithm for successfully classification of XOR data. Basically, Back-propagation algorithm consist of two phases: one is forward phase and another is backward phase. The forward stage is the stage where activation transmitted from input layer to output layer via hidden layer. Whereas, backward phase classify in order to alter the weighted and biased values and observe the error between actual and requested values which is propagates backward.

Radial Basis Function (RBF) Networks

RBF network was introduced by Moody and Darken. Radial basis function networks are three layer feed-forward neural network. An RBF network is the combination of input layer of processing nerve cells, a hidden layer to transfer RBF

nerve cells to next layer and a output layer of generated nerve cells which is give output of the network [7].The transfer function of RBF network in the hidden layer is called a radial basis function (RBF). The RBF networks divided the input spaces or points into a set of points which has a constant distance from given point, called centre and for utilization of these hyperspheres points a neuron transfer function is define which is in the form

h(x) = g(||x – c ||^2)

Convolutional Neural Network (CNN)

In deep learning for the processing of supervised and unsupervised data neural network is the most efficient technology. The neural networks have faster processing of images, videos and other format of datasets but in the recent years deep learning uses convolution neural network for the classification and processing of supervised and unsupervised datasets. The convolution neural network most efficiently work on unsupervised deep learning that learn and perform filtering in the image domain [7]. In convolution neural network (CNN), a convolution layer which perform linear mathematical operations and it is uses convolutions at the place general matrix multiplication at least in one layer. The CNN is also called shift invariant or space invariant which is based on the shared weighted architecture.

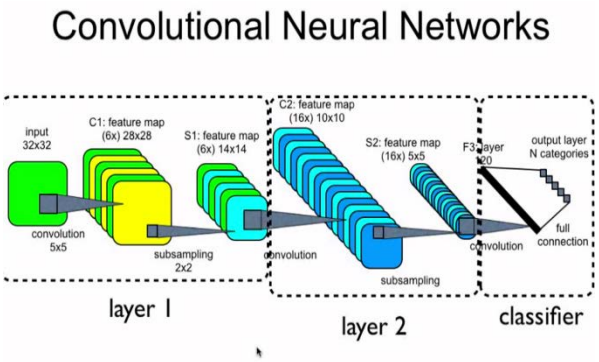


Fig. 3: Convolution neural network

Training of Neural Network

Once a neural network has been introduced or design for the particular operation or processing thenneuralnetwork is ready to be trained with the given dataset for which it is design. To start the training process of network first the starting weights are selected arbitrary to train and make the network error free. After that the training or learning of neural network is begins with random set of data like 30% data to check network and 70 % data to train the network.There are mainly two methods to trained a neural network: supervise and unsupervised. Supervised training of neural network include a process of providing the network with the wanted outputs with the input data and in unsupervised training neural network involve only inputs without any outside help. After extraction is perform on the image and display the rectified image to the network.

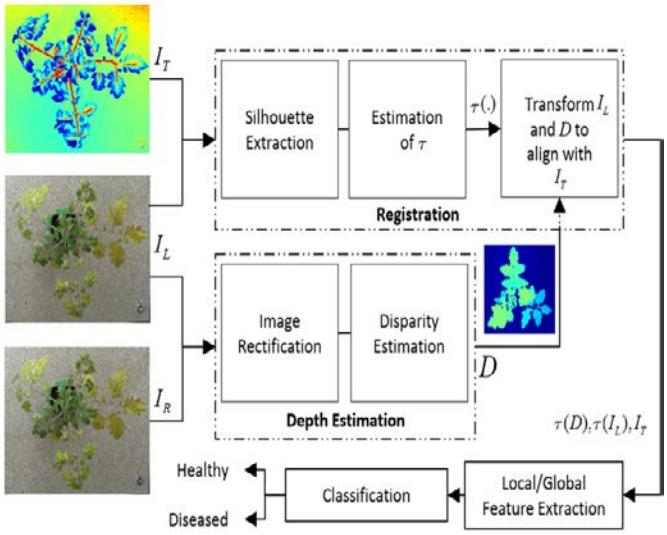


Fig 4: Training of dataset

Image Processing

Image is the assembly of number of segmentswhich have a specified position and value is known as “picture elements and pixels”. An image or digital image is binary representation of visual things and information as picture elements and pixels. In computer science, Digital image processing is define as the processing of digital images by use of digital computer through the image processing algorithms. Image processing is the technique to carry out functioninglike image enhancement, image segmentation to extricate convenient information from the image.

Image processing is the type of signal processing in which input is the form of image and generated output is also in the form of image with extracted features. In image processing, there is two methods are used which is “Analogue and Digital processing”. The image processing is widely used in the field of computer science, core engineering, nuclear medicine, astronomical observation, signature recognition, number plate detection, agriculture etc. [13].

Image Processing Techniques

Image processing is widely used in the field of core engineering and computer science. There are two methods are used in image processing: Analogue and Digital image processing. Other image processing techniques which is used for digital image processing is image formation, image acquisition, image enhancement, image segmentation, edge detection and processing of images. The different image processing techniques can be explain by the diagram and it is the best representation of image processing techniques and the processes involved in image processing are shown.

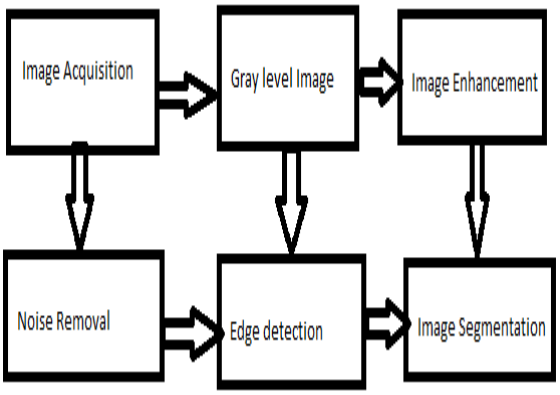


Fig. 5: Image Processing Techniques

Image Acquisition

First step in image acquisition is to capture the leaves using mobile phone or digital camera. These stored images of the leaves from the database are load by specifying the path. There are some images of crops leaves for image acquisition.

(a)

(b)

Fig. 6: Disease crops leaves

Image Pre-processing

Pre-processing that perform on the picture to improves the quality and features of the picture and image-video by removing noise and distortions of image and enhance features of image that use for further processing. Clipping is result of processing of an image on the basis of intensity of image and clipping of the images based on the region of interest

(ROI), image smoothing, image enhancement and contrast enhancement are done here. Figure 7 shows the images after performing image enhancement and pre-processing.

(a)

(b)

Fig.7: Enhanced Image after Pre-Processing

Result of Trained Dataset

For input set of data and captured images after performing image processing different class of diseased sample of crops leaves like Pear, cherry, and peach, porosity, Pair, grayleaf spot, crops leaves infected with bacterial, crops leaves diseased with sun burn, leaves with scorch disease and leaves which is infected with fungal disease are taken. Fig. 8 shows the original and captured input images after performing image processingimages and get the output in form of segmented images. The segmented images can be classified and detect into different crops diseases. Fig. 9 show the original captured, segmented image and masked image where input leaves is infected and diseased with early scorch and different types of disease and at the output shows the experimental result and classification of disease of leaves using feature extraction and image rectification method.

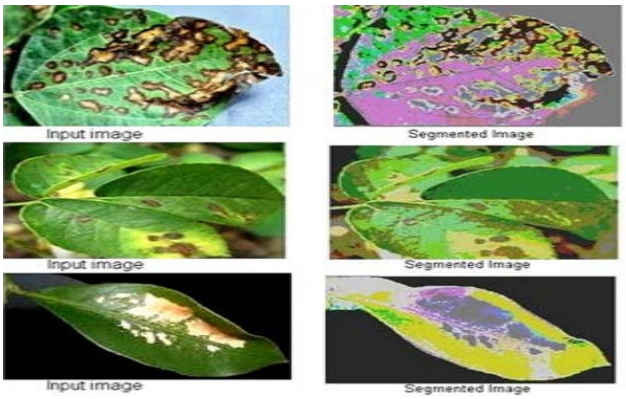


Fig. 8: Captured input images

TABLE I: Different Leaf Disease Detection

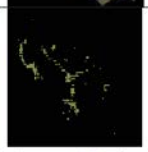
Captured Leaf	Segmented Leaf	Masked Leaf	Experimental Result
			Leaf has no disease
			Leaf has disease
			Leaf has no disease
			Leaf has disease

Fig.9: Leaf disease detection

Conclusion:

We have conclude and developed the automated disease detection in crops using convolution neural network with the help of image processing and it's techniques which is able to identify or classify crops leaves has disease or not. A set of crops leaves which contain the category of leaves, Number of original leaves images, Total number of leaves images: original captured images and segmented and Number of leaves images from the group of data for classification and processing. It first process by the image processing model and then use convolutional neural network to detect diseased leaves of crops. In this paper, several techniques of crops leaves disease detection is evaluated and discussed in terms of varied features and framework.

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