WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

DEVELOPMENT OF AN ARTIFICIAL NEURAL NETWORK BASED SYSTEM FOR EARLY DEDUCTION AND CLASSIFICATION OF PLANT DISEASE USING LEAF IMAGES

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ABSTRACT

The goal of this project is to implement a Plant Disease Detection System using imageprocessing and image recognition with the help of Convolutional Neural Network (CNN). Plant disease can directly lead to stunted growth causing bad effects on yields and economic losses The traditional methods rely on specialists, experience, and manuals, but the majority of them are expensive and time-consuming. This project proposes a disease detection and classification algorithm with the assistance of machine learning mechanisms and image recognition tools and also integrates this algorithm with an android application, Identifying and recording the contaminated area comes first, followed by image preprocessing then the infected area is identified and feature extraction is performed on the same and then the image is processed by the convolutional neural network to identify whether the image of the leaf under supervision is diseased or not. Plant disease identification can help farmers not just to increase yields and moreover help in increasing the GDP.

Keywords : CNN, Image Processing, Image Recognition, Image Pre-Processing, ImageSegmentation, Feature Extraction, Classification.

INTRODUCTION

Deep learning is a machine learning technique that teaches computers to do what comes naturally to humans. Deep learning has helped in evolution in all types of domains such as video, audio and image processing. In India, agriculture is humanity's oldest and most essentialactivity for survival. The growth of population during the last years has led to a higher demandfor agricultural products. To meet this demand without draining the environmental resources the agriculture uses, automation is being introduced into this field.

Image concept overview

Image is a collection of rectangular arrays of dots which are known as pixels. The size of an image can be determined by the number of pixels present in it. It can simply be calculatedby width x height. Each and every pixel present in an image is a certain type of colour. While working with the black and white image in which the pixels are totally white or totally black, the options are really restricted as only a single bit is needed for every pixel.

Neural networks overview

Neural networks are made out of basic components. These components are handled bythe nervous system of the human body. As in nature, the components are associated in such a way that they operate the working of the system to a large extent. You can prepare a neural system to play out a specific capacity by changing the estimations of the associations (weights) between components. In order to train a network, the input/target are necessary.
Neural network systems are designed in such a way that they solve difficult problems very easily containing design acknowledgment, ID, grouping, discourse, vision, and control frameworks.

Pattern Recognition overview

Pattern recognition is a fast-growing technique nowadays. It is playing a very significantrole in various other techniques as well. It is a process with the help of which a pattern is recognized by computer or machine. It helps in putting patterns into various categories with its reliable and efficient methods. The demand for such techniques is increasing at a rapid pace. Itis firmly related to a technique called machine learning. Pattern recognition is basically used incomputer vision. It is an essential part of artificial intelligence that intends to provide human intelligence to the machines or the computer. It is having the capability to solve complex problems,efficient classification of the data and solve various other real-world problems as well.

Classification Overview

The versatile set of required features extracted from various patterns in the past stages are utilized here. Here the classification and recognition of the features is done and they are mapped to their respective classes. Learning procedures are categorized into two parts. One is supervised learning and the other one is unsupervised learning. In the case of supervised learning, the classifiers are very well aware of the each and every pattern category among various pattern classes. Whereas in the case of the unsupervised learning, the various attributesof the system are modified on the basis of input given to the system.

RELATED WORK

A number of steps have been made to bring advancement in agriculture and plant disease identification, To recognize Zang's[1] proposed a correlation-based feature selection approach in 2022.Support vector machines (SVM) use colour, texture, and shape features as input to identify apple leaf diseases like mosaic, powdery mildew, and rust. Under natural lighting, though, it is unable to detect apple leaf disease.
This model [2] suggests a proposal for visual plant stem and leaf disease detection. Thedeveloped method is focused on image processing and involves the following steps: first, the images are segmented using the K-Means technique, and then the segments are passed througha trained neural network. The proposed method accurately and automatically identifies leaf diseases, according to the final results. The statistical classification based classifier worked welland was able to successfully identify and diagnose diseases.

A fruit disease detection system which provides the alternate way for good and healthyquality and estimation of productivity [3] is proposed. System uses K-means clustering approach for image segmentation. System implements Speed up Robust Feature (SURF) algorithm for feature extraction. Artificial Neural Network concept is used for pattern matchingwhich classifies the diseases. The proposed system detects the diseases on grape, apple and pomegranate. The accuracy for generating the results is upto 90%.
A computer vision based approach for detection of diseases on wheat crops [4] is studiedand analyzed.This system considers two common diseases on wheat: yellow rust and septoria. This system is based on marker controlled watershed segmentation, super pixel based feature analysis and SVM classification. The proposed framework is tested with set of 60 healthy and 120 unhealthy wheat crops images. Dimension of image is 3264x2448. This system proved thatthe SVM classifier performs better than ANN in terms of detection accuracy of yellow rust with95% and of septoria with 70%.
To extract the texture extraction of images of vegetables which will later useful for classification [5] is proposed. The features including red and green component, skewness, kurtosis, variance, and energy etc. are extracted from images. Finally, Decision Tree classifier performs classification on above mentioned features which produce the results of the classification. System is tested with 269 images of vegetables divided into 8 classes. To increasethe computation images are resize to 300x300 dimensions. The accuracy is 95% for classification of diseases.The diseases detection on fruits [6] is reported. This system uses image processing concept for detection of diseases on fruit, leaf and steam to increase the quality and productivity.To achieve this, the concept of artificial neural network is used. Research is carried out on grapesand apple diseases (for Grapes- Black Rot, Powdery Mildew and for Scab, Rot). The experimentis carried out on two databases, one with trained diseased images and other with query images of leaves, steams, fruits of grapes and apple. The images are classified according to their diseaseson the basis of color, texture and shape feature. The proposed system has achieved 90% of accuracy.

METHODOLOGY

CNN

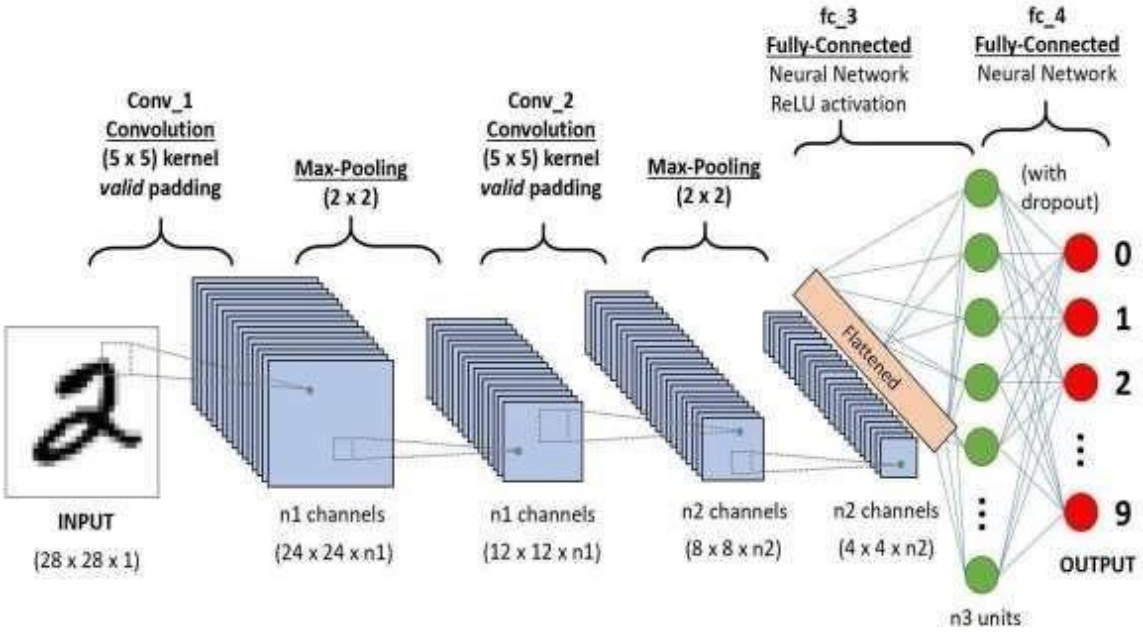
A Convolutional Neural Network (ConvNet/CNN) is a Deep Learning algorithm which can take in an input image, assign importance to various aspects/objects in the image and be able to differentiate one from the other. The pre-processing required in a ConvNet is much lower as comparedto other classification algorithms. While in primitive methods filters are hand-engineered, with enough training, ConvNet have the ability to learn these filters/characteristics.

Convolution Layer

The role of the ConvNet is to reduce the images into a form which is easier to process,without losing features which are critical for getting a good prediction. Conv2D parameters isthe number of filters that convolutional layers can learn from. It is an integer value that determines the number of output filters in the Convolution Layer.

Pooling Layer

Pooling layers are used to reduce the dimensions of the feature maps. Thus, it reduces the number of parameters to learn and the amount of computation performed in the network Furthermore, itis useful for extracting dominant features which are rotational and positional.



RESULT

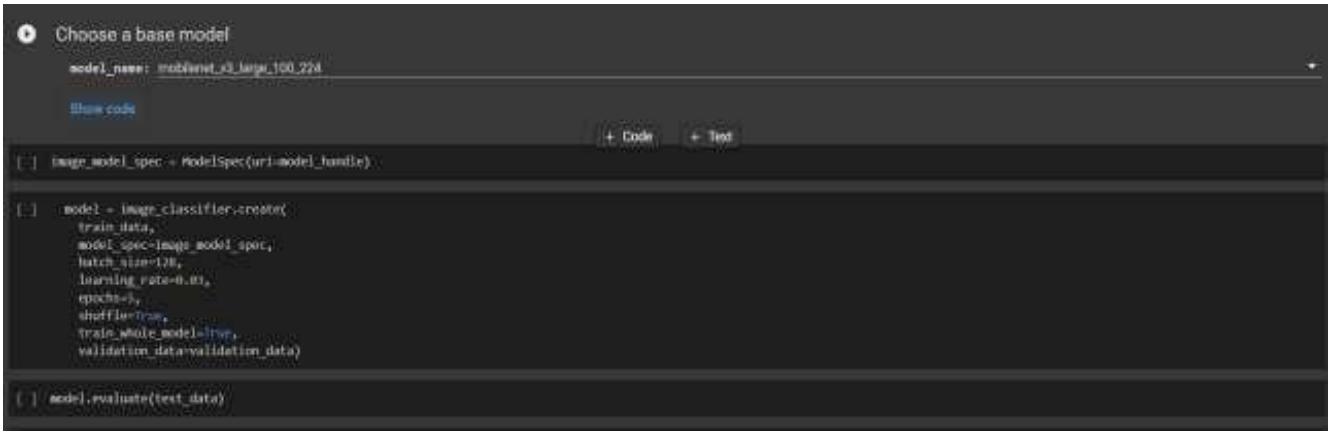
Dataset

This dataset has been developed and used for various real-life operations consisting of ahuge number of classes. This dataset consists of images of 14 plant varieties. The dataset shows17 fungal infections, 4 bacterial diseases, 2 fungal illnesses, 2 infectious diseases, and 1 mite- induced disease. Twelve plant species also show images of healthy leaves that have no obviousillness. The input data is resized to 224x224 or 229x229 pixels as required by the networks. This is followed by creating the training and validating directories.

Classes of PlantVillage Dataset	Disease Cause	Annotation Label	Training Images	Validation Images	Testing Images
Apple Scab	Fungi	A_Scab	441	126	63
Apple Black Rot	Fungi	A_Blk_Rot	435	124	62
Apple Cedar Rust	Fungi	A_C_Rust	192	55	28
Apple Healthy	-	A_Healthy	1151	329	165
Blueberry Healthy	-	B_Healthy	1051	300	151
Cherry Healthy	-	Ch_Healthy	598	171	85
Cherry Powdery Mildew	Fungi	Ch_Mildew	736	210	106
Corn (maize) Common rust	Fungi	Corn_Rust	835	238	119
Corn (maize) Healthy	-	Corn_Healthy	813	233	116
Corn (maize) Northern Leaf Blight	Fungi	Corn_Blight	690	197	98
Corn (maize) Gray leaf spot	Fungi	Corn_Spot	360	102	52
Grape Black Rot	Fungi	G_Blk_Rot	826	236	118
Grape (Black Measles)	Fungi	G_Blk_Measles	968	277	138
Grape Healthy	-	Grp_Healthy	296	85	42
Grape Leaf Blight (Isariopsis Leaf Spot)	Fungi	Grp_Blight	753	215	108
Orange Huanglongbing (Citrus greening)	Bacteria	O_HLBing	3855	1101	551
Peach Bacterial Spot	Bacteria	Pec_Bact_Spot	1608	459	230
Peach Healthy	-	Pec_Healthy	252	72	36
Pepper Bell Bacterial Spot	Bacteria	Pep_Bact_Spot	698	199	100
Pepper Bell Healthy	-	Pep_Healthy	1034	297	147
Potato Early Blight	Fungi	Po_E_Blight	700	200	100
Potato Healthy	-	Po_Healthy	107	30	15
Potato Late Blight	Infection	Po_L_Blight	700	200	100
Raspberry Healthy	-	Ras_Healthy	260	74	37
Soybean Healthy	-	Soy_Healthy	3563	1018	509
Squash Powdery Mildew	Fungi	Sq_Powdery	1285	367	183
Strawberry Healthy	-	Straw_Healthy	319	91	46
Strawberry Leaf Scorch	Fungi	Straw_Scorch	776	222	111
Tomato Bacterial Spot	Bacteria	Tom_Bact_Spot	1488	426	213
Tomato Early Blight	Fungi	Tom_E_Blight	700	200	100
Tomato Healthy	-	Tom_Healthy	1114	318	159
Tomato Late Blight	Infection	Tom_L_Blight	1336	382	191
Tomato Leaf Mold	Fungi	Tom_L_Mold	667	190	95
Tomato Septoria leaf Spot	Fungi	Tom_Sept	1240	354	177
Tomato Spider Mites	Mite	Tom_Sp_Mite	1174	335	167
Tomato Target Spot	Fungi	Tom_Target	984	280	140
Tomato Mosaic Virus	Virus	Tom_Mosaic	262	74	37
Tomato Yellow Leaf Curl Virus	Virus	Tom_Curl	3750	1071	536

Training the Model

The data generators that read pictures from the source folders are converted to float32 tensors and they are fed into the network. As the data that goes into the neural network should be normalized in some way to make it more amenable to process.



CONCLUSION

The creation of an android app to detect plant diseases using image processing and image recognition is summarised in this report. The successful detection of plant disease is very important for cultivation of the crop and this can be done by using image processing. A smart phone application based on image processing technique which analyses colour features of spots in plants is developed and the preliminary measurement results in the recognition of the number of spots and their area on plant leaves showed accuracy higher than 90%. Convolutional neural networks (CNN) are the most widely used classification technique for classifying plant diseases. The dilemma of costly domain experts will be solved if plant diseases could be detected automatically. Early identification of plant diseases would assist farmers in growing crop yields, which would raise India's gross domestic product (GDP).