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A Survey on Classification of Tomato Plant Diseases Using Deep Learning Architectures

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Abstract

Tomato is considered as an important vegetable crop which is cultivated widely across the world due to inbuilt protein and nutrient content. Over the past few decades, tomato crops acts high nutrient energy streams and it is vitally represented as one of the important production on the food resources. However due to changes of climatic conditions and crop cultivating methods, it has been effected with natural growth and it leads to various disease. Hence it is considered as primary concern as it leads to financial loss and economic crisis. In order to effectively detect and classify diseases affecting the plant, manual technique and automated technique using machine learning algorithms has been employed. In particular, those methods could not able to achieve the expected outcomes as It is time consuming and less accurate on manual monitoring of the crop disease Therefore deep learning model has been analyzed in depth in this article as an efficient model towards early detection and classification of plant diseases on its detailed and complex architecture to rescue tones of agricultural products after cultivation and production to classify the plant disease into numerous diseases categories. This article carries out a detailed survey on deep-learning approaches in terms of layer and functions to identify disease affected region and classes of tomato plant diseases such as Bacterial spot, Early blight, Septoria leaf spot, on disease characteristics and its features extracted from images of diseases.

Keywords: Tomato Plant Disease, Disease Classification, Machine Learning, Deep Learning.

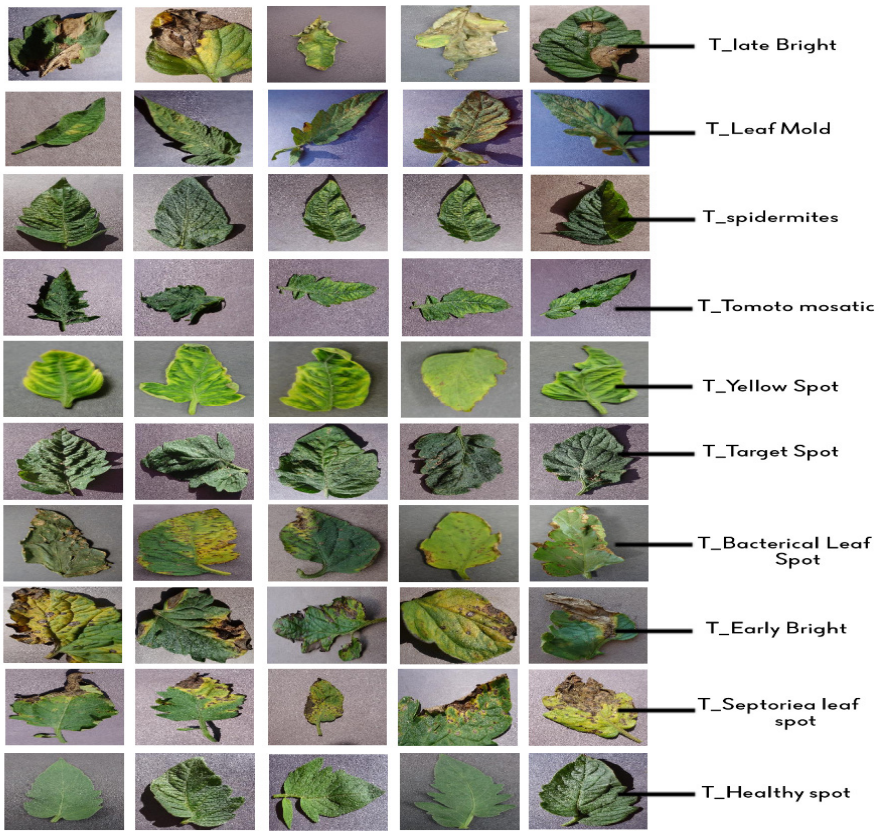
1. Introduction

Tomato plant disease is a significant crop around the world which exposed numerous diseases causing which leads severe losses in the production. In agriculture, precise agriculture is much important to establish disease free cultivation and to enhance the economical development of the countries. Basis classifications of the disease occurring in the plant are viral, bacterial and fungal[1]. Plant Disease is identified with respect to the colour spot and texture patterns of the plant leaves and its stem region [2].To simplify the identification process with enhanced accuracy of the plant disease detection, image processing approaches based on deep learning models can be employed. In identification of the tomato plant diseases, Image processing plays a significant role to extract optimal outcomes on the reducing the human efforts [3]. Further Image processing techniques assist to identify plant diseases more accurately and within small period of time. To produce best results, various image processing approaches has to be employed to detect and classify tomato leaf diseases using conventional supervised and unsupervised machine learning architectures.

The conventional machine learning approaches for disease identification of tomato diseases produces misclassification error on evolving diseases characteristics of the various type of disease of tomato. Considering the large environmental impact of the tomato disease, reduced detection time of learning approaches, and its reduced accuracy. Machine learning model [4] considered is less adoptable and it cannot be widely applied to plant disease prediction to achieve the previously mentioned outcomes. Further it has become necessary to achieve quick and accurate disease prediction on tomato diseases classification on projection of deep learning approaches [5].

Disease image segmentation is processed using projected deep learning architectures [6]. Therefore, these deep learning techniques may perform effectively in early detection of disease and classification of the disease accurately. The performance results of the deep learning models depict an increase in performance accuracy. Hence review of the literatures carried out in this work. Recently it is been observed that most of the

tomato leaves are affected by the diseases which gradually reduces the strength of the palm causing severe loss in yield and there are nine common diseases widely found namely i) Bacterial spot(ii) Early blight(iii) Septoria leaf spot(iv)late blight(v)leaf meld (vi)spider two spotted(vii)target spot(viii)tomato mosaic virus(ix)yellow leaf curl virus.[7].



- Bacterial spot can affect all above ground parts of a tomato plant, including the leaves, stems, and fruit. Bacterial spot appears on leaves as small (less than ⅛ inch), sometimes water-soaked (i.e., wet-looking) circular areas.
- Early blight infection **starts at the bottom of the plant with leaf spotting and yellowing**. Initially, small dark spots form on older foliage near the ground. Leaf spots are round, brown and can grow up to 1/2 inch in diameter. Larger spots have target-like concentric rings.
- Septoria leaf spot is **caused by the fungus Septoria lycopersici**. This fungus can attack tomatoes at any stage of development, but symptoms usually first appear on the older, lower leaves and stems when plants are setting fruit. Symptoms usually appear on leaves, but can occur on petioles, stems, and the calyx.
- Leaf symptoms of late blight first appear as **small, water-soaked areas that rapidly enlarge to form purple-brown, oily-appearing blotches**. On the lower side of leaves, rings of grayish white mycelium and spore-forming structures may appear around the blotches.
- Tomato leaf mold is **typically only an issue in greenhouse and high-tunnel tomatoes**. The disease is driven by high relative humidity (greater than 85%). Foliage is often the only part of the plant directly infected. Infection will cause infected leaves to wither and die, indirectly affecting yield.
- The best way to begin treating for two-spotted mites is to **apply a pesticide specific to mites called a miticide**. Ideally, you should start treating for two-spotted mites before your plants are seriously damaged.

- Target spot, or early blight is **one of the most common diseases attacking leaves and stems of potatoes and tomato**. The disease is caused by the fungus Alternaria solani. On the leaves the disease starts as small circular to oval dark brown to black spots.
- Tomato mosaic virus (ToMV) Long considered a strain of TMV, ToMV is a distinct viral species, also transmitted by contact. Present on every continent, this virus is found more frequently than TMV on tomato and pepper, both in field crops and under protection.

- YLCV is **transmitted from diseased to healthy plants by silverleaf whitefly**, which feeds on a wide range of hosts . Levels of TYLCV can be correlated to the population size of its vector silver leaf whitefly. It is not known if native whiteflies can spread the virus.

2. Related work

In this part, conventional approaches applied to early detection and classification of the different plant disease especially tomato plant is measured by incorporating the deep learning model has been detailed as follows.

2.1. Automated Tomato Plant Disease Classification using Transfer Learning

In this method, Transfer learning based automated method is analyzed towards identifying and categorizing evolving plant diseases in plant region using intensity moments. It produces the features and those features are classified using activation function. Transfer learning model has ability to identify the important three types of leaf diseases such as viral, fungal and bacterial. Transfer learning is a machine learning based classifier which is capable of detecting the disease on its evolving characteristics. It splits the sharp contrast on disease discrimination. Intensity moments of the plant region are supported for extracting features in order by tuning parameter of the permutation function along the its image structure of the feature organization through ensemble classifier learning model[8] .

2.2.Segmentation of Vegetation indices for plant Disease classification

In this method, plant diseases diagnosis is computed by gathering the infected region of the diseased plant. Studding is a disease infected leaves which is examined on identification of changes in greenness of the infected portion of the leaf and with normal leaf. Value of Vegetation indices (VI) from remote sensing images has been used to measure the greenness [9]. Thus Vegetation indices are calculated in the infected images of the plant. These Vegetation indices of the disease computed gathers the infected region from the disease images. Normalized Difference Vegetation Index, Green Normalized Difference Vegetation Index, Soil Adjusted Vegetation Index and Enhanced Vegetation Indices are popular crop disease based vegetation indices used in the proposed work.

3. Review representation of the deep learning approaches for Tomato plant disease

In this part, deep learning architecture has been analyzed on basis of disease feature extraction and classification model has been described in the table

Table 1: Review Representation of the Plant Disease detection

Technique	Type of disease identified	Benefits of the method	Limitations of the method	Author name and year
Convolution Neural Network	Leaf Spot and Leaf Curl	It can enhanced to other type of fungal disease detection	It is adoptable to selected features	Hussain, Mahbub; Bird, Jordan J.; Faria, Dec2018..

Semantic Segmentation – ResNet 32	Mosaic and Early blight	It is capable to identifying fungal disease infections	It is difficult towards interpreting the output variable of the disease	Almadhoun, H., & Abu-Naser, S. (2017).
Semantic Segmentation using Linknet 32	Bacterial spot, leaf mold	It is benefited to large canopy	shape and texture relationships is difficult	G. Wang, Y. Sun, and J. Wang, vol. 2017, pp. 1–8, Jul. 2017.
Recurrent Neural Network	Early blight and target spot	It is enhanced to 3D image information	Disease discrimination is complex	A. J. Wakeham, G. Keane, and R. Kennedy, Sep. 2016.
Transfer Learning	Late blight and Leaf spot	It suitable in determining the disease in various variation on the particular environment conditions	Defining model parameters high complex	T. Xiao, Y. Xu, K. Yang, J. Zhang, jun 2015.

4. Analysis of Deep Learning Classification models

A performance evaluation between the classification accuracy of two types of deep learning architectures has been carried out. Convolution Neural Network has been analyzed with hyper parameter tuning has been provided. Two important deep learning algorithms for disease identification has been used along this paper are the ResNet and VGGNet.

- **VGGnet Architecture**

The VGGNet is deep CNN architecture which has a pyramid shape. In this architecture, the input layers one moves forward and the layers become deeper and wide. Further, the Convolution layers are followed by max pooling layer, ReLU activation function and fully connected layer. VGGNet is a high scalable architecture for standardization of the disease classification and since pre-trained of VGGNets are easily accessible for the latent features for effective classification. The model can be easily provided for a wide range of problems like over fitting and feature evolving scenarios. Limitation is training VGG Nets consumes a high computation time and is a GPU intensive task [10].

- **ResNet Architecture**

ResNet consist of various residual modules of the deep learning layers which either perform a function on the input using sigmoid function [11]. These modules are stacked on top of other layers to form fully connected network architecture of convolution neural network. On employing ResNet, it capable in identifying the disease of the plant on evolving features. It is easy to include or eliminate the residual layers as needed for disease identification. It processes the network deeper for training as it becomes more complex and time consuming [12].

Conclusion

In this article, a detailed analysis of the deep learning technique to detect and classification of tomato plant disease in the agriculture field has been highlighted with numerous literatures on processing methods. Those techniques are evaluated with respect to image pre-processing, feature extraction, feature selection and disease classification against plant characteristic of tomato plant leaves on its proposed architectures and hyper

parameter tuning parameters. However disease prediction model of tomato diseases deals with CNN model to classify the disease region efficiency and effectively on the extracted hidden features and sparse features. It is applicable to the various plant leaves to along the identification of mineral deficiency in the plant.

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