Tomato Leaves Diseases Detection Using Image Processing and Deep Learning

[1]Prof.Satish Manje, [2]Mr. Trusharth Pawar, [3]Mr. Khan M. Waseem, [4]Miss.Sneha Sapale

[1]Asst.Professor,[2,3,4]UG Student,[1,2,3,4]Computer Engg. Dept. Shivajirao S. Jondhle College of Engineering & Technology, Asangaon, Maharashtra, India.

[1]satishmanje93@gmail.com, [2]pawartrusharth@gmail.com, [3]khanwaseem0215@gmail.com, [4]snehasapale17@gmail.com,

Abstract: Tomato is a very popular crop, this paper tries to solve the disease-causing problems that farmers face. This research paper attempts to eliminate the harmful side effects of chemicals and pesticides with the help of the Image Processing system. In this study, 10 different types of tomato leaf disease were diagnosed including one healthy class. Farmers can use pictures of affected tomato leaves and it will predict disease. The system has shown more than 96% accuracy in the end. It is an easy-to-use program that will help farmers, especially the "tomato" crop to reduce pests by recognizing leaf diseases and increasing yields by creating more opportunities for research on various vegetable diseases and the market for expertise.

Keywords: Agriculture, Science, Integration, Discovery, Disease, Leaf, CNN, Image Processing

I. INTRODUCTION

Tomato is a popular fruit consumed throughout the world. There are many tomato farmers in India who grows tomatoes on a commercial scale and harvest these fruits for their primary income. There is a demand for tomatoes in all seasons. For a Tomato farmer to be self-sufficient, it is necessary for him to know the methods of properly handling the pesticides and chemicals in his field. This is because, each year, before the tomatoes are matured, Tomato plants get destroyed due to the attack of insects and diseases which lead to poor crop harvest. There is a little variation in quality, quantity, demand, and price in the tomato market all year. Many diseases of tomatoes are caused due to insect attacks, bad weather, environment, soil, polluted water, and poisonous insecticides. This research tends to detect leaf diseases of tomatoes using up-to-date technology "Image Processing". If any of the plants had been affected by any disease farmers had to wait for days for disease confirmation. But computer science and well build technologies have made many things possible. Farmers can easily learn about pesticides, seeds, and even diseases through a phone call to the local agriculture consultant. Though it might not be possible for the consultant to give any suggestion without observing the plant. And that is a very lengthy process that consumes more time. Image processing made that task so easy that now only by snapping pictures of affected plant and inputting that image in disease detecting system farmers can learn about which disease attack they are facing. Pre- a trained model is needed for the system.

In this research 9 popular tomato leaf diseases Septoria Leaf Spot, Tomato mosaic, Bacterial Spot, Yellow curved, Late blight alongside healthy tomato leaf used. CNN (convolutional neural networks) is the best for making image processing a success

II. AIMS AND OBJECTIVE

a) Aim

The aim of the research paper is to detect tomato leaf disease using Deep Learning

b) Objective

- Detect the affected Tomato leaves to increase the productivity of tomatoes.
- To eliminate the harmful side-effect of chemicals and pesticides.
- Combine agricultural sector with computer science.

III. LITERATURE SURVEY

Paper 1: Identification of Tomato Plant Diseases by Leaf Image Using Squeeze Net Model

To reduce the size of the model, squeeze net was built with 3 strategy designs namely, reducing filter size, reducing input channels and down sampling at the end layer of the network. Squeeze Net uses a squeeze layer (with lxl filter to decrease the input channel from 3x3) and expand the layer (a combination of lxl and 3x3 filters to reduce filter size), squeeze layer and ReLU activation layer. Fire modules on Squeeze Net architecture consist of two layers, expand layer

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and sequeeze layer, both of which are the main keys of Squeeze Net architecture.

Paper 2: Tomato Leaf Disease Detection using Convolutional Neural Networks

This research paper adopts a different form of the CNN architecture called LeNet to classify tomato leaf diseases. LeNet is a CNN model that content convolutional, activation, pooling & fully connected layer. The CNN model used to classify tomato leaf diseases has an additional convolutional layer, activation and max pooling layer. layers in contrast to the LeNet architecture. The CNN model published in this research paper achieved 94-95% accuracy indicating possibility of a neural network performs even under adverse conditions.

Paper 3: Plant Leaf Disease Detection & Classification Based on CNN with LVQ Algorithm

In this paper, diseases detection and classification method are presented based on CNN with Learning Vector Quantization algorithm. The dataset consists images of 500 tomato leaves. Three distinct input matrices have been acquired for R, G & B channels to start convolution for every image in the dataset. Each input image matrix has been convoluted. The relu activation and 2D Max Pooling layer added to output matrix. Total 500 feature vectors which acquired from original images have been used for testing and training operations in the LVQ algorithm. The research has been performed on healthy and leaves affected by disease images to perform classification. The proposed system effectively detects four different types tomato leaf diseases. To improve classification different filters or different size of convolutions can also be used for best result.

IV. EXISTING SYSTEM

There are several proposed architectures for Image classification. Convolutional is the base of all deep learning models. This approach was proposed by Azeddine Elhassouny and Florentin Smarandache, CNN model use to classify tomato leaf diseases was inspired from Mobile Net model.10 common tomato leaf disease and 7176 images used in this reseasrch. The model accuracy was 88.6%

V. COMPARATIVE STUDY

SR NO.	PAPER TITLE	AUTHOR NAME	TECHNOLOGY	ADVANTAGE	DISADVANTAGE
1.	Identification of Tomato Plant Diseases by Leaf Image Using Squeeze Net Model.	Akbar Hidayatuloh1, M. Nursalman2, Eki Nugraha3	Squeeze Net Model	Model produce small size so can be implemented on servers and mobile devices.	Only 1400 images used to train the model and accuracy of model was 86%
2.	Tomato Leaf Disease Detection using Convolutional Neural Networks	Kandiraju Sai Ashritha, Alla Pranathi, Prajwala TM, Nagaratna B. Chittaragi*, Shashidhar G. Koolagudi	LeNet Model	LeNet model is simple to implement and accuracy of model is 94-95%	LeNet is very old model proposed in 1989
3.	Plant Leaf Disease Detection & Classification Based on CNN with LVQ Algorithm	Adem Tuncer, Melike Sardogan, Yunus Ozen	CNN and LVQ Algorithm	In Proposed model filters are applied to three channels based on RGB	512x512 px image size used which increases training time. Only 500 images used

Table 1: Comparative Analysis

VI. PROBLEM STATEMENT

The drawback of existing system uses only basic CNN Model to predict the plant leaf disease and with these approaches the system is less accurate. Dataset used in existing system was small.

VII. PROPOSED SYSTEM

In the proposed system deep learning and Image processing used to recognize the tomato leaves disease. In this research 10000 images used. Dataset for this research contains 9 types of sample of different leaves diseases of tomato and healthy class building 10 types as:

- Tomato_Early_blight
- Tomato__Target_Spot
- Tomato_Late_blight
- Tomato__Tomato_mosaic_virus
- Tomato_Bacterial_spot
- Tomato_Septoria_leaf_spot
- Tomato_Spider_mites_Two_spotted_spider_mite
- Tomato_Leaf_Mold
- Tomato_Tomato_YellowLeaf_Curl_Virus
- Tomato_healthy

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Plant village dataset is used. Train and test data in ratio 80% and 20% respectively. Images of resized to (64x64) pixels

VIII. ALGORITHM

Step 1: Start

```
import pandas as pan
import cv2 as cv
```

Step 2: Loading Dataset

```
directory_root ← '/content/drive/MyDrive
/plantvillage/'
```

Step.3: Image Data Augmentation

```
aug ← ImageDataGenerator (
   width_shift_range ← 0.2,
   height_shift_range←
0.1, shear_range←0.2,horizontal_flip← True,)
```

Step.4: CNN Model

```
leaf_classifier←Sequential()
leaf_classifier.ad(Conv2D(32,(3,3), input
shape←(64,64,3), activation←'relu'))
import numpy as nump
leaf_classifier.add(MaxPooling2D(pool_size←(2,2)))
leaf_classifier.add(Dropout(0.2))
leaf_classifier.add(Conv2D(64,(3,3), activation←'relu'))
leaf_classifier.add(MaxPooling2D(pool_size←(2,2)))
leaf_classifier.add(Dropout(0.2))
leaf_classifier.add(Conv2D(128,(3,3), activation←'relu'))
leaf_classifier.add(MaxPooling2D(pool_size←(2,2)))
leaf_classifier.add(Dropout(0.4))
leaf_classifier.add(Flatten())
leaf_classifier.add(Dense(activation←'relu', units←64))
leaf_classifier.add(Dense(activation←'relu', units←128))
leaf_classifier.add(Dense(activation←'relu', units←64))
leaf_classifier.add(Dense(activation←'softmax',
units←10))
leaf_classifier.compile(optimizer←'adam',
loss←'categorical_crossentropy', metrics←'accuracy'])
leaf_classifier.compile(optimizer←'adam',
loss←'categorical_crossentropy', metrics←'accuracy'])
```

Step.5: Training Model

```
leaf_classifier.fit(X_train,one_hot_train,epochs=75,batch_
size=128,validation_split=0.2)
```

Step 6: Predicting Result

```
def model_predict(img_path, model):
   print(img_path)
   img ← image.load_img(img_path, target_size←(224,
224))
# Preprocessing the image
   x ← image.img_to_array(img)
   # x ← np.true_divide(x, 255)
## Scaling
 x←x/255
   x ← np.expand_dims(x, axis←0)
   preds ← model.predict(x)
   preds←np.argmax(preds, axis←1)
   if preds←←0:
preds←"Bacterial_spot"
elif preds←←1:
preds←"Early_blight"
elif preds←←2:
preds←"Late_blight"
elif preds←←3:
preds←"Leaf_Mold"
elif preds←←4:
preds←"Septoria_leaf_spot"
elif preds←←5:
preds←"Spider_mites Two-spotted_spider_mite"
elif preds←←6:
preds←"Target_Spot"
elif preds←←7:
preds←"Tomato_Yellow_Leaf_Curl_Virus"
elif preds←←8:
preds←"Tomato_mosaic_virus"
else:
preds←"Healthy"
return preds
preds ← model_predict(file_path, model)
result←preds
```

Step.7: Upload the image

Step.8: The system will predict the disease with the trained neural network & display result healthy or disease name

Step.9: Exit

IX. MATHEMATICAL MODEL

The Adam optimizer as an extension to probabilistic gradient descent.Learning rates for each of the different parameters from the first & second approximate gradients is calculated using adam algorithm. The Proposed method of this research have used learning rate ← 0.001

$$v_t = (1 - \beta_2) \sum_{i=1}^{t} \beta_2^{t-1} . g_i^2$$

$$L_i = -\sum_j t_{i,j} \log(p_{i,j})$$

To perform classification and prediction task a neural network use, a very recent study showed that classification error and mean square error perform worse than that cross-entropy function [10]. Cross-entropy error do not get smaller enough, so does the weight change. The Proposed method of this research have used categorical cross entropy "(5)" as reduced function. Learning rate walks through the minimum loss using it like a step. Local minimum converges and stuck immediately instead of global minima if higher learning rate is used.Learning rate after successful run of every epoch model dynamically decreases by monitoring the validation accuracy. Advantage of higher learning rate is faster

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computation time . It also manually checks the accuracy and decreases learning rate after some successful epochs to get the global minima.

X. SYSTEM ARCHITECTURE

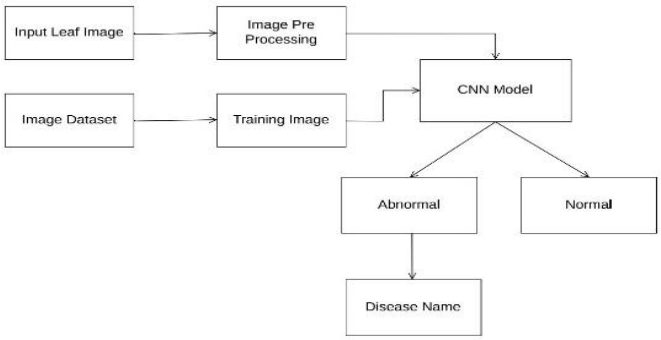

Fig.1: System Architecture

Description:

First image dataset is loaded. Image data is augmented to increase the size of dataset.

Then dataset is split in training and testing

80% and 20%. The CNN model is trained with image size reduce to 64x64 pixels and Adam optimizer. User uploads image of tomato leaf .The trained model is used to predict the class of healthy or disease name

XI. ADVANTAGES

• It will help farmers, especially Tomato growers, to identify diseases early and increase yields.

• It is widely used as they achieve high accuracy with less error rate.

• CNN and Image Processing solves complex real-world challenges

XII. DESIGN DETAILS

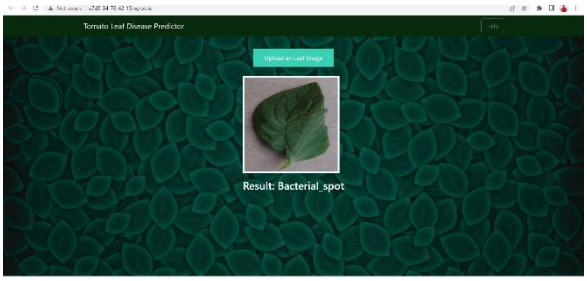

Fig 2: Result

The web application is created using python flask framework. The user uploads a tomato leaf image captured from camera. When user clicks predict then the pre-trained model identifies the class healthy or disease name.

XIII. CONCLUSION

Thus, we have tried to implement the paper present by Tahmina Tashrif Mim, Md. Helal Sheikh, Roksana Akter Shampa, Md. Shamim Reza and Md. Sanzidul Islam "Leaves Disease Detection of Tomato Using Image Processing",IEEE 2019 and according to implementation proposed CNN model identified the tomato leaves diseases.This research will help farmers to identify affected tomato leaves diseases and increase the productivity of tomatoes.

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