iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** V **Month of publication:** May 2021

DOI: https://doi.org/10.22214/ijraset.2021.34544

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue V May 2021- Available at www.ijraset.com

Plant Diseases Detection and Pesticide Suggestion using Transfer Learning

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Abstract: Plant diseases affect the life of not only farmer's but also businesses which are dependent on it. Plant disease detection is a computer vision problem which tries to identify the disease splat is infected with using an image of a plant leaf. Different kinds of models have been proposed to tackle this problem. This paper focuses on generating small, lightweight and accurate models with the help of deep learning and transfer learning.
Keywords: Neural Networks, Decision Tree, Random Forest, Segmentation

I. INTRODUCTION

Farming is one among the basic yet foremost essential tasks humans ever perform. Entire population of the world depends upon farming and its by-products. In the modern world farming is not just an occupation but a base for many businesses and food industry. In Many countries farming is a primary source of income for most of the population. Even though farming is extremely essential for the survival of the population it highly depends upon natural factors like rain, quality of soil, humidity and others,due to this it becomes very challenging to try farming in a profitable manner. Many times crops get infected with diseases which not acted quickly can infect the entire farm leading to huge loss of your time, energy and most significantly money which was invested by the farmer in that farm. In countries whose economy highly depends upon farming, the majority of the population is engaged in farming activity. Poor disease identification and management can have a damaging effect on the economy. On the individual scale these effects can be catastrophic because farming is their primary occupation.Plant diseases are often easily stopped if acted quickly but the method of detection is extremely tedious, time consuming and takes a talented person. Many people who lack education in farming can't afford professionals just to spot the disease.Due to current technical advancement, simple computation and high connectivity this problem can often be automated and solved using advanced machine learning and deep learning algorithms to avoid any damage as early as possible. Due to the ease in availability of the internet and computation problems like this can easily be automated and implemented in remote areas with the help of smartphones. Machine learning algorithms like decision trees, artificial neural networks, SVMare proving to be as effective as humans in finding patterns.This can be used to implement a system which can be cost effective, accurate and fast for detecting plant diseases. In the following sections of this document we are going to briefly discuss a few solutions which have been proposed to solve this particular problem of disease detection with high accuracy.

II. LITERATURE SURVEY

A. Tomato Plant Disease Classification in Digital Image using Classification Tree

In this paper the author proposed a system to detect and classify diseased tomato leaves. The proposed system makes use of the choice tree algorithm as it's core component to classify the diseased leaves. In the process of training this technique, a dataset of 383 colored images of healthy and infected tomato leaves is employed where each image belongsto at least one of the 6 categories based on the type of disease. Otsu's method is used to segment images using thresholding. Otsu's method is an image processing technique which is used to perform automatic thresholding and divind an image into 2 classes foreground and background. Then each image is randomly sampled 10 times to increase dataset size. Author Tried to make use of different features extracted from the color, shape and texture of the leaf in the image. From pixel value of image author extracted 9 different features

1) Maximum RGB value among all the pixels.
2) Mean of all the pixel values.
3) Standard deviation of all pixel values.

Author also took features such as area of leaf, euler num-ber, orientation. extent , perimeter, convex area, filled area, eccentricity, length of major axis, equi diameter and length of main axis into consideration, These features are extracted with help of image processing done on output images obtained by applying Otsu's method. For extracting the texture of the imageautor made use of correlation of pixels, contrast, energy and homogeneity for grey scaled image. Above features are used to train decision tree algorithms.

Using this process autor was able to predict plant diseases with accuracy of 97.3%. Even though the system is able to predict with high accuracy this system is not suitable for a wide variety of plants. Systems accuracy can be increased with the help of a random forest algorithm which reduces the effect of outliers on the output even more.

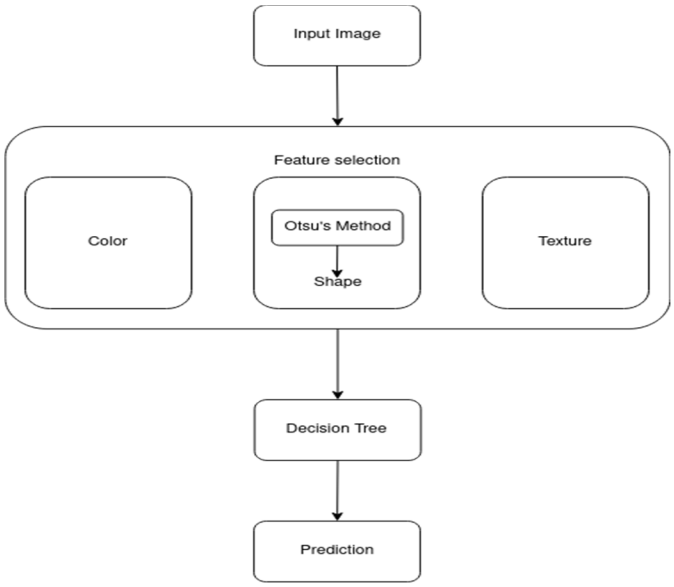

Fig. 1 Tomato leaf disease classification model overview

B. Leaf diseases Detection and Fertilizer Suggestion

In this paper a more generalized system is proposed by the author which is able to detect plant diseases of a wide variety of plants accurately. The author also tries to suggest fertilizers based on the plant species and the disease with which it is infected with the help of a database which stores the list of diseases and their fertilizers. This paper can be considered as an improvement over previous paper as it uses a random forest classification algorithm to predict the type of disease plant is suffering from. To train the model, the author splitted image dataset consisting of healthy and infected plant leaf images into a training and testing set randomly which helps to generate a well balanced training and testing set. After Splitting images into training and testing sets, the contrast of each image is enhanced in order to separate the background and foreground. These enhanced images are segmented using a clustering algorithm based upon their pixels which are used to determine the percentage of affected areas. For training purpose instead of using raw image as input for the random forest algorithm following features are handpicked by the authors like mean, standard deviation, skewness, RMS value, variance, smoothness, kurtosis, IDM, contrast, correlation, energy and homogeneity of the pixels of the input image. These 13 features are used in the training process of a random forest algorithm which is an ensemble learning method which uses many randomly generated decision trees to predict the result.This approach reduces the probability of overfitting and the random forest algorithm is not easily affected by outliers compared to the decision tree. Author of this paper goes even one step further to suggest fertilizers based on diseases detected. Pair of diseases and their fertilizers are stored in a database which is used to implement this system. Even Though the results obtained by this method are more reliable and accurate, the strategy of extracting features by hand is inefficient and sometimes humans are not able to recognize patterns as good as algorithms such as neural networks.

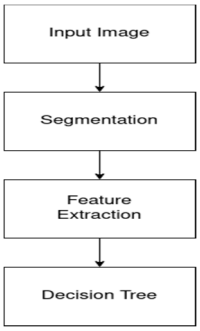

Fig. 2 Leaf disease detection and fertilizer suggestion model

C. Improved Segmentation Approach for Plant Diseases Detection

In this paper the author tried to solve the problem with the help of a neural network algorithm. More emphasis is given on the image enhancement which affects the performance of the model significantly. The model is divided into 4 stages which are as follows

1) Image enhancement
2) Image segmentation
3) Feature extraction
4) Classification

In image enhancement phase images from the dataset are enhanced to improve accuracy by reducing noise and applyingother image processing techniques. To remove noise, a median filter is used after that image color space is changed from RGB to LAB and on that color negation is applied. In image segmentation phase infected areas of leaf are segmented using RGB pixel values, from these segments the shape of the leaf is extracted. In the classification stage a neural network algorithm is used to predict the diseases the leaf is infected with. In this paper the author uses a 5 layer fully connected neural network using this strategy. The author was able to achieve 99% accuracy.

III.PROPOSED METHODOLOGY

The proposed model tries to include the best features of all models explained in the literature survey and tries to improve them. The model is divided into 2 stages

1) Image preprocessing
2) Classification

In image preprocessing the size of image is resized to224*244 pixels in order to reduce the cost of each operation on image and improve overall performance of the system while having high accuracy. As neural networks are highly sensitive to the range of input data to be provided each pixel value of the image is normalized by multiplying with 1/255 which converts range of pixel values from 0 to 255 into 0 to 1 which helps to train neural networks efficiently. As neural networks performbetter work of finding hidden patterns and tries to relationship among the hence we decided to completely remove segmen-tation and feature extraction step which remove bias from humans and also preserves hidden pattern if present. For The classification stage we used a pre-trained mobilenet modeland applied transfer learning on it in order to achieve improved accuracy and reduce training time which is generally required to train a neural network from scratch. Mobilenet is a class of small, lightweight computer vision models which are used for computer vision applications on mobile and embedded devices. Which produces good results at a low computational cost. For transfer learning we removed the output layer of the mobilenet and added a new GlobalAveragePooling layer followed by a dropout layer to avoid any over-fitting with a dropout probability of 20% followed by a dense output layer having 38 neurons each representing one class from the dataset. This model consisted of a total of 3,267,814 parameters including trainable and non-trainable parameters. Result of this model is used to query a database which returns appropriate information about the plant disease along with it's possible remedies.

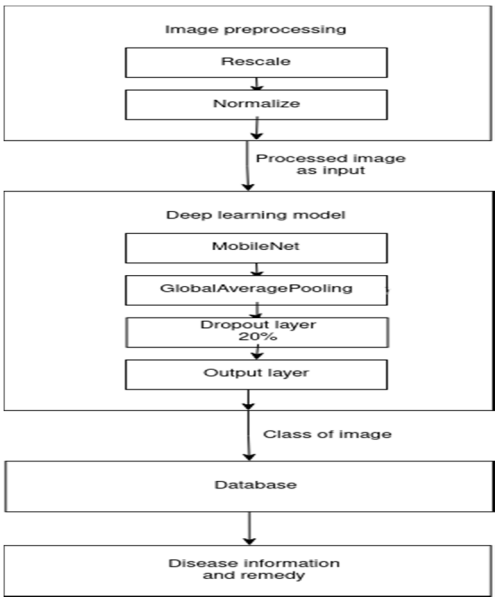

Fig. 3 Proposed Model Overview

IV. CONCLUSIONS

The main aim for this paper was to create a lightweight,fast and accurate system which could be used to identify plant diseases and suggest remedies at low computational cost and which could be used even on mobile devices and embedded devices. Hence we conclude that solutions built with neural networks tend to perform better and could be used on low powered devices.

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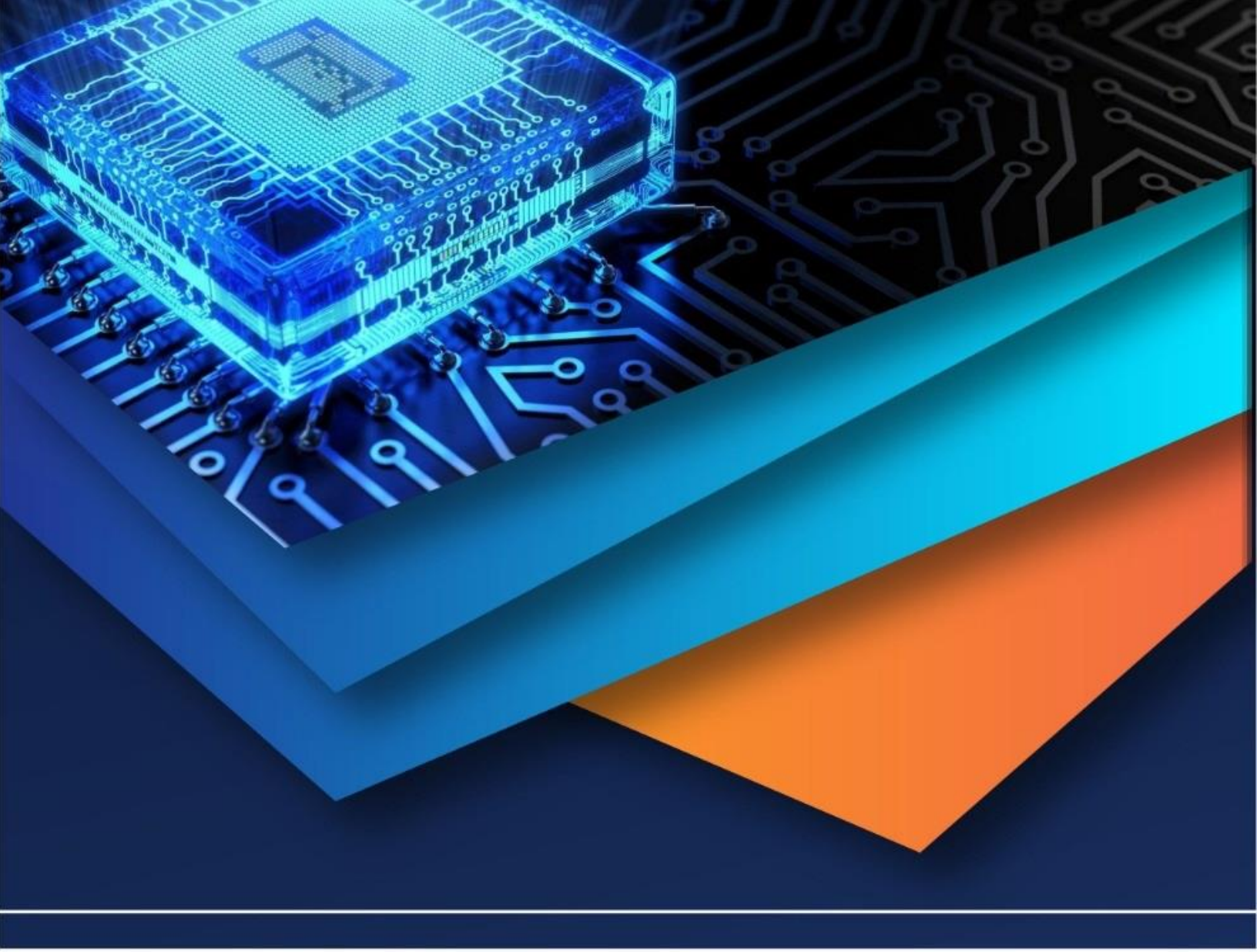

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