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Tomato Grading: A New Approach for Classifying and Predicting Tomato Quality based on Visual Features

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Abstract

Increased awareness about nourishing and healthy lifestyles to propel the consumption of vegetables in order to meet diverse dietary and nutritional needs. The global tomato market was valued to register a Compound Annual Growth Rate of more than 3.8% over the projection horizon of 2021-2026. The planned approach that calculates the grade of the tomato in regard to its external features. Grading is sorting or categorization of tomatoes into different grades according to the size, shape, colour etc and is one of the foremost necessary processes in post harvesting, however this procedure is sometimes administered manually, that is not economical as a result it needs huge estimate of enrollment, and have an inclination to human error. The grading method is performed by capturing the tomato image using web camera which calculates the percentage of ripeness based on unique set of features that are utilized to train the neural network. Color emerges as an extremely prominent feature for recognizing defect and matureness of the tomato. The major objective is to check the tomato quality with high speed for evaluating maximal count of tomatoes in least amount of time. For spoiled tomatoes, the proposed system helps in identification of tomato plant disease and allocate countermeasures that can be used as a fortification mechanism against the disease. The tomato plant disease detection can be done by observing the spots on the leaves of the diseased plant. In order to detect plant diseases, the approach we are endorsing is image processing using Convolution neural network (CNN).

Keywords: *Tomato Grading; Convolutional Neural Networks; Image Processing; Web Camera; Compound Annual Growth Rate*

1. Introduction

Agriculture sector have always held a momentous share in our national income [2]. Over two-thirds of the working populace in India is engaged directly in the agriculture domain. The agronomics sector in Asian nation is anticipated to impel superior propulsion within the next few years due to accrued investment in farming sector like irrigation conveniences, warehousing and cold storage. With the advances in agribusiness innovation, improved cultivating procedures along with the accessibility of pesticides, tomatoes are delivered for a huge scope. and this tomato crop has latterly acquired a tremendous business significance.

It is because of this reality that a great deal of cash is depleted annually by governments across the globe, for exploring new advances, finding latest techniques of cultivating and furthermore contemporary methods for counteraction of harvest decrease because of vermin, characteristic catastrophes and dry spell [9]. It is additionally a notable certainty that the creation of a decent quality vintage not just advantages purchasers, who essentially structure the top finish of the food chain, yet additionally monetarily benefits cultivator who strives to make such extraordinary yield. In an agrarian perspective, the better the quality, the more the compensation, since rural produce isn't just utilized for direct utilization by individuals however additionally by nourishment business, which exploit items like jams, sauces, pickles etc.

Tomato is the world's biggest vegetable harvest after potato and yam, however it tops the catalog of canned vegetables [2]. Tomatoes are utilized for soup, salads, pickles, ketchup, puree, sauces and from various perspectives. Accordingly, quality checking of vegetables turns into the necessity of great significance for assembling businesses also as for the farmers. Another supplementary benefit of identifying the maturity aspects of tomato, is to choose the expiry in different words the timeframe of tomato within the event that the farmer is choosing to stock the same [7]. The proposed system architecture involves an Image handling based tomato quality reviewing framework utilizing outer highlights of tomato to foresee the magnitude of ripeness with reference to that specific tomato.

Figure 1: Tomato Plant

2. Literature Review

Shwetha S. Deulkar have introduced “An Automated Tomato Quality Grading using Clustering based on Support Vector Machine” [2]. The proposed framework which ascertains the evaluation of natural product dependent on its outside features. This framework performs shading highlights furthermore, size of products of the soil the natural product side view picture. The Otsu thresholding and K-Means batching estimations are used to isolate the features of the fruit. Implementation of this framework will have applications in natural product quality reviewing in field like food science and exchanges where normalization is fundamental. Our framework got an exactness of 91.66% Surampalli Ashok, et al, have presented a framework dependent on "Tomato Leaf Disease Detection Using Deep Learning Techniques" [3]. Prior prediction of Plant Leaf diseases is a huge need in a cultivating economy like India. The designed technique is utilized to recognize the Leaf contamination using picture getting ready strategies reliant on Image division, batching, and open-source computations, as such all adding to a strong, safe, and precise course of action of diseased leaf with respect to Tomato Plants. The proposed technique has accrued a precision level of 98%.

L.Sherly Pushpa Annabel, V. Muthulakshmi have introduced an ideaology based on “AI-Powered Image-based Tomato Leaf Disease Detection” [5]. In this paper, novel tomato leaf ailment area is proposed which includes four particular stages that consolidates picture preprocessing, division, feature extraction and picture gathering. RGB to grayscale change, thresholding, GLCM and self-assertive woods classifier are the various computations that are used for execution of the proposed system. The results show that the proposed technique describes the disorders with a precision of 94.1%. Megha.P.Arakeri presents a system based on “Computer Vision Based Fruit Grading System for Quality Evaluation of Tomato in Agriculture industry” [7]. This paper proposes a programmed and powerful tomato natural product evaluating framework in light of PC vision procedures. The proposed quality assessment technique comprises of two stages: improvement of equipment and programming. The hardware is made to get the image of the tomato and move the item to the legitimate repositories without manual intervention. The item is made using picture getting ready strategies to separate the natural item for disfigurements and availability. Preliminaries were done on a couple of photos of the tomato normal item. It was seen that the proposed strategy was productive with 96.47% precision in surveying the nature of the tomato.

Akshay Kumar, Vani M have introduced an ideology based on “Image based Tomato Leaf Disease Detection” [4]. Leaf sicknesses are the serious issues in agrarian area, which influences crop creation just as financial benefit. Early identification of illnesses utilizing profound learning could evade such a disaster. At present, CNN is a class of profound realizing which is broadly utilized for the picture arrangement task. We have performed experiments with respect to the CNN engineering for recognizing illness in tomato leaves. We prepared a profound convolutional neural organization utilizing Plant Village dataset of 14,903 pictures of unhealthy and solid plant leaves, to distinguish the kind of leaves. The prepared model accomplishes test exactness of 99.25%.

System Architecture

Tomato Overview

Tomatoes have long been acknowledged to be an honest source of lycopene, the phytochemical which makes them red but which also has some symbolic antioxidant properties. Tomatoes are also exported to numerous destinations. In the process of categorizing these tomatoes, they are divided into three major sections which are as follows:

Unripen Tomato

This is the first category of tomato where 100% of it is green. They are biologically immature and unripe tomatoes that are high in essential nutrients and other health benefits like prevention of cancer, good eye health, immunity booster and so forth.

Figure 2: Unripen Tomato

Ripen Tomato

This is the second category of tomato where more than 90% of it is red. Ripened tomatoes are wealthy in carotenoids, which are fundamentally the phytochemicals that secure plants against sun beams which further instigate free extremists and thus benefits us while being consumed.

Figure 3: Ripen Tomato

Rotten Tomato

This is the third and last category of tomato where some mold spots and discoloration is noticed. Contaminated tomatoes contain harmful bacteria which leads to poisoning caused by Salmonella. Thus, consuming them make us sick.

Figure 4: Rotten Tomatoes

Proposed Method

Objective

With huge extent production and the requirement for great quality tomatoes to satisfy end-user and market guidelines criteria, have prompted the requirement for an inline, exact, reliable evaluating framework during the post-harvest procedure. The peculiar objective of this research were to build up an effective picture preparing calculation, to review tomatoes into various grading classifications. This proposed framework can be applied in real-time tomato post-harvest techniques since its quick, modest, precise, and non-detective, thus improved diminished review time and quality arranging ensure in tomato creation and supply chain management.

Data Exploration

Acquisition of Dataset

The leaf dataset consists of 2511 images of healthy and unhealthy plant leaves divided into five categories by disease name and state of health. The images are in high resolution JPG format. For prediction of tomato quality grading, the dataset consists of almost 560 images of tomato wrt different categories such as ripen, unripen and rotten tomato, followed by leaf input, disease name along with remedies were collected from Kaggle.com. The data was acquired from 2014 to February 2021.

3. Materials And Methods

We have introduced a methodology to perform maturity evaluation assessments of agrarian produce in an economical manner with a basic arrangement. The arrangement utilizes picture preparing procedures remembering a high speed yet less troublesome arrangement to diminish assessment time and quality organizing guarantee in tomato assembling and production network. The following are some of the inputs used to recognize the tomatoes quality:

Web Camera

Figure 5: Web Camera

Here, we are making use of the systems web camera with a resolution of 0.92-megapixel Video: 1280 x 720 (HD) at 30 fps that helps in capturing the input image of a tomato from the reflection of a hand phone directed to the lens of the web camera. Also an original tomato could be given as an input in front of the web camera.

Images

Pictures are deciphered a lot faster than text which is the reason pictures can impart an item, administration or brand instantly. Therefore, here the image of a tomato is being used as an input to detect its quality. In this case we are using two types of input images:

Tomato Image

First a tomato image is shown in front of the web camera lens with a correct amount of light to detect its quality. Then a tomato image can be downloaded or captured from google, if not, other imagery sources or an original tomato can be shown as an input instead.

Figure 6: Tomato Image

Leaf Image

In this type of input, we are redirected to the leaf page if the tomato is detected as spoilt. After which we are allowed to choose the type of leaf related to the rotten tomato and the program will automatically analyse and define the name of the bacteria on screen.

Figure 7: Leaf Image

System Implementation

Convolutional Neural Network Training Flow Chart

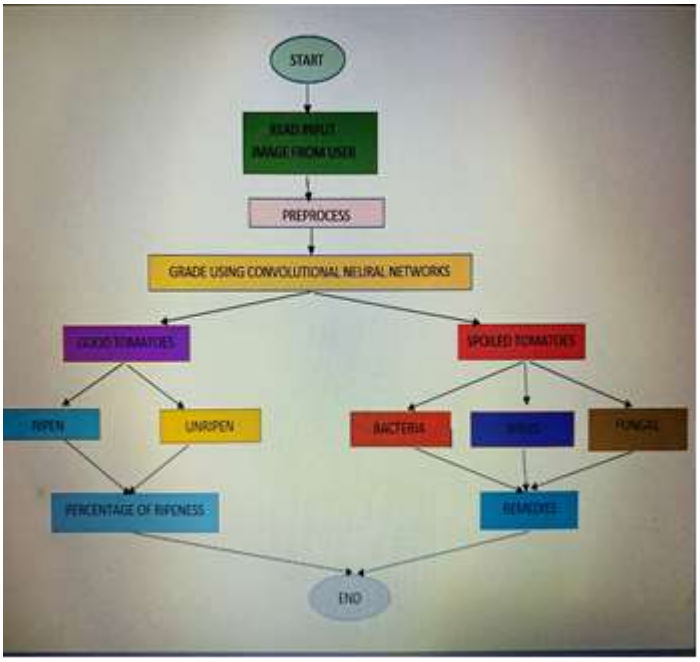

Figure 8: Convolutional Neural Network Training Flow Chart

Image Processing

Pictures are extracted from the plant, for this situation dataset pictures are the ones that are put away effectively in the data set for examination. The pictures to be distinguished couldn't measure up straightforwardly to the dataset pictures, as that may delude the process of the detection system. The pictures are handled with a progression of highlight extraction systems and are then divided to decide the influenced bit of the leaf to be thought about utilizing the CNN Classifier. Similarly, extraordinary tomato pictures are being used to prepare the convolutional neural network organization. At long last, when the network is trained, it will be used for additional reviewing of tomatoes. At that point results are utilized to distinguish and group the evaluation of tomato followed by tomato plant infection if tomato is spoiled and propose a reasonable answer for the farmer's as a prudent advance [14-19].

System Architecture

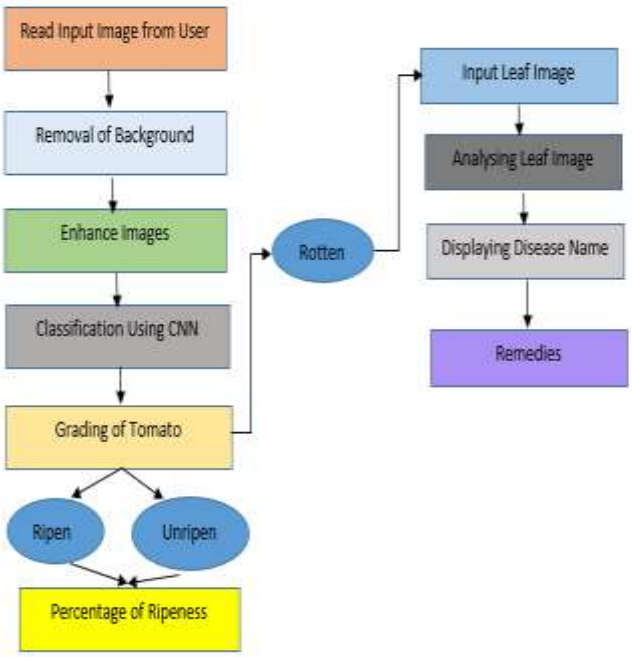

Figure 9: System Architecture

Convolutional Neural Network

A CNN calculation utilized in this recommended technique is a various leveled highlight eradication mechanism that maps the pixel esteems and assesses something very similar with the prepared dataset picture. The analyzed picture is characterized into infection influenced and typical leaf as the picture classifier procedure that has been deployed and further been analysed. For the preprocessing, the tomato would be taken from the user, after which the feature is enhanced for feature extraction where colour based features are extracted. At last these features are given to the convolutional neural network for training purposes and when the training is complete it would be finally used for grading.

Processing

In this process, there are three categories of input image evaluation. First we take an unripen green tomato and place it in front of the web camera for it to analyse the quality and the percentage of unripenness.

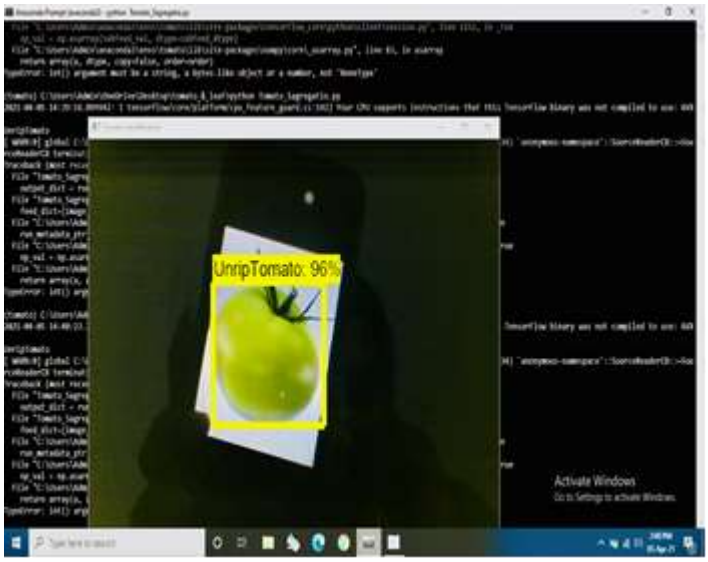

Figure 10: Unripen Tomato Output

Second a ripen red tomato is being placed in front of the web camera and the software again analyses its quality of ripeness and displays its result on the screen with the exact percentage.

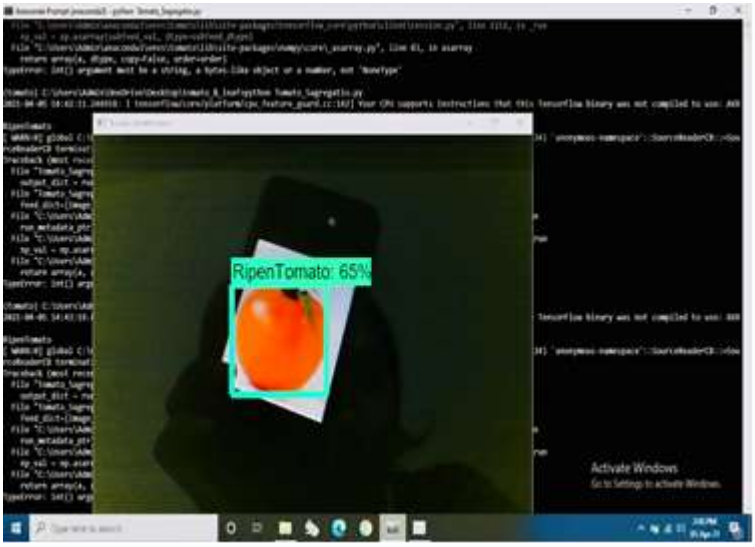

Figure 11: Ripen Tomato Output

For the final step a rotten/spoiled tomato is been showcased in front of the web camera for it to recognize how spoiled is the tomato and what caused it. The screen then displays the bacteria's name and the percentage affected followed by precautionary measures.

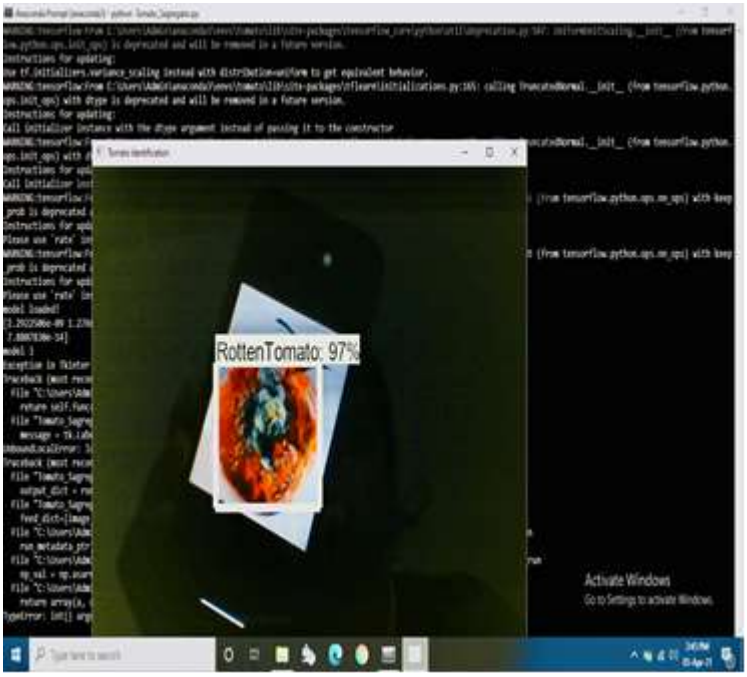

Figure 12: Rotten Tomato Output

Once the type of bacteria is detected, the screen immediately redirects us to the remedy page.

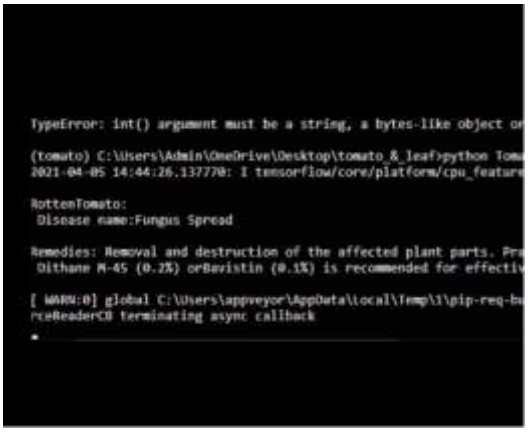

Figure 13: Disease Name will be Displayed

Basically the disease starts with the tomato leaf part and then spreads to the whole tomato and if further measures are not taken wisely then eventually the entire plant until the root will go of waste.

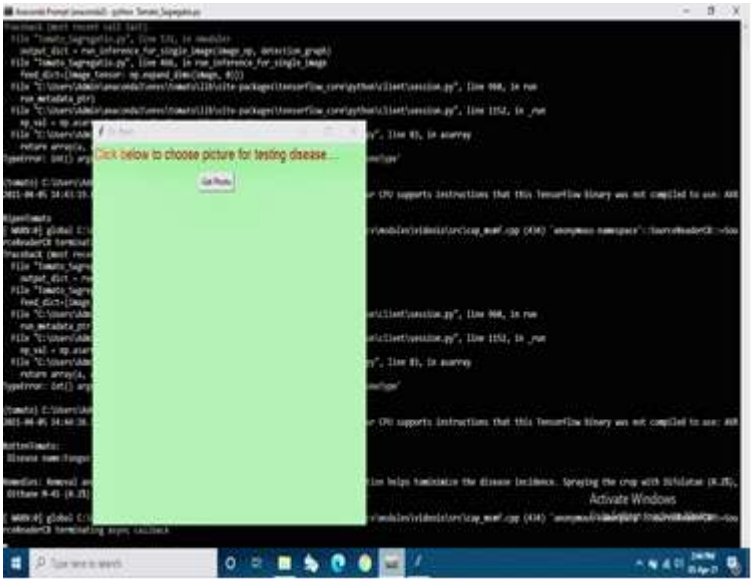

Figure 14: Leaf Page

Therefore, the right leaf type is being selected in the redirected remedy page where a set of leafs will be displayed for us to choose.

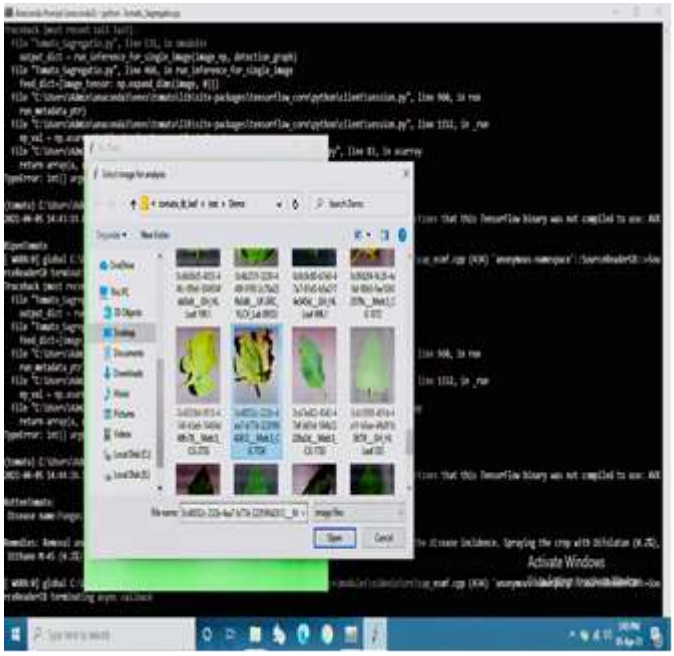

Figure 15: Diseased Leaf Selection

All we need to do is select the right type of leaf and allow it to analyse with trained network database so that it could display the exact disease name that caused the spoilt tomato.

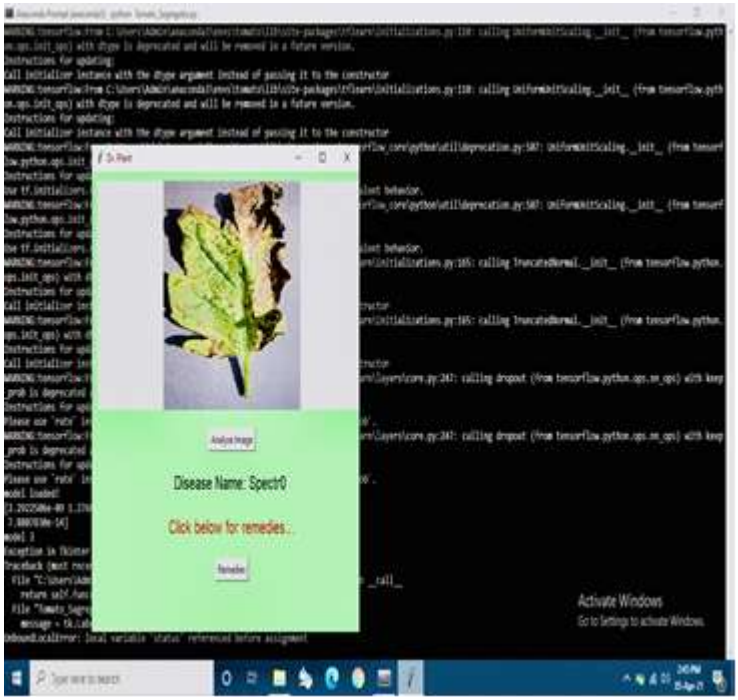

Figure 16: Disease Name Prediction

And also below this diseased name there would be a remedy box, if clicked it would display the list of remedies to prevent this disease because early detection helps in increasing the crop yield and thus helps us improve economic growth as well as the food reserve of our nation.

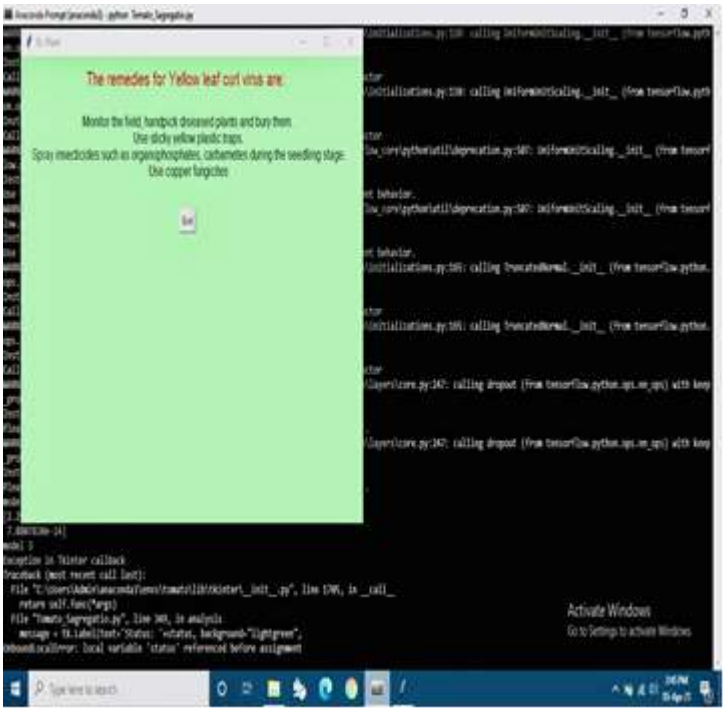

Figure 17: Remedy

3. Conclusion

The ideal technique illustrates the tomato grading: A new approach for classifying and predicting tomato quality based on visual features. Firstly, a tomato image is shown in front of the web camera lens with a correct amount of light to detect its quality. we are redirected to the leaf page if the tomato is detected as spoilt. The pictures are handled with a progression of highlight extraction systems and are then divided to decide the influenced bit of the leaf to be thought about utilizing the CNN Classifier. Once the type of bacteria is detected, the screen immediately redirects us to the remedy page. The proposed tomato quality classifier has achieved an accuracy of 91.77%.

Future Scope

Using new distinct technologies and techniques, we can build more velocious and economical application for user. First of all, we tend to take into account solely eight diseases during the analysis of this project, thus the scope of defect detection is limited. So as to extend the scope of the disease detection massive datasets of various diseases ought to be used.

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