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A LEAF DISEASE IMAGE CLASSIFIER USING DEEP RESIDUAL NETWORKS AND YOLOV3 OBJECT DETECTION ALGORITHM

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ABSTRACT

Nowadays, technology has been part of everyone's life. Technology advancements are now making a new phase in the medical field. Emerging machine learning technologies are beginning to transform agricultural sciences and improve them in making such many ways. To aid in the detection and classification of plant diseases, the study presents a Deep Learning approach by examining the leaf of the given plan. Furthermore, the categorization is performed in steps to eliminate possibilities at each level, resulting in increased prediction accuracy. To identify a leaf in the supplied image, a YOLOv3 object detector is utilized. ResNet18 is used to analyze the leaf. ResNet18 model is were trained to subject the transfer learning. Once that each layer is identified, the type of leaf will check and the models of Convolutional Neural Network will classify what diseases that occur in a plant. A disease identification system with an accuracy of 96% was developed. Research shows that management of crop diseases can help improve.

Keywords: yolo v3, cnn, resnet18, keras.

INTRODUCTION

Substantially, plant disease diagnosis plays an underlying role in science and art. The procedures in detection and diagnosis include specific identification of manifestations. Through the utilization of systematic techniques where it is intrinsically visible and innate interpretation is necessary. The studies of the disorder conditions discuss within the examinations of evident forms present on the plants. Consequently, the Philippines may be an "Agricultural" land, and the community for approximately 70% relies on tillage or cultivation fields. A paramount degradation in the standard and number of farm goods due to the disease prevalent on plants. Furthermore, the detection of certain conditions comprises various levels such as acquisition, pre-processing, and segmentation of images, aspect extraction, and analysis.
The majority of diverse plants are tainted by the variations of parasitic and bacterial sicknesses. Because of the outstanding tendency of populace, the climatic conditions additionally cause the plant disease.

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The major difficulties of supportable advancement are to lessen the use of pesticides, cost to save the climate and to increment the quality. Exact, precise and early finding may lessen the use of pesticides. Plant diseases generate a significant threat to food protection. Due to the insufficiency of the fundamental structure, it prompts difficulty on the fast identifiable verification. The combination of worldwide technology advancement entrance and the continuing improvements in PC vision presented credible by perceptive knowledge has prepared concerning mobile phone aided illness determination.

The plant disease causes an impediment to the function of the plant alters its fundamental capacities. The plants of any variety are reliant upon sickness. Nonetheless, every class is delicate to trademark illnesses. Every period the plant condition varies upon the occupancy of the microorganism, environmental state as well as the harvests and varieties cultivated. In addition, any plant assortments are mainly imperiled on flare-ups of illnesses and some are invulnerable.

The visual approach of detecting the plant illness is an intricate task, which may cause less precision, and only allowed and feasible in limited areas. Nevertheless, the utilization of programmed location procedure is time-efficient, generates less trial with more accurate results. Some extensive plant conditions show earthy colored yellow blemishes or initial scorch and diverse parasitic, viral, and antibacterial infection. Image preparation is a strategy implemented for estimating the affected region concerning the illness. Additionally, using image preparation can aid in determining the feature in the tone of the affected zone. Image classification is the task of deriving data classes from a multiband scan pattern dataset or image. The raster or scan pattern from a photo, the characterization enables usage for producing modern guides.

Leaf stands a majority role during a plant; because it is the mouth for it since, without the leaves, several plants couldn't live. The plants also stand as a requisite role within the organic phenomenon here on earth. All plants could have several conditions if a leaf incorporates a disease. Because of the elements like

sicknesses, bug assaults and abrupt change in the climate condition, the efficiency of the yield diminishes. Programmed recognition of plant illnesses is fundamental to consequently identify the indications of sicknesses as right on time as they show up on the developing stage.

Agricultural losses have a vital impact on humans because the source of food is usually from a plant. Monitoring of plant diseases presents a vital function within the thriving agriculture of products in these fields. Image classification has been a productive product of technology. Today, the simplification of image processing is used within the majority.

The process of separating one image into several segments is known as Image Segmentation. There is a transformation from adopting image segmentation from straightforward thresholding technique utilization shifting to cutting-edge shading of picture division techniques. Since PCs possess neither technique for deliberately distinguishing objects, as a result, there is a creation of portion picture for a comprehensive array of approaches. The segmentation cycle relies on varying features discovered in the photo. It may denote shading details, limits, or a piece of the image.

Convolutional Neural Networks (CNNs) are a class of profound learning organizations stimulated by biological methods. CNN's address a colossal achievement in picture acknowledgment. It is most customarily applied to disintegrate the symbolism and is oftentimes operating in the background of picture arrangement. Additionally, it is at the core of Facebook's image categorization for self-driving vehicles. They are consolidating their efforts in the background in fields ranging from healthcare to security. This research implies to unravel the plant problems, specifically in leaves. This indicates that they can familiarize themselves with the channels that must be manually constructed in various calculations. CNNs have a plethora of applications, ranging from picture and video recognition, picture grouping, and recommender frameworks to common language handling and clinical picture examination. Using Convolutional Neural Network (CNN), the leaf diseases can classify. A CNN works by separating highlights from pictures. This kills the requirement for manual component extraction. The highlights are not prepared. They are learned while the organization trains a bunch of images. It assembles absolute learning designs amazingly definite for PC vision tasks. CNNs learn highlight discovery through several concealed panels.

The panel extends the compound variety of the learned aspects. Detecting and curing the leaf diseases at a really early stage, helps such big savings and energy. The detection and classification of leaf diseases accurately is that the key to stop agriculture loss. As an answer to those problems, the researchers have studied and connected the technology to the agricultural sciences. With this program, we will detect the leaf and immediately provides a remedy to that. Machine based methodologies for sickness identification and arrangement of rural item have become a significant piece of development. Paper presents a review on existing announced methods valuable in discovery of infection. CNNs are ordinate correspondences of “multilayer perceptrons”.

“Multilayer perceptrons” generally indicate fully correlated networks, that is, one layer in each neuron is connected with all neurons in the subsequent layer. This "completely connectedness" of certain organizations enables them to be disposed to overfitting data. Ordinary processes of regularization consolidate the addition of some kind of measurement calculation of loads to the reversal operation. CNNs foster an alternative approach towards regularization: by the use of the progressive example in data and accumulate more unpredictable samples using more modest and cautious cases. Subsequently, CNNs are on the lower extraordinary on the size of connectedness and multifaceted nature, CNNs are on the lower extraordinary.

REVIEW OF RELATED LITERATURE

There are many studies regarding to emerging image processing and plants. The research has shown different Machine Learning and Deep Learning strategies to satisfy this paper. Deep-Learning based disease classification models comprise the utilization type of CNN paradigms such as AlexNet, GoogleNet, modified GoogleNet, LeNet, Caffe and Deconvolutional Network, and VGGNet. There are implementations of ResNet model for several applications like Paying more Attention, Large-Scale Plant Classification and ImageNet classification by ResNet-50.

According to Liu, Bin, *et al,* conducted the research "Identification of apple leaf diseases supported deep convolutional neural networks." is implemented at an Apple Leaf Diseases Classifier using the mix of Alex Precursor and Cascade Inception Architecture. It also provides an honest comparison between their model and therefore the other models likeResnet-20, SVM, GoogleNet, Back Propagation (BP) Neural Network, AlexNet, and VGGNet-16 on the idea of performance, accuracy, convergence rate (with relation to epochs) and also the computational resources required. These criteria were tested on the apple disease dataset compose of 1053 images. The classifier that was built gave an accuracy of 97.62%

A paper by Sue Han Lee makes use of Caffe framework and Back-Propagation mechanism in training the model. One of the approaches utilized in understanding the interior working of the CNN model and visualizing the chosen filters was done using Deconvolutional Network. The Deconvolutional Network provides a function that permits us to determine the feature map at each layer by deconvolution and unpooling right down to input image pixel. The models were trained on two datasets, MalayaKew Dataset and addition of local leaf data to original dataset. According to experimental data obtained, the model trained on the modified database yielded only a marginal increase in model accuracy when compared to the model trained on the first dataset.

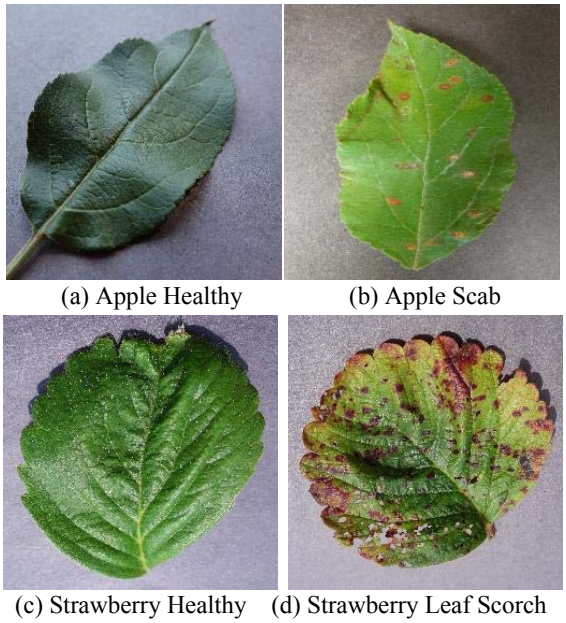
In another paper that proposes a plant identification system, the quality VGGNet-16 architecture was taken and modified by adding more convolution layers for learning the combined species and organ features resulting from the high-level fusion architecture model. Moreover, this model as well as Fine-tuned VGGNet-16 was trained on the PlantClef2015 dataset consistent with the experimental results, the High-level fusion architecture didn't perform better compared to the fine-tuned VGGNet-16.

METHODOLOGY

Dataset

The collection of data employed in this study paper and trained in the program and different CNN models are obtained from SP Mohanty's Git-Hub repository called 'PlantVillage' dataset. The dataset included raw images, data distribution for SVM and other useful data. The raw images have grayscale and colored pictures. Each category yields close to 55k photos, which includes 38 distinct classes. Overall, t the dataset has a total of 38 classes, the datasets are pre-trained already in the python model come from the GitHub. In this study, coloured (RGB) images were utilized to train and categorize the diseases.

As a result, the selected dataset includes 29 classes and 36k images. Division of the dataset is done on the selected dataset as shown in Table-1 and resulting into 8 superficial classes. Now, the dataset is divided into training and validation sets, each comprising 80% and 20% of the dataset. Thus, we have 28938 and 7210 images for training and validation sets. The Figure-1 below is the examples of datasets. Utilizing pictures of plant leaves from a public dataset of 36,158 accumulated by controlled conditions, the researchers train every learned convolutional neural network.



(a) Apple Healthy (b) Apple Scab

(c) Strawberry Healthy (d) Strawberry Leaf Scorch

Figure-1. Images from the dataset.

Table-1. Division of dataset.

Leaf Category	No. of Images used as Datasets
Apple	3171
Cherry	1906
Grape	4062
Peach	2657
Pepper	2475
Potato	2152
Strawberry	1565
Tomato	18170
Total	36158

Image Processing

The measurement of the images used in the PlantVillage dataset has 256x256 pixels. Moreover, Keras deep learning framework is used to process the data and create the image factors. The following factors are employed in training:

Rotation - Randomly Rotate a Training Image via Multiple Angles

Brightness - Assists the model in adapting to changes in lighting conditions during training by feeding images of varied brightness. Shear - Adjust the image in a clockwise or counter-clockwise direction to adjust the shearing angle

Zoom - Provides the input image scaled by various factors Vertical/Horizontal Flip - The image is randomly flipped about the vertical/horizontal axis.

The whole process is divided into 3 stages (Figure-3):

a) An input image is initially taken, A You Only Look Once (YOLOv3)[9] object detector to run over the input to acquire the coordinates of bounding boxes around leaves present in the image, if any. The detector splits the taken input image in a grid and then analyzes every cell to identify features of the target object.

b) The leaves are then identified in the image using the OpenCV library using the given coordinates. These extracted images are passed as input to a CNN Classifier which classifies the input into the 8 classes of plants from the dataset.

c) CNN classifiers are trained to recognize diseases associated with each of the eight (8) plant classes. The output of stage 2 is used to invoke the classifier that was trained to classify the various diseases associated with that plant. If none exist, the leaf is considered as 'Healthy'.

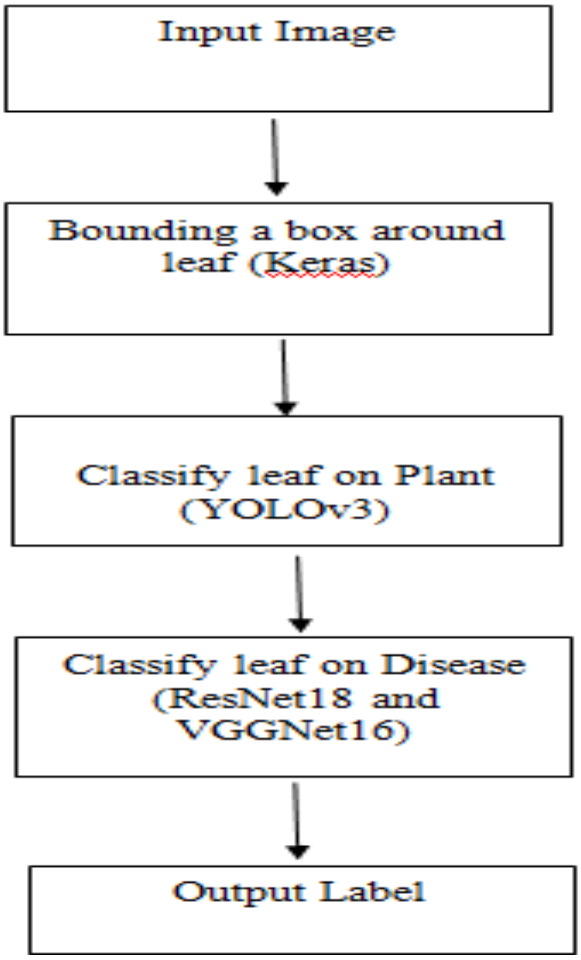


Figure-2. Block of process in running the program.

Every stage was trained on the same dataset to provide better accuracy and consistency.

EXPERIMENTATION AND ITS RESULTS

YOLOv3 Object Detector

At conventional computer vision methods, a sliding window was utilized to search for objects in varying positions and scales. Generally, it was presumed that an object's aspect ratio is fixed since it is an expensive operation. YOLOv3 is an algorithm used as an Object Detector.

In comparison to recognition algorithms, a discovery calculation doesn't just anticipate class marks yet identifies areas of items also. Along these lines, it orders the picture into a class, yet it can likewise identify numerous Objects inside an Image. This Algorithm applies a solitary Neural organization to the Full Image. It implies that this organization isolates the image into districts and determines bouncing receptacles and possibilities for all-region.

Furthermore, the bouncing boxes are weighted by the predicted possibilities. YOLO then prompts toward the item classification issue remarkably. Through the organization, it elevates the whole photo in a particular moment. SSD is another article recognition calculation that improves the picture once. However, a profound learning organization, yet YOLOv3 is much faster compared to SSD while performing completely similar exactness.

The images were manually annotated. This had to be done in a step-by-step pattern. In this case on applying, it in Leaf Disease Classifier, the YOLOv3 is a tool to cropped out the image of leaf out of the image itself. This detector-algorithm is use to detect and returns the (x,y) coordinate of the opposite corners. The YOLOv3 returns a bounding box that surrounds the leaf that are cropped out. In the Figure-3a, it shows the raw image from the input where there is no bounding box. From the Figure-3a, the program will produce the 4b where the bounding box is drawn around the leaf.

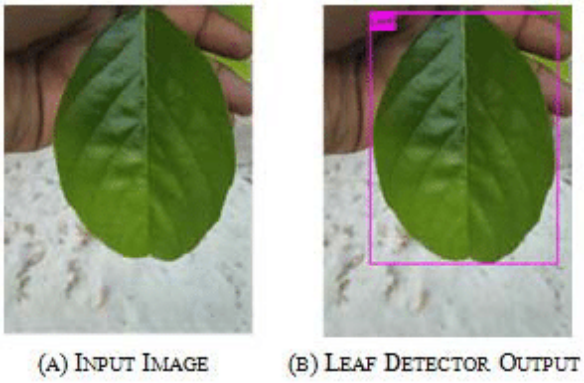


Figure-2. Images of YOLOv3 from input to output

Using VGGNet Structure

The info pictures subsequent to preprocessing are gone through these weight layers. The preparation pictures are gone through a pile of convolution layers. There are absolute of 13 convolutional layers and 3 completely associated layers in VGG16 engineering. We can sum up the particular of a VGG-block as at least one convolutional layer with similar number of channels and a channel size of 3×3, a step of 1×1, same cushioning so the yield size is equivalent to the information size for each channel, and the utilization of a corrected direct actuation work. These layers are then trailed by a maximum pooling layer with a size of 2×2 and a step of similar measurements. Due to the poor accuracy seen using the simple classifier [10], it had been decided to adopt a proven network structure, VGG16 during this case.

The model was trained from scratch after modifying the output layer to satisfy the classification requirements. it absolutely was observed that the model had an accuracy of fifty. 26% from the graph in Figure-6 and converges very slowly. Thanks to this fact, it absolutely was decided to use transfer learning to possess faster training times and better accuracy. These advantages are because the model has learned to acknowledge most of the features and must only undergo some epochs of coaching so as to

enhance accuracy and fine-tune prior knowledge to suit the applying. The VGGNet Structure is a credible structure that we can use because of its detailed architecture model (Figure-4).

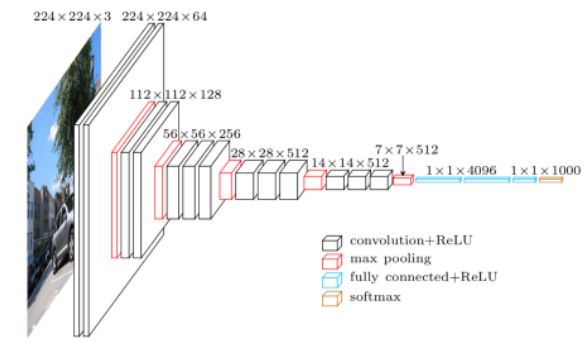


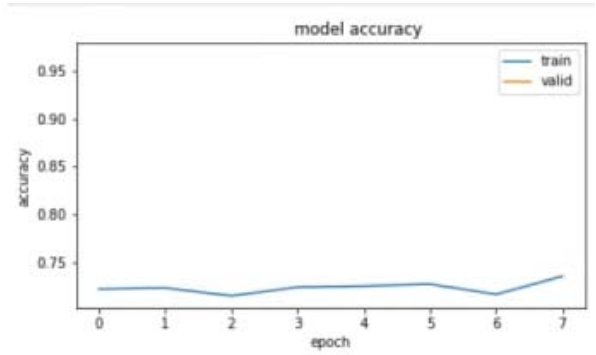
Figure-4. VGGNet16 structure model.

RESULTS

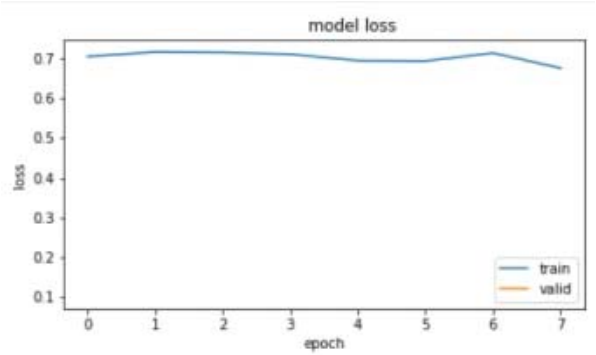
An epoch is a machine learning terminology that refers to the number of passes through the entire preparation dataset that the machine learning calculation has completed. In terms of counterfeit neural organizations, an age alludes to one cycle through the full preparing dataset.

Normally, preparing a neural organization takes in excess of a couple ages. All in all, on the off chance that we feed a neural organization the preparation information for more than one age in various examples, we expect a superior speculation when given another "inconspicuous" input (test information). An age is regularly stirred up with an emphasis. Cycles are the quantity of clumps or steps through divided bundles of the preparation information, expected to finish one age. Datasets are typically gathered into clusters (especially when the amount of information is enormous). A few peopleutilize the term emphasis freely and allude to getting one cluster through the model as a cycle.

If the cluster size is the entire preparing dataset, then the number of ages equals the number of iterations. Normally, this is not the case for practical reasons. The program is trained with the datasets find in the Plant Village Datasets. The Results show high accuracy and low loss (Figure-5) the program is showing a promising result as it shows that it can detect the leaf. (Figure-6).



(a) Model accuracy



(b) Model Loss

Figure-5. Model accuracy and model loss.

The results shown in the epoch serves a great presentation of the program in determining the disease of the leaf that is processed on the program itself.

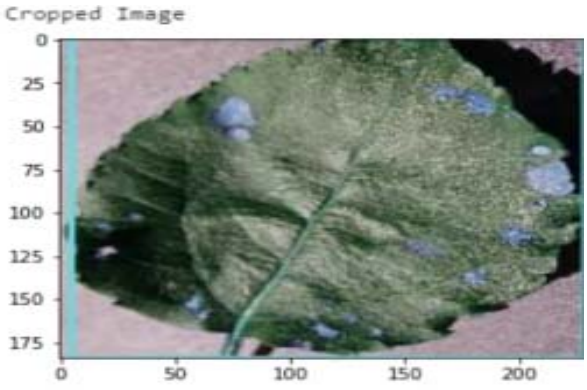


Figure-6. Program output.

The Figure-7 shown the output image that can see that the leaf has scab and it cropped the photo where the leaf is located.

CONCLUSIONS

The Philippine agriculture is performing marginally better compared in 2018. It remained a burden on an otherwise robust economy in the year 2019.

Furthermore, agricultural generation increased by approximately 0.4 percent in the final quarter of 2019, conveying the entire year average to 0.7 percent. All things considered, Image Processing, at the same time with AI, can be characterized as a distinct advantage in the new time. This study aides in expanding the nature of any item.

To recognize the weeds, we can utilize this technique. Weeds are those unfamiliar plants that are filled in the fields, and it contends with the yields to improve natural conditions, including water, manures and even daylight. It antagonistically influences the development of yields. Edge-based machine classifiers can recognize these weeds. Infrared picture examination helps with comprehension and checking of water system frameworks. Indeed, even the infrared picture examination can be utilized to visualize the collect time. PC vision and picture preparing can likewise be utilized to rate products of the soil stocks dependent on shading, volume and shape. Robotized quality examination of food items can help ranchers protect a great deal. Image-processing based approach methodology is proposed and helpful for plant infections identification.

The above-described system may be extended to be as a real-time system supported video input that might open an occasion to unsupervised plant management. Another feature that would be incorporated to the given system would behave the system suggest a cure for the identified disease. A disease identification system with accuracy of 96% was developed. Research shows that management of crop diseases can help improve.

The implementation of deep learning systems could help in better diagnosis of diseases in crops as these analyze all the way down to the tiniest unit of a picture, a pixel. This level of detail can't be analyzed using the naked eye. Precision can be accomplished utilizing advancements, for example, computerized reasoning, IoT, calculation dependent on principles, AI relapse strategies, picture preparing, move learning, hyper-unearthly symbolism, leaf extraction and division.

For that reason, the infection recognition in plants implies a notable role within the agribusiness area, since having illness in plants is very prevalent. If not taken a legitimate consideration, in that case, it prompts consequences on plants in which specific item quality, value, or profitability is affected. For instance, a disease called little leaf sickness is a dangerous illness discovered in pine trees in the United States. Identification of plant disease by any programmed or digital system is beneficial. This program recognizes the indications and manifestations of illnesses even in the commencement period. Early detection of an ailment manifested by the plant leaves is feasible through the application of this program. It depreciates the enormous job of checking in extensive properties of yields.

In most pragmatic circumstances, nonetheless, customary strategies can't be the most proper decision. It is indiscreet to overlook contrast between real pictures and guessed information. In this manner, improved strategies and another acknowledgment framework dependent on various direct relapse are made.

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