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Crop Surveillance using Drone

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Abstract

Every year we face a huge loss of crop and agricultural revenue to pests. These pest infections are one of the main challenges faced by farmers today. To reduce the problems caused by the leaf deceases a proper surveillance of the crops is essential. The farmers are dependent on observation through naked eyes to analyze the risks of infections on their crops. This method is tedious and is not very fruitful. In this paper we discuss a system to use drones for crop surveillance. We will be using a tensorflow and keras models to train and identify the leaf infection. We will be using the open source Plant Village dataset of images that has about fifty thousand imagens of more than 14 crops with about 17 different types of infections. We are building an application that will accept RGB formatted images and convert them to HSI format. The HSI image will be segmented and we identify the leaf infection. We propose to acquire a video of the crop field via drone, then convert the video to .jpg images using existing tools and using these images to run the tests. This way the farmer will be able to save time and efforts and get better yield.

Keywords: Segmentation, Tensorflow, Convolutional Neural Network.

1. Introduction

Indian farmers face huge losses each year due to infection of various pests on the crop. A normal human monitoring cannot accurately predict the amount and intensity of pests and disease attacking the farm for spraying correct and enough fertilizers/pesticides to eliminate the host. There is an urgent need to deliver cost effective and easy to use technological upgradation to the Indian farmers to help them reduce the cost and effort that goes into agriculture and help them understand and predict the need of their crops and the precautions that are need to maintain the health of the produce. The health of a plant leaf is an early indicator of the crop health and the quantity of yield. Recognizing the infection can help the farmer in taking precautionary measures and in turn help in improving the quality of the crop.

The proposed drone aims to decrease the time and effort required in the maintenance of the crops and fruits for farmers. This drone will help farms to access wet land which is hard for humans to perform in.The purpose here to not only reduce human effort but provide better efficiency in terms of identification and, in some cases, prediction ofoccurrence of pests and infections to the crop. The use of such systems will result in decreased operations cost and increased yield for farmers.

2. Related Work

There have been several previous studies in attempt to automate the process of analysing risks of infections. The plant village dataset is popular amongst the researchers in this filed. There have been multiple types of experiments

in order to ease the process of decease identification and to improve the accuracy of the results.

Most common approaches use the tensorflow or keras libraries to train the dataset. An android application is many researcher's go-to front end interface since android is largely accessible to rural farmers. It has been observed that a CNN of multiple layers drastically improves the accuracy. In some cases, the output was up to 95% accurate when a five layered convolutional neural network was used.

In our experiments we will be working with a desktop application, using pre-trained models of tensorflow and keras to increase the efficiency of the results. During our work we had also developed a web-based app that uses Django. We later found that the desktop application is slightly better in terms of accuracy and user experience. We will be sharing

3. Dataset

The first task was to get the right dataset. The success of our model deepened on it! We had three options to collect datasets. When we first started looking for a dataset, we were unaware of the Plant Village dataset.

The first approach we thought of was creating our own dataset by using a web scrapper. This would have been time consuming and inefficient. Before we could move on, we did some digging and concluded that the ecosia website is a great resource if one were to create a plant related dataset by scraping. However, we found another option.

The second-best dataset we came across was to use the dataset by LeafSnap. It is a mobile application that helps to identify tree species from photograms of their leaves. The developers of LeafSnap had made their dataset public. This dataset has images of more than 20 species of plants. While this is a good dataset to place your linear model on, we choose to go with crowdAi dataset of plant village.

The plant village dataset was released by crowdai as a part of one of their challenges. It is a public dataset of 54,305 images of diseased and healthy plant leaves collected under controlled conditions. The images cover fourteen species of crops, including: apple, raspberry, , cherry, peach, grape, orange, tomato, pepper, potato, soy, squash, strawberry and blueberry. It contains images of seventeen basic diseases, four bacterial diseases, two diseases caused by mold (oomycete), two viral diseases and a disease caused by a mite. Twelve crop species also have healthy leaf images that are not visibly affected by disease. This dataset has both coloured and black and white images. Our primary focus was on coloured images.

Here is a structure of the dataset:

```
└── PlantVillage
    ├── Pepper__bell___Bacterial_spot
    ├── Pepper__bell___healthy
    ├── Potato___Early_blight
    ├── Potato___Late_blight
    ├── Potato___healthy
    ├── Tomato_Bacterial_spot
    ├── Tomato_Early_blight
    ├── Tomato_Late_blight
    ├── Tomato_Leaf_Mold
    ├── Tomato_Septoria_leaf_spot
    ├── Tomato_Spider_mites_Two_spotted_spider_mite
    ├── Tomato__Target_Spot
    ├── Tomato__Tomato_YellowLeaf__Curl_Virus
    ├── Tomato__Tomato_mosaic_virus
    └── Tomato_healthy
```

Fig 1: File structure for the dataset used.

4. KERAS Model

We used keras with a tensorflow backend to build our training models. Keras is an opensource library built in python that makes experimenting with data in real time easier. Keras was a perfect choice since it comes prepacked with tensorflow. It also works with other popular options such as 'pytorch'. We used keras with tensorflow to build our model, which we then trained using Kaggle.

The purpose of this model was to train our program to identify the properties of infected and healthy leaves and be able to differentiate between them.

We can see in the following figures that with more training we were able to achieve better results. The deviation between predicted and true labels reduces quickly and the accuracy of predicting pictures using a model increases greatly during the training.

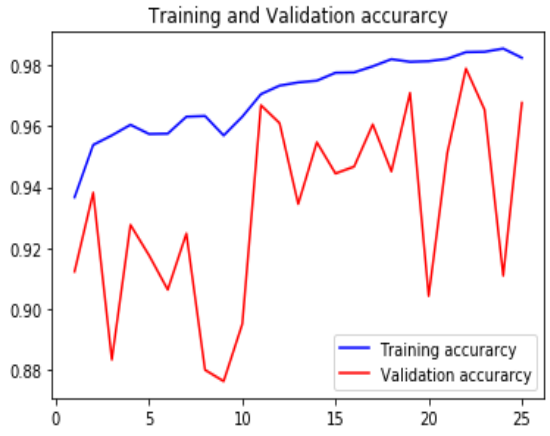

Fig 2: Training and validation accuracy.

Using pre-trained modules:

Training with a dataset this big would have taken many days. To improve the output of our application we decicded to use a pretrained module. We used the AlexNetModel and a cnn_model created using the pickle library.

5. Front End

We experimented with a web based front end. For this we used a Django server. However, we decided to go with a desktop frontend with a cleaner look. Here is how the web frontend looked:

Fig 3: The web based front end deployed using Django.

For the desktop frontend we used 'qt designer' and required 'PYQT5' library. To create an executable version of the project 'pyinstaller' library was used. Here is a snapshot of the desktop version:

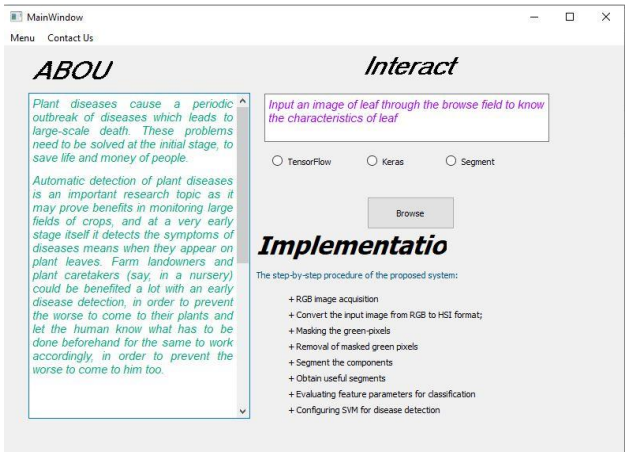

Fig 4.1: The desktop frontend developed using qt designer.

The above installer has three options. The tensorflow and keras options use different trained modules for classification. The segmentation option is used for viewing the process of image processing from RCB to HSI and see how different parts of a leaf are segmented for recognition. The detailed process of segmentation is discussed further in the paper.

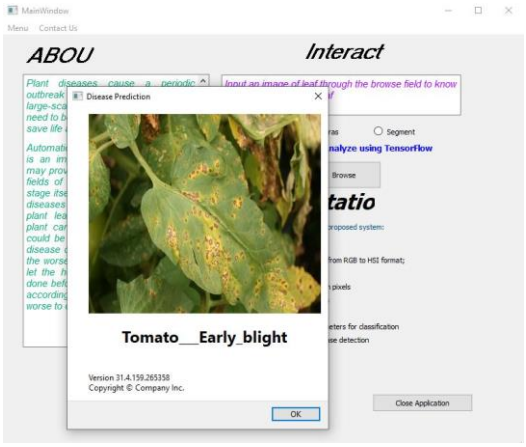

Fig 4.2: A leaf decease is identified using the program.

6. Image Segmentation

When a farmer manually analyses a crop for decease, he uses his conscience to distinguish between the heathy and infectious leaves. However, computers do not have such capability. That is why we train the computer by feeding data and teaching it to distinguish between a good and faulty leaf. To accomplish this task, we use image segmentation. Image segmentation means breaking of image into various parts on the basis of its characteristics. In simpler words, we separate the leaf from any and all unnecessary elements that might be in the background, like crop branches. Then, we separate the infectious part of the lead and use this to identify the decease based on our trained model.

- We first take the user's desired image in .jpg, .jpeg or .png format and convert it into HIS format. HSI stands for hue, saturation and intensity. This format is most closely associated with human vision.
- The next step is to mask the green pixels. Generally,the green part of the leaf is healthy. We eliminate these masked green pixels.
- Then, we segment the image to obtain useful infected area that is to be passed to the classifier.
- The classifier then runs on the segmented data and we obtain the desired result.

7. Problems Faced

- The training of module on a local computer is very hard as a local computer usually lacks the required power. While trying to train the model locally, we had to invest a lot of time and the results were still inaccurate as the training data was insufficient.

- There prime reason for a few inaccurate results is that some plat leaves exabit very similar features but are not from the same species.
- A problem in segmentation is that sometimes the infected area is similar to the branches in the background of an image. This might result in inaccurate results.

8. Conclusion

By using a simple drone to cover a large area of a field we can collect the data of the entire field. Using any online tool to break this video files into images in easy. We can scan these images for potential outbreak of plant deceases. In some cases, we might even predict the outbreak before its inception.

This is an easy to use application to help identify multiple types of plant leaf deceases.

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