STUDY AN IMAGE PROCESSING BASED APPROACH TO IDENTIFICATION OF BANANA PLANT DISEASE USING DIY BUILT F450 DRONE

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Abstract - In this research paper is an image processing-based approach is being proposed and used for banana plant disease detection and locating using Aruco Marker ID tags and a DIY-Built F450 Drone at very low cost. Author tests our results on three diseases which effect on banana crops; they are: Cordana, Pestalotiopsis and Sigatoka. The proposed approach is image processing based and is much supported Convolutional Neural Network (CNN) adopting AlexNet Architecture. The approach consists of 6 main phases; capturing images of plants with their individual Aruco Tag ID to Google Drive database from drone, data pre-processing, images are segmented using RGB to HSI conversion, applying mask to K-means clustering on the images, extracting feature from data and training Neural Network Model.

Keywords - Neural Network, Convolutional Neural Network, Plant Disease, Image Processing

I. INTRODUCTION

Despite India being the Top country of Bananas Production in the World and having the Safest Cultivation Practices as of 2020, it is inevitable to state that banana trees in plantations still do get infected with diseases which are spreadable to other plants. These diseases can be caused by external factors such as Pests, Climate and many more. It is even crucial to an extent they term it as "Banana Covid". Hence, it is a necessity to trace an average of 846,000 square meters of plantation and isolate plants which are infected with diseases similar to how contact tracing of humans is carried out. There are an average of 4,000 plants in 1 acre in Tamil Nadu. It is impossible to avoid the plants from getting infected by external factors, however, it is still possible to ensure other plants do not get infected due to the spread of disease from infected plant. Due to the shortage of manpower on banana plantation sites, it would be very efficient and effective to use a customised F450 DIY Drone to do those identification & diseased plant integrating MATLAB and its location around the plantation with its mission planning semi-autonomous feature and other own customised programmed features such as ESP32 Live Cam integrating Arduino & Raspberry Pi Camera Module integrating Python.This paper discusses the Data Processing Techniques used to do image processing and locating of Banana crops and my process of customizing my own built DIY F450 Drone to perform this mission at very low cost as possible.

II. BACKGROUND STUDY

As far as Tamil Nadu, India is concerned, Bananas are fruits and high herbs which are cultivated for three primarily purposes; food consumption, production of fibre used in the textile industry and also for ornamental purposes. These Banana fruits are being exported to other countries from Tamil Nadu as well such as South Korea and Europe. Through this, research has proven that farmers are earning about Rs. 8 lakhs for one hectare of banana crops grown which is quite a huge profit [8].

The Top Banana diseases in India as of current which are spreadable to other plants are i) Black Bacteria Wilt and ii) Black Sigatoka as well. Due to these diseases, the production of banana crops will be badly affected [3]. Hence, this affects both consumers and also farmers' rice bowl due to reduction in banana crops production. Therefore, this Banana Disease is an important issue to be addressed. It is inevitable prevent Through this; research has proven that farmers are earning about Rs. 8 lakhs for one hectare of banana crops grown which is quite a huge profit [12]. The Top Banana diseases in India as of current which are spreadable to other plants are i) Cordana, ii) Sigatoka and iii) Pestalotiopsis. Due to these diseases, the production of banana crops will be badly affected [3]. Hence, this affects both consumers and also farmers' rice bowl due to reduction in banana crops production. Therefore, this Banana Disease is an important issue to be addressed. It is inevitable prevent Banana Plants to get infected, however it is possible to prevent spreading to other crops once it is being discovered through computer Machine Learning algorithms for disease detection and tracing location of infection in a database.

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III. TYPES OF DISEASES IN BANANA LEAF

3.1. Cordana

It is a worldwide common disease for banana plants. The two Neocordana fungi causing this disease are: Cordanamusea and Cordanajohnstonii.The symptoms are big, oval, pale brownto spindle-shapeddying lesions with pale grey concentricpatternswith a brown border enclosed by a yellow halo separating the lesion from the healthy tissue. Eventually, the leaves transform brown and dry out.The leaf spots caused byCordanamusae are bigger and oval-shaped to elliptical-shaped. Those caused by Cordana johnstonii are usually smaller and become more spindle-shapedas days pass by.Spreadfrequentlytakes place at leaf margin weakened by ageing, poorconditions of environmental, nutritional deficiencies, infections caused by other leaves. Symptoms are most oftennoticed around lesions caused by other fungus on other leaves. When the infection is connected with other diseases such assigatoka, the lesions are even bigger and become dead. This takes place under humid conditions especially. Therefore, to control this, early detection is crucial to prevent the spread of the disease to other plants [6].



Fig. 3.1 Cordana

3.2. Sigatoka

It is also known as Leaf Spot or Leaf Streak Disease. Initial symptoms include light yellowish spots on the leaves. As time passes by, a small number of these spots enlarge such as becoming oval. Moreover, the colour changes to dark brown too. Eventually, the centre of the spot would die, turning to light grey, surrounded by a brown ring. Sometimes, it could be even worst when several spots combine together, killing the large sector of the leaf. There are also external factors that cause the spread of this disease such as Rainfall, dew and temperature especially when higher than 21 degree Celsius. This would drop the yield production by 30-50%.

Therefore, in order to make this spread of the disease under control, locating the diseased plant and isolating it from other healthy plants is primary step. Alternatively, proper cultural practices such as improved drainage, weeds control, disease suckers' removal, correct spacing adoption are also helpful.



Fig. 3.2 Sigatoka

3.2. Pestalotiopsis

The early symptoms of the disease arebrown, narrowlesions that would become irregular brown spots overtime. The lesions slowly spread from the leaf middle to the margin andbrown spots appeared on the affected leaves. There is a clearyellowish boundary around the spot. Blighted tissue frequently covers one-third to one-half of the infected leaves.Wind and water movement easily disperses spores of Pestalotiopsisto other plants, hencelocating the diseased plant and isolating it from other plants can be proven to be critical in preventing the movement of the disease [10].



Fig. 3.3Pestalotiopsis

IV. DRONE FLYING REGULATIONS IN INDIA

The diagram below has been summarised the categories and requirements as per latest revised guidelines for flying Drone in India, 2022. As seen in diagram below, there are 5 main categories. As for my DIY Drone, it falls under Micro Category as it is slightly around 2kg. As for our project, the drone would be flying maximum of 6-8 feet as for banana crops height to capture images. Moreover, there would be a livestream of the forward camera of the

drone which means there would be a visual line of sight at all times when in-flight [11].

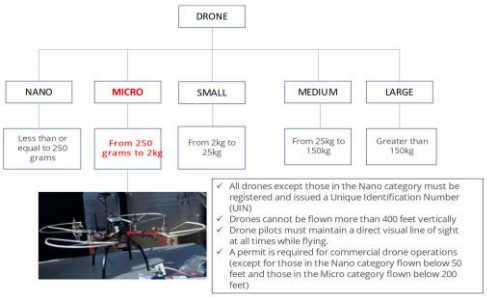


Fig. 4.1 Drone Categories and Subsequent Regulations

V. METHODOLOGY

The DIY F450 Drone System as shown in diagram below comprises of 3 main systems. Pixhawk Flight Controller to control the movement of drone, ESP32 Cam (Livestream to laptop using common IP Address) to view and lead the drone path, Using Raspberry Pi 4 Cam to capture images and upload to Google Drive database.

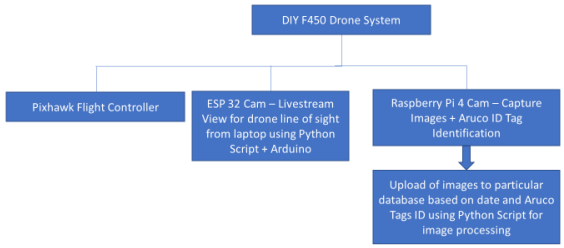


Fig. 5.1 DIY F450 Drone Systems

The data was collected at a banana plantation in Palani, Tamil Nadu, India. There were two sets of data to be taken: Training dataset and Testing dataset. Training dataset was taken using 10 images from each category of Banana Plants (Healthy, Sigatoka, Cordana and Pestalotiopsis) from the plantation as shown in figure 5.2 below with the farmer's explanation.



Fig. 5.2 Location of collection of Training dataset

Next, Testing dataset was collected from banana plants especially grown within the first three months after plantation as research has proven banana leaves grown within the first three months are more prone to spreading of any disease compared to other stages of banana leaves. Hence, eight different banana plants with 5-8 feet distance interval were selected and tagged with their corresponding Aruco Tag IDs as seen in figures below.



Fig. 5.3 Banana Plant 1



Fig. 5.4 Banana Plant 2



Fig. 5.5 Banana Plant 3

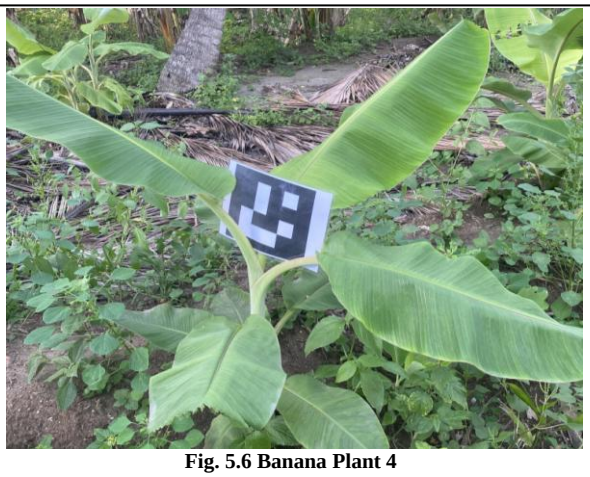


Fig. 5.6 Banana Plant 4



Fig. 5.7 Banana Plant 5



Fig. 5.8 Banana Plant 6

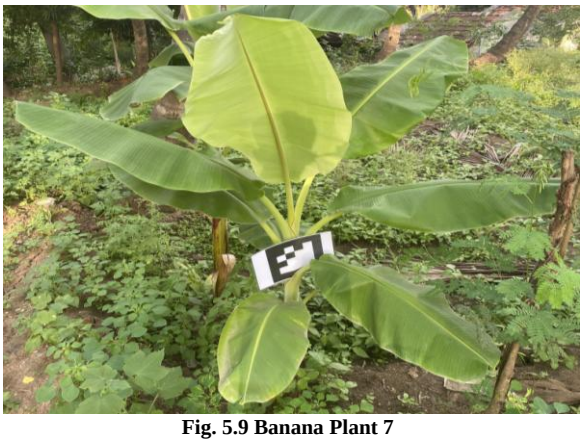


Fig. 5.9 Banana Plant 7



Fig. 5.10 Banana Plant 8

Each leaf in each plant was captured using the in-built Raspberry Pi Camera in the own DIY-built drone and uploaded to Google Drive database folder number according to the 4X4 Aruco Tag IDs generated and detected using Python Script. The images from database can be retrieved anytime for image processing using MATLAB as seen in the flowchart in figure 5.11.

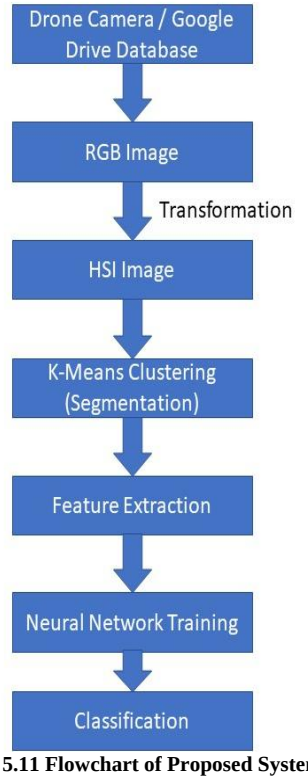


Fig. 5.11 Flowchart of Proposed System

Using the below leaf from Plant 2 taken from DIY Drone as an example to demonstrate the system in figure 5.12.



Fig. 5.12 Leaf used for demonstration

5.1 Transformation of RGB Image into HSI

The first step after loading images from database into MATLAB would be converting RGB Image to Hue Saturation Intensity (HSI) as seen in the Graphical User Interface (GUI) in figure 5.13.

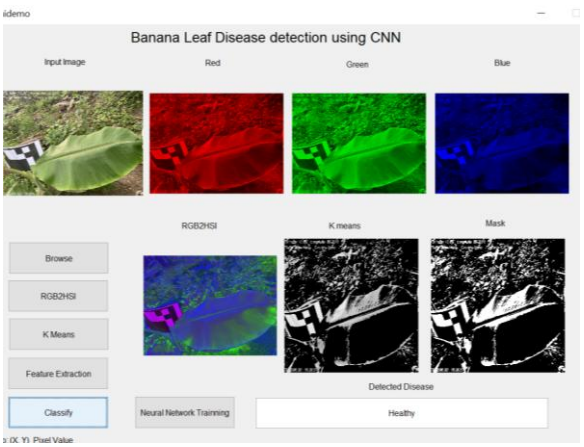


Fig. 5.13 Banana Leaf Disease Detection GUI (MATLAB)

The HSI color model improves human's perception of color. Hue is the color perception impacted by the wavelength. Saturation refers to the extent of purity of the color free from grayscale dilution. High saturation infers that the color has high purity whereas low saturation infers that there is a abundance of dilution with white light produced by Red, Green and Blue Primary components. Hue and Saturation combined provide the pixel's color content. Intensity refers to the energy level of the light. Intensity is not dependent on either hue or saturation. Altogether, HSI produce any color and light intensity [7].

5.2K-Means Clustering

The second step would be doing Image Segmentation [1]. Image Segmentation is used to locate objects and boundaries such as curves, lines. As for this project, Clustering-Based Method is used for Image Segmentation. K-means algorithm would be used as seen in figure 5.14 below.

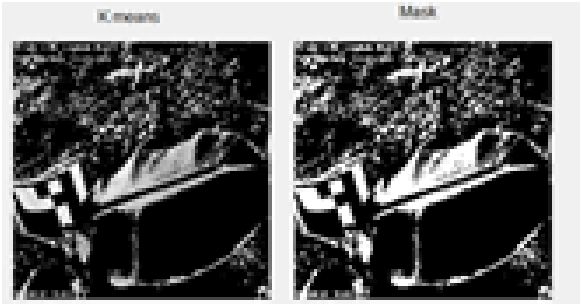


Fig. 5.14K-means clustering and Binary masking

K-means algorithm is an unsupervised one used to detect groups that were not explicitly labeled in the data. It is very simple for interpretation and resolution. For a bigger number of variables in the dataset, K-means operates faster than any other types of clustering. Binary masking in K-means algorithm is where white region dictates foreground and black region dictates background [8].

5.3Feature Extraction

It is part of dimensionality reduction processand comes in handy when thereis a huge dataset and there is a need to reduce the number of features without deleting any crucial information.

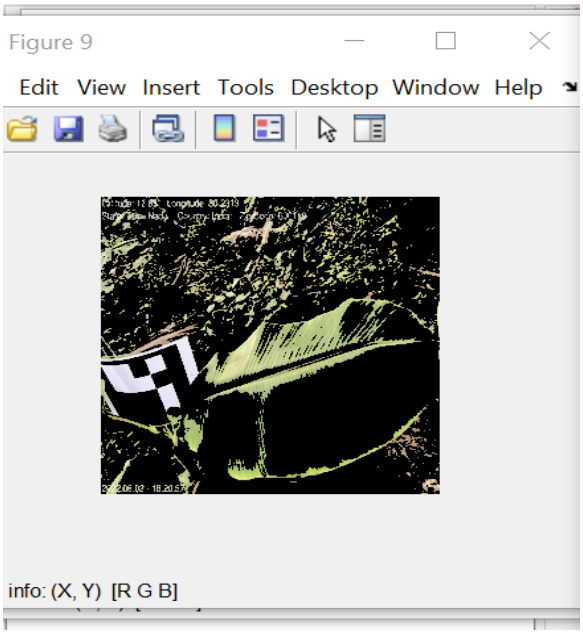


Fig. 5.15 Feature Extraction Process of demo leaf

5.4Classification using Neural Network

Lastly, training Neural Network Models enable to map inputs to outputs with a training dataset given. The training process involves evaluating a set of weights in the network that proves to be good, or sufficient enough, at solving the Banana Plant Disease Detection [4]. AlexNet Architecture was the

first Convolutional Neural Network (CNN) which used Graphics Processing Unit to increase performance. In dataset folder for each category of banana leaf, the Feature Extraction image of each Training data is created.

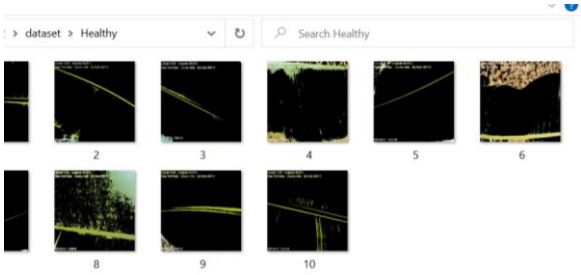


Fig. 5.16 Feature Extraction of each training dataset image

The Feature Extracted image from the test dataset is compared with each feature extracted image created for each category of train dataset to see which category matches with that. It will then display whether the leaf is healthy or not and what type of disease it is affected with.

VI. EXPERIMENTAL RESULT AND OBSERVATIONS

Training Progress Report is plotted and it is reported that the data accuracy is 97.50%. There are 50 passes of the whole training dataset completed by machine learning algorithm.

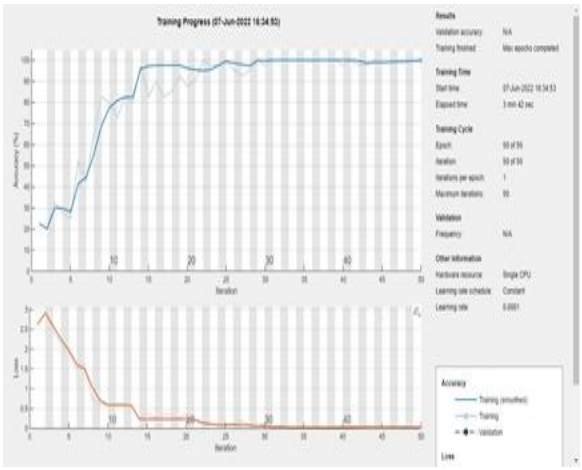
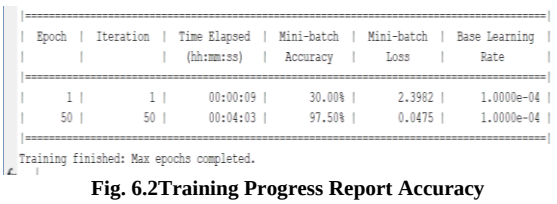


Fig. 6.1 Training Progress Report of data



Epoch	Iteration	Time Elapsed (hh:mm:ss)	Mini-batch Accuracy	Mini-batch Loss	Base Learning Rate
1	1	00:00:09	30.00%	2.3982	1.0000e-04
50	50	00:04:03	97.50%	0.0475	1.0000e-04

Training finished: Max epochs completed.

Fig. 6.2Training Progress Report Accuracy

Going through the whole test dataset of 38 leaves over 8 banana plants, there are 7 plants which are healthy and 1 plant which is affected by Sigatoka.

VII. CONCLUSION AND FUTURE WORK

During this study, an image-processing-based approach is proposed and used for banana plant disease detection using a low-cost DIY Drone and connecting to a database. We tested our MATLAB and Python scripts program on three most critical spreadable diseases which effect on the banana plants; they are Cordana, Sigatoka and Pestalotiopsis.

The proposed approach is image processing based and is much supported Convolutional Neural Network (CNN) adopting AlexNet Architecture. The approach consists of 6 main phases; capturing images of plants with their individual Aruco Tag ID to Google Drive database from drone, data pre-processing, images are segmented using RGB to HSI conversion, applying mask to K-means clustering on the images, extracting feature from data and training Neural Network Model.

For future research, I would like to develop program to detect more range of diseases for banana plants. Furthermore, I would like to further improve on my drone mission by using fully autonomous feature with Dronekit Python AI Scripts to control drone.

REFERENCES

[1] A Gentle Introduction to Image Segmentation for Machine Learning. V7labs.com. (2022). Retrieved 3 May 2022, from https://www.v7labs.com/blog/image-segmentation-guide.

[2] A Guide on Splitting Datasets WithTrain_test_split Function. Bitdegree.org. (2019). Retrieved 3 May 2022, from https://www.bitdegree.org/learn/train-test-split.

[3] Banana Plant Disease Classification Using Hybrid Convolutional Neural Network. Hindawi. (2022). Retrieved 3 May 2022, from https://www.hindawi.com/journals/cin/2022/9153699/.

[4] Brownlee, J. (2019). Why Training a Neural Network Is Hard. Machine Learning Mastery. Retrieved 3 May 2022, from https://machinelearningmastery.com/why-training-a-neural-network-is-hard/#:~:text=Implications%20for%20Training-,Learning%20as%20Optimization,at%20solving%20the%20specific%20problem.

[5] Confusion Matrix, Accuracy, Precision, Recall, F1 Score. Medium. (2019). Retrieved 3 May 2022, from https://medium.com/analytics-vidhya/confusion-matrix-accuracy-precision-recall-f1-score-ade299cf63cd.

[6] Cordana leaf spot | Improving the understanding of banana. Improving the understanding of banana. (2022). Retrieved 7 June 2022, from https://www.promusa.org/Cordana+leaf+spot.

[7] Cse.unr.edu. (2022). Retrieved 7 June 2022, from https://www.cse.unr.edu/~looney/cs674/mgx8/unit8.pdf.

[8] K-Means Clustering And Why It's Good For Business. Dotactiv.com. (2022). Retrieved 7 June 2022, from https://www.dotactiv.com/blog/why-k-means-clustering-is-good-for-business.

[9] OpenCV: Canny Edge Detection. Docs.opencv.org. (2022). Retrieved 3 May 2022, from https://docs.opencv.org/4.x/da/d22/tutorial_py_canny.html.

[10] Pestalotiopsis (Pestalotia) Diseases of Palm. Edis.ifas.ufl.edu. (2022). Retrieved 7 June 2022, from https://edis.ifas.ufl.edu/publication/PP141.

[11] Pro, R. (2022). Drone Laws in India | UAV Coach (2022). UAV Coach. Retrieved 3 May 2022, from https://uavcoach.com/drone-laws-in-india/.

[12] Profitable Banana Farming Business; Know Cost & Profit Details. Krishijagran.com. (2021). Retrieved 3 May 2022, from https://krishijagran.com/agripedia/how-to-start-a-profitable-banana-farming-business-cost-profit-details-inside/.

[13] Singh, G. (2013). Important diseases, insects and pests of Banana and their management . - Krishisewa. Krishisewa.com. Retrieved 3 May 2022, from https://www.krishisewa.com/disease-management/286-dbanana.html.

[14] The Sobel and Laplacian Edge Detectors. AI Shack. Retrieved 3 May 2022, from https://aishack.in/tutorials/sobel-laplacian-edge-detectors/.

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