A Project Report on

Automation for Indian Agriculture to analyze fitness and life-cycle of crops using drones

Submitted in partial fulfillment of the requirements for the degree of

BACHELOR OF TECHNOLOGY

in

Computer Science and Engineering

by

Eshan Dutta	1417111
Dinesh M	1417161
Santosh Mahato	1417139

Under the Guidance of

Mahesh D S

Department of Computer Science and Engineering

Faculty of Engineering, CHRIST (Deemed to be University),
Kumbalagodu, Bengaluru - 560 074

April-2018

Faculty of Engineering

Computer Science and Engineering

CERTIFICATE

This is to certify that **Santosh Mahato** has successfully completed the project work entitled "**Automation for Indian Agriculture to analyze fitness and life-cycle of crops using drones**" in partial fulfillment for the award of **Bachelor of Technology** in **Computer Science and Engineering** during the year **2017-2018**.

Mahesh D S
Assistant Professor

Dr. K. Balachandran
Head of Department

Dr. Iven Jose
Associate Dean

Faculty of Engineering

Computer Science and Engineering

BONAFIDE CERTIFICATE

It is to certify that this project titled ”Automation for Indian Agriculture to analyze fitness and life-cycle of crops using drones” is the bonafide work of

Name	Register Number
Eshan Dutta	1417111
Dinesh M	1417161
Santosh Mahato	1417139

Examiners [Name and Signature]	Name of the Candidate : Eshan Dutta, Dinesh M, Santosh Mahato
1.	Register Number : 1417111, 1417161, 1417139.
2.	Date of Examination :

Acknowledgement

We would like to thank CHRIST(Deemed to be University) Vice Chancellor, **Dr. Rev. Fr. Thomas C Mathew**, Pro Vice Chancellor, **Dr. Rev. Fr. Abraham**, Director of Faculty of Engineering, **Fr. Benny Thomas** and the Associate Dean **Dr. Iven Jose** for their kind patronage.

We would like to express our sincere gratitude and appreciation to the Head of Department of Computer Science and Engineering, Faculty of Engineering **Dr. K. Balachandran**, for giving me this opportunity to take up this project.

We also extremely grateful to my guide, **Mahesh D S**, who has supported and helped to carry out the project. His constant monitoring and encouragement helped me keep up to the project schedule.

We also extremely grateful to my project Co-ordinator, **Kukatlapalli Pradeep Kumar**, who has supported and helped to carry out the project. His constant monitoring and encouragement helped me keep up to the project schedule.

Declaration

We, hereby declare that the project titled "**Automation for Indian Agriculture to analyze fitness and life-cycle of crops using drones**" is a record of original project work undertaken by us for the award of the degree of **Bachelor of Technology** in **Computer Science and Engineering**. We have completed this study under the supervision of **Mahesh D S**(**Computer Science and Engineering**)

We also declare that this project report has not been submitted for the award of any degree, diploma, associate ship, fellowship or other title anywhere else. It has not been sent for any publication or presentation purpose.

Place: Faculty of Engineering, CHRIST(Deemed to be University) , Bengaluru
Date: 02-04-2018

Name	Register Number	Signature
Eshan Dutta	1417111	
Dinesh M	1417161	
Santosh Mahato	1417139	

Abstract

As per the current agricultural trends in India, crop protection and crop enhancement is the top priority due to decline in the production rate caused due to pests and other crop diseases. The agricultural growth has faced potential threat due to increase in the demand and decline in production. In order to prevent plant diseases, we have come up with image processing techniques to monitor the crop growth. Our project uses drones for surveillance of crops and identify diseases. Photographs captured from drone in agricultural fields will be processed in a computer device to analyze and decide whether the crops are healthy or not.
Keywords- *agriculture; crop disease; image processing; drone.*

Contents

LIST OF FIGURES

GLOSSARY

.

Item	Description
Drone	A drone is an un-manned aerial aircraft which flies from a remotely controlled system
UAV	**U**n-manned **A**erial **A**ircraft. It is an aircraft which flies without pilot. It is controlled remotely from a system
ESCs	**E**lectronic **S**peed **C**ontrollers
OpenCV	**O**pen **C**omputer **V**ision
Python	A programming language. In this project it is used to process images
SIFT	**S**cale **I**nvariant **F**eature **T**ransform
Edge Dectection	An algorithm to detect edges of the object
Adaptive Thresholding	A mechanism to modify the pixels of an image
Micro controller	A compact computerized device which has an embedded circuit
GDP	**G**ross **D**omestic **P**roduct

Chapter 1

INTRODUCTION

1.1 Problem Formulation

This project has been inspired from the epitome of current hitches in Indian Agriculture. Our nation imbibes mechanization and technology in very few parts of the country, whereas the remaining major areas still continues to carry out traditional ordinary and conventional techniques and tools. This is leading to the use of human labor in large scale which otherwise could have been used for other accomplishments. The current scenario requires a speedy act to improvise the pace and efficiency of the existing practice of yielding crops. The use of machinery plays an essential role to carry out efficient and judicious happenings in agriculture which will simplify varied harvesting with increased output.

In the thought process of this problem formulation, we were interested in engaging drones for improving the technology of Indian farming in a unique way. The core idea is to detect pests and weeds at the very early stage and provide solution to it using drones.

1.2 Problem Identification

The current problems which we are trying to rectify are:- detection of pests and manual supply of pesticides. These two problems constitutes some challenging approaches to figure out the simple solution. Thus we have come up with drones to detect diseases in crops and then spray pesticides onto the crops for rectification. The automated spraying of pesticides into the crops can be a boom to human labor and to save our precious time.Drones are mostly electric powered which is yet another great advantage. Its pollution free and eco-friendly. The detection of pests is carried out by capturing images from a camera which is fitted on the drone. Now these pictures are processed in a computer running algorithms of Open Computer Vision in python programming language.

1.3 Problem Statement & Objectives

1. Analyze and improve the life cycle of the crops.
2. Detect pests/diseases in crops.
3. Spray pesticides.

1.4 Limitations

1. Due to budget constraints, the drone is assembled with minimum capabilities eg-power of the motors, battery used is limited.
2. The camera mounted on the drone is a cellphone camera. For image processing its better to have a high resolution camera.
3. We need high configured computers to process images with high resolution which otherwise takes nearly infinite processing time.

Chapter 2

RESEARCH METHODOLOGY

The initial step is to analyze the problem that Indian Agricultural practices is facing in early pest or disease affected leaf in crops. We have analyzed the same through various research papers and articles of some renowned journals like of IEEE Explore which is licensed in college campus. In addition to IEEE explore journals like IOSR, Southern Journal of Agriculture Economics has given us enough raw input to gain idea on how to approach for solving the aforementioned problem. On surfing the internet, we found numerous image processing techniques implemented for pest detection but it's a tedious task to choose the appropriate one as our reference model among them. This is the reason we referred various research papers published in different journals around the globe. The following table cites various research papers along with their objectives, methodology, published year, publisher and their author's name.

Year	Author	Objective	Methodology	Publisher
1971	Robert P. Jenkins	Research on systems approach for pest control	System Analysis	Sourthern Journal of Agricultural Economics
2006	Mark L Gleason, Brooke A Edmundus	Study Tomato Diseases and Disorders	Research Work	IOWA State University Journal
2013	Maged Wafy, Hashem Ibrahim	To identify weed Seeds in mixed sample of Wheat grain.	SIFT Algorithm	IEEE
2013	Rupesh G Mundada, Dr. V. V. Gohokar	Detection of Pest in Greenhouse using image processing	Image Processing	IOSR-JECE
2014	Jagadeesh D. Pujari, Rajesh Yakkundimath, Abdulmunaf S Byadgi	To identify and classify fungal disease affected on Agricultural crops.		IEEE
2016	Amrita A. Joshi, B.D. Jadhav	To Monitor and Control Rice Disease.	Image Processing Technique	IEEE
2016	Preetha Rajan, Radhakrishnan B, Dr. L. Padma Suresh	To detect and classify pests from crops	Support Vector Machine	IEEE
2016	Nileshrao C Sawant,Renuka Panchagavi	Compare and Analyze Image processing Techniques for pest detection	Computer Vision, AI	IJARCSSE

FIGURE 2.1: Table: Research Papers Referred

Chapter 3

LITERATURE SURVEY AND REVIEW

Use of Computers has been immensely used for data collection, data management, data analysis and computer simulation in the studies on plant pathology [I]. Computer image processing technologies have been used in the studies on plant diseases. This description can be extracted from a training image, then it will be used to match between the object in a training image and test image containing many other objects. To perform reliable recognition, its an important aspect for features extracted from the training image is formally invariant to an image translation, noise and illumination, rotation and zoom out. Thus it was a much required module to identify objects that is invariant to scaling, orientation, and partially invariant to affine distortion and illumination changes[2]. Images are obtained from the UAV from plants separation form the background. A better image segmentation and noise in the resulting plants were made to eliminate the morphological filtering. To represent the resulting plant was subjected to the binary image acquisition and counting process[3].

3.1 Literature Collection and Segregation

Some specific diseases show general symptoms that are be caused by different pathogene produced by leaves, roots etc. The present study has been focused on early detection and classification of fungal disease and its related symptoms[4]. As per the 2010 FAO (Food and Agricultural Organization), worlds agriculture statistics, India is the world's largest producer of many fresh fruits and vegetables, milk, major spices, select fibrous crops such as jute, staples such as millets and castor oil seed. India is the second largest producer of wheat and rice, the world's major food staples. India is the world's second or third largest producer of several dry fruits, agriculture-based textile raw materials, roots and tuber crops, pulses, farmed fish, eggs, coconut, sugarcane and numerous vegetables. India ranked in the world's five largest producers of over 80 percentage of agricultural produce items, including many cash crops such as coffee and cotton, in 2010.

Computer Vision Systems (CVS) developed for agricultural applications, namely, detection of weeds, sorting of fruits in fruit processing, classification of grains, recognition of food products in food processing, medicinal plant recognition, etc. In all these techniques, digital images are acquired in a given domain using digital camera and image-processing techniques are applied on these images to extract useful features that are necessary for further analysis[5]. Plant disease diagnosis is an art as well as science. Many diseases produce symptoms, which are the main indicators in field diagnosis. The diagnostic process (i.e., recognition of symptoms and signs), is inherently visual and requires intuitive judgment as well as the use of scientific methods. The photographic images of symptoms and signs of plant's diseases used extensively to enhance description of plant diseases are invaluable in research, teaching, diagnostics, etc. Plant pathologists incorporate digital images using digital image transfer tools in diagnosis of plant diseases[6]. Till now experts identify the presence of the disease in the plants manually, but it is expensive for a farmer to consult an expert due to their distant availability, so it is required to detect the symptoms of the plant diseases automatically as early as they appear on the plant. Early detection will help farmers to avoid huge loss. Technology support would help them in early detection of diseases, cutting on cost of pesticides, and good returns for the efforts, thus making the profession attractive. To remedy this situation various alternatives are being searched to minimize the application of these hazardous chemicals. One of the main concerns of scientists is the automatic disease diagnosis and control. Several key technologies incorporating concepts from image processing and artificial intelligence are developed by various researchers in the past to tackle this situation.

Agriculture is one of the oldest profession taken by men and most rural communities and many cities depended on agricultural production for their livelihood. Not only has the sowing of crops shaped our landscape and environment, it has also influenced many aspects of society. Throughout the history, agricultural activity has been the engine that spurred land ownership, maintained state and local economies, motivated pioneers and family farmers to produce “amber waves of grain.” There has been a significant technological advancement in terms of growth in agriculture using modern ways of farming and harvesting crops. These include use of modern machinery that can reduce human labor and enhance the process of cultivation and harvesting of crops, use of heavy machinery like crop harvester, crop sprayer, cotton harvester etc. has tremendously increased the process of agricultural farming and it generates a lot of raw materials for industries in certain amount of time. Due to such technical advancement in the field of agricultural science, crops seasons are not necessary for the growth of crops that grow in certain seasons. Crops can be grown in any seasons to meet all kinds of industrial needs. Industries process these raw materials to produce fodder for livestock and to meet human demands which rises annually. Food scarcity is a major problem across the globe, due to increasing demand in consumption and a steady decline in crop growth rate.

Many countries exports lots of crops from India including fresh fruits. The agriculture in India is an important topic in Indian geography. 49 percent of the population in India is depending on agriculture. In the total geographical area in India, 141 million hectares is net sown area and 195 million hectares is gross cropped area. The agriculture shares 14 percent of GDP and distribution of income and wealth. It provides essential amenities like food for the people and fodder for the animals. It also provides the major source of raw materials to the agro-based industries in India. The vast relief of country, varied climate and soil conditions harvest a variety of crops. All tropical, subtropical and temperate crops are grown in India but predominantly food crop is cultivated in the 2/3rd of total cropped area. India has three major cropping seasons called Kharif, Rabi and Zaid. The Kharif season is from July to October and Rabi season from October to March. The crops grown between the months of March to June called Zaid.

3.2 Critical Review of Literature

Literature survey and studies in agricultural science indicate lot of studies done to improve the crop growth and its life cycles. Development of an automated system for identifying and classifying different diseases of the contaminated plants is an emerging research area in precision agriculture. Identification of the diseases is the key to prevent qualitative and quantitative loss of agricultural yields. Popular methods proposed include detection of weed in plants seeds, sapling infestations, identification of rice disease, detection of fungal disease in cotton plants, extraction of leaves features to study the production of Ayurveda medicines. The present study is concerned with detection of diseases that affects crops and causes decline in production. Early detection and diagnosis is the main objective of the methodology proposed.

Chapter 4

ACTUAL WORK

Description:- This chapter deals with our real work that is being completed using OpenCV python. Starting from the way our drone is planned to scan the infected areas to process, find and suggest a solution to the disease found; here are the modules through which we will describe our work. Here are the briefing of modules.

1. Image Acquisition.
2. Image Processing with Python Programs through OpenCV Algorithms.
3. Post-Implementation.

4.1 Agenda of the Drone (Image Acquisition)

This procedure is implemented to make our idea feasible in real life scenario. Otherwise it would have been nearly impossible to detect diseases of crops in big land. The whole land will be divided into several vantage points. Our drone will be flying through these vantage points.
The steps are:-

1. Drone captures images in point A.
2. If it finds some disease in point A, we will resend it to a point which is further to A. (say C)

3. In case we find disease there, there are probabilities that the whole area is infected.

4. In such case we will send the drone to point B. If disease is found, its confirmed that all the three points are infected and thus the area needs to get sprayed.

FIGURE 4.1: Point to Point Pest Scanner Algorithm

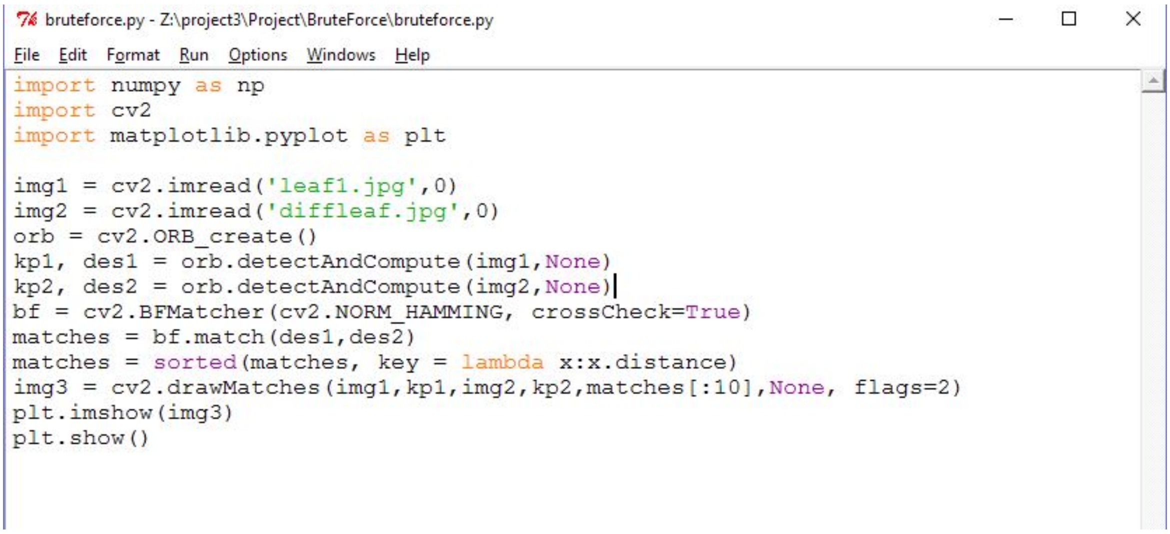
4.2 Working with OpenCV in Python (Image Processing Algorithms)

Using Brute Force Matcher to analyze and compare between a healthy leaf and an unhealthy leaf: The mechanism of Brute-Force Matcher works quite simple. The algorithm picks a descriptor/parameter of the healthy leaf and then mapped with the other descriptor/parameter in the unhealthy leaf. This analysis makes it easier for us to spot any unusual happenings in the examined leaf.
The steps of creating a Brute-Force Matcher Algorithm:-

1. Create an object of BFMatcher using cv2.BFMatcher().

2. The above mentioned function BFMatcher() takes two parameters.

3. Specify the parameters :-
    - Distance measurement: cv2.NORML2 or cv2.NORMHAMMING2. This type of parameter specifies the distance measurement to be used. The use of parameter is on the basis of Binary String based descriptors or the default ones.
    - Boolean Variable: This variable remains false by default. In case this variable is true, it returns the matches with value (i,j). i in set A has j descriptor B as the best match and vice-versa.
4. Read the images of the leafs
5. Obtain the descriptors
6. Match the descriptors
7. Read the images of the leafs
8. Plot and show




```
import numpy as np
import cv2
import matplotlib.pyplot as plt

img1 = cv2.imread('leaf1.jpg',0)
img2 = cv2.imread('diffleaf.jpg',0)
orb = cv2.ORB_create()
kp1, des1 = orb.detectAndCompute(img1,None)
kp2, des2 = orb.detectAndCompute(img2,None)
bf = cv2.BFMatcher(cv2.NORM_HAMMING, crossCheck=True)
matches = bf.match(des1,des2)
matches = sorted(matches, key = lambda x:x.distance)
img3 = cv2.drawMatches(img1,kp1,img2,kp2,matches[:10],None, flags=2)
plt.imshow(img3)
plt.show()
```

FIGURE 4.2: Brute Force Matcher (Python Program)

A module in python using Hough Circles to Identify Septoria in tomato leafs: Septoria is a disease caused by fungi which leads to cause holes on the leaf. It affects plants like wheat, tomato etc. In OpenCV, there are properties like Hough Circles, erode, adaptive threshold. We have used these properties to process the images which are captured by our drone. After processing our images, we could identify the holes and affected portion of the leafs.

FIGURE 4.3: Septoria Diseased Leaf

Some Attributes of OpenCV used in this project:

- Gaussian Blur : It is a technique used in image processing to reduce the noise of an image.This consequently reduces the image clearly or detail.It makes an image out-of-focus. In order to enhance the image structures at different levels we apply gaussian blur. In mathematics, it is like performing convolution of an image that helps in reducing the high frequency structures of the same. In Python, gaussian kernel is used to apply gaussian filter to the image. The function for the same is cv2.Gaussian Blur(). The parameters that this function can take are:- Height and Width of the kernel. These values must be positive. Next parameter is the standard deviation in the directions X and Y; sigmaX and sigmaY respectively. In case only one specification is given i.e sigmaX or sigmaY then the specified one will be taken. The mathematical equation for one dimensional Gaussian function is:-

$$G(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{x^2}{2\sigma^2}} \qquad \text{--------- (1)}$$

FIGURE 4.4: Gaussian Blur Equation

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}} \qquad \text{--------- (2)}$$

FIGURE 4.5: Gaussian Blur Equation in 2-Dimensions

- Segmentation and Thresholding in Image Processing:- It is a process which is carried out for image segmentation. Image segmentation is the process of segregating a digital image into several segments which is nothing but sets of pixels. We perform segmentation to convert images into a simplified form that is more precise and the one which is making more sense. We can locate boundaries, entities such as lines, points etc in images. So, basically image segmentation assigns pixels in an image with specific characteristics.
  All the pixels that are selected in an area that maps to some features or properties like intensity, texture, or color. The corresponding areas differ greatly with same features and properties.
  The applications of Image Segmentation are Face Detection, Iris Recognition, Locating Objects(Crops,forests,road etc),Surgery Planning, Content-based image retrieval.
  Thresholding is nothing but the simplified way of image segmentation. This method is used to generate binary images. The pixel value which is bigger than a threshold value,is given one value which may be white.Which otherwise is assigned to a value like black. The function used for this is cv2.threshold. The First

Argument in the thresholding function is foundation(source) image. The Second Argument is the threshold Value for identify the varieties of pixels. Then comes the third argument which is maxVal whose value will be given in case the pixel value is crossing the threshold level.
The mathematical functions of Binary and Binary Inversion Thresholding are:-

- **THRESH_BINARY**

$$\mathrm{dst}(x,y) = \begin{cases} \mathtt{maxValue} & \text{if } \mathrm{src}(x,y) > T(x,y) \\ 0 & \text{otherwise} \end{cases} \qquad \text{--------(3)}$$

FIGURE 4.6: Binary Thresholding

- **THRESH_BINARY_INV**

$$\mathrm{dst}(x,y) = \begin{cases} 0 & \text{if } \mathrm{src}(x,y) > T(x,y) \\ \mathtt{maxValue} & \text{otherwise} \end{cases} \qquad \text{----------(4)}$$

FIGURE 4.7: Binary Inversion Thresholding

- Hough Circle Transform in Image Processing:- The Hough Circle Transform is an elementary practice in Image Processing to identify circular shaped entities in an image. This method is a kind of feature extraction procedure to detect circles. It is evolved from Hough Transform. Through this, we can find circles in the irregular image inputs. The circle nominees are chosen by polling in the Hough parameter space followed by picking a local maxima in the accumulator matrix.

(a,b) is the center of the circle and r stands for radius. In a 3-Dimensional figure, circle parameters are recognized by the intersection of conic shaped surfaces which are similar to points in a 2-D figure. The whole process is a two stage task. The first stage is to figure out the optimal center of the circle using fixed

$$(x-a)^2 + (y-b)^2 = r^2 \qquad \text{---------(5)}$$

FIGURE 4.8: Circle Equation in 2-D

radius two dimensional space. The second stage is all about searching a optimal radius in the 1-D space. In OpenCV, Hough Gradient Method is used that uses the gradient information of edges. The Function used in cv2.HoughCircles(). This function has quite a few parameters whose usage will be seen in the following code.

```
import cv2
import numpy as np

img = cv2.imread('opencv_logo.png',0)
img = cv2.medianBlur(img,5)
cimg = cv2.cvtColor(img,cv2.COLOR_GRAY2BGR)

circles = cv2.HoughCircles(img,cv2.HOUGH_GRADIENT,1,20,
                            param1=50,param2=30,minRadius=0,maxRadius=0)

circles = np.uint16(np.around(circles))
for i in circles[0,:]:
    # draw the outer circle
    cv2.circle(cimg,(i[0],i[1]),i[2],(0,255,0),2)
    # draw the center of the circle
    cv2.circle(cimg,(i[0],i[1]),2,(0,0,255),3)

cv2.imshow('detected circles',cimg)
cv2.waitKey(0)
cv2.destroyAllWindows()
```

Result is shown below:

image

FIGURE 4.9: Hough Circle Transform

- Erosion in Image Processing:- Erosion is defined for binary images and later it was extended to grayscale images, and complete lattices. The image is viewed as division of a Euclidean space in binary erosion. In binary erosion, the hint is to review an image with a simple, pre-defined shape, drawing conclusions on how the shape turns in an image.

1. Element B consists of a center which is located on E.
2. The erosion of A by B can be assumed as locus of point.
3. It is reached by center of B when it moves inside A.

Grayscale erosion is basically a function to match Euclidean dimensional space consisting a set R which represent the reals. The mathematical function of Grayscale erosion is as follows:-

$$(f \ominus b)(x) = \inf_{y \in B}[f(x+y) - b(y)], \qquad \text{----------(6)}$$

FIGURE 4.10: Binary Erosion

4.3 Post-Implementation

After completing the task to disease detection or fungus detection, we need to find a solution to it such that the disease dont spread any further. For Septoria Diseased Leafs, a liquid called chlorothalonil. It's an organic compound largely applied as a broad spectrum, non complete fungicide, with other uses as a wood protectant, pesticide etc and to control mold, mildew, bacteria, algae. Host and pathogen. Leaf mold occurs due to fungus Passalora fulva (previously called Fulvia fulva or Cladosporium fulvum). It is not well known to be pathogenic on any plant other than tomato. It leads to form certain Pale greenish-yellow spots, which is usually less than 1/4 inch, with no distinct boundaries, form on upper sides of the leaf. The best remedy to it is to apply baking soda. It's a natural remedy.

4.4 Experimental and/or Analytical Work Completed in the Project

Detection of the Disease Septoria in Tomato Plants:- Septoria is a disease that happens in tomato leaves mostly. It happens due to fungus that leads to numerous leaf spot. We have developed a python program to identity septoria. This python program uses certain attributes of OpenCV such as Gaussian Blur, Erosion, Adaptive Thresholding, Segmentation, Hough Circles, etc. These attributes are very powerful tools in achieving enhanced image processing in this modern era.

Some sample leafs which are Septoria affected:-

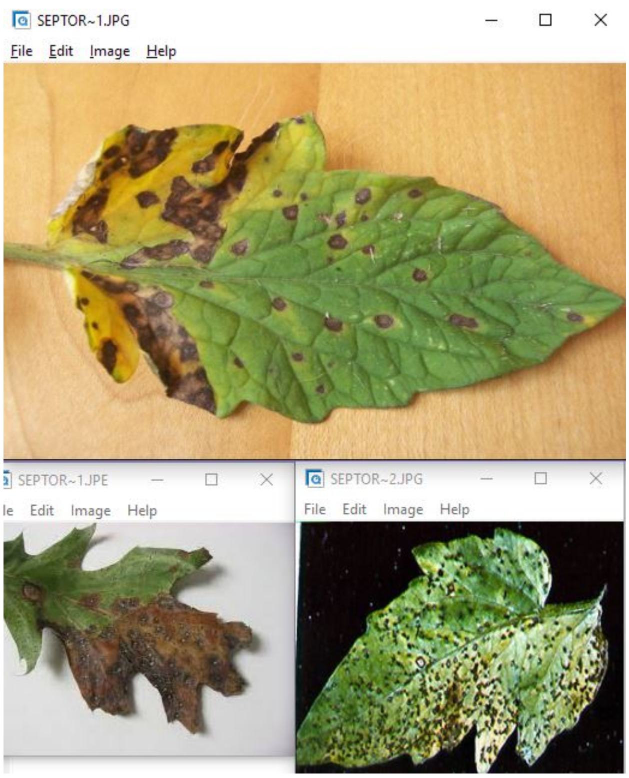


FIGURE 4.11: Septoria Affected Leafs

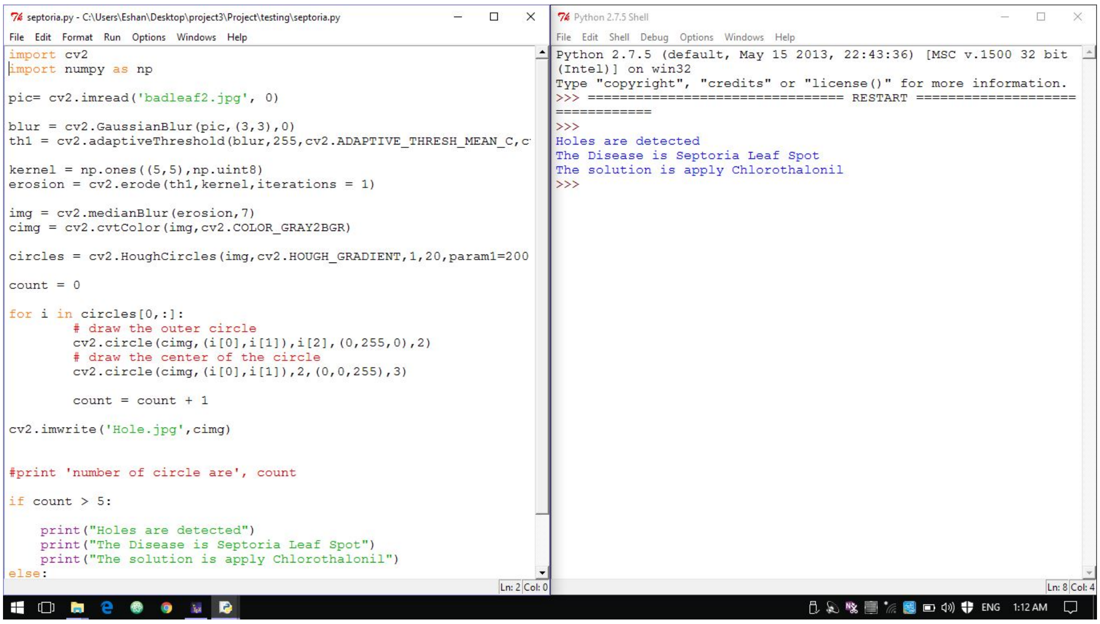


FIGURE 4.12: Experiment- Python Program to detect Septoria

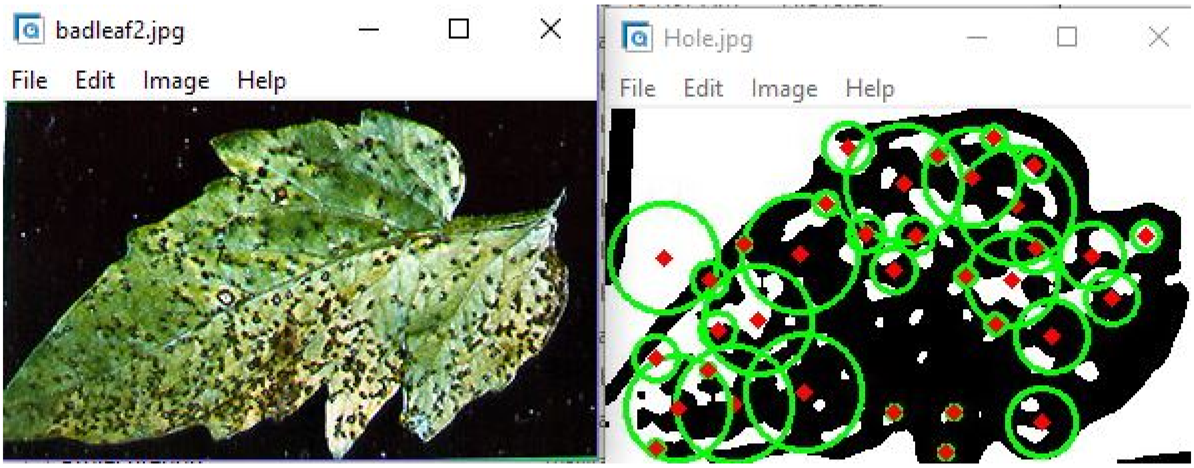


FIGURE 4.13: Analysis-1 of Python Program to detect Septoria

Description of Analysis-1(Heavily Affected Leaf):- The Python Program showed in Figure 4.12 is being executed. Input given is a leaf affected by Septoria. We can see the leaf which is being analyzed in the figure 4.13(left) is having numerous holes. This leaf is heavily affected by Septoria. The code snippet shown above is giving us a processed image from the original one. The processed image(Figure 4.13 right) is showing us the holes(circular objects in the leaf) through the usage of hough Circle Transform attribute of OpenCV.

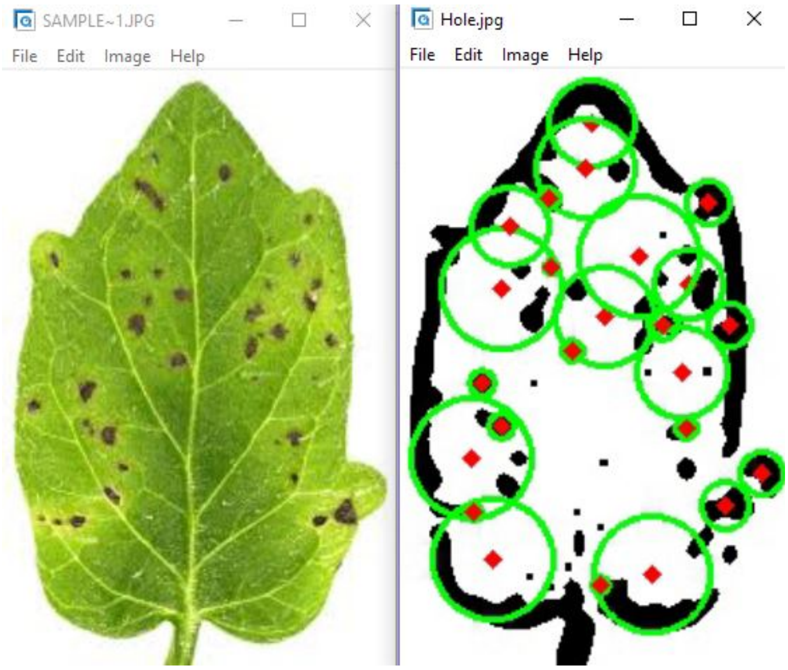


FIGURE 4.14: Analysis-2 of Python Program to detect Septoria

Description of Analysis-2(Moderately Affected Leaf):- The Python Program showed in Figure 4.12 is being executed. Input given is a leaf affected by Septoria. We can see the leaf which is being analyzed in the figure 4.14(left) is having a few holes. This leaf is moderately affected by Septoria. The code snippet shown above is giving us a processed image from the original one. The processed image(Figure 4.14 right) is showing us the holes(circular objects in the leaf) through the usage of hough Circle Transform attribute of OpenCV.

Description of Analysis-3(Healthy Leaf):- The Python Program showed in Figure 4.12 is being executed. Input given is a leaf which is healthy. We can see the leaf which is being analyzed in the figure 4.15(left) is having no holes. This leaf is not affected by any disease. The code snippet shown above is giving us a processed image from the original one. The processed image(Figure 4.15 right) is showing us the clear processed image which is clean without any circular highlights. In this case the Hough Circles attribute did not find any circular objects in the leaf. Thus there are no circles in the analyzed leaf.

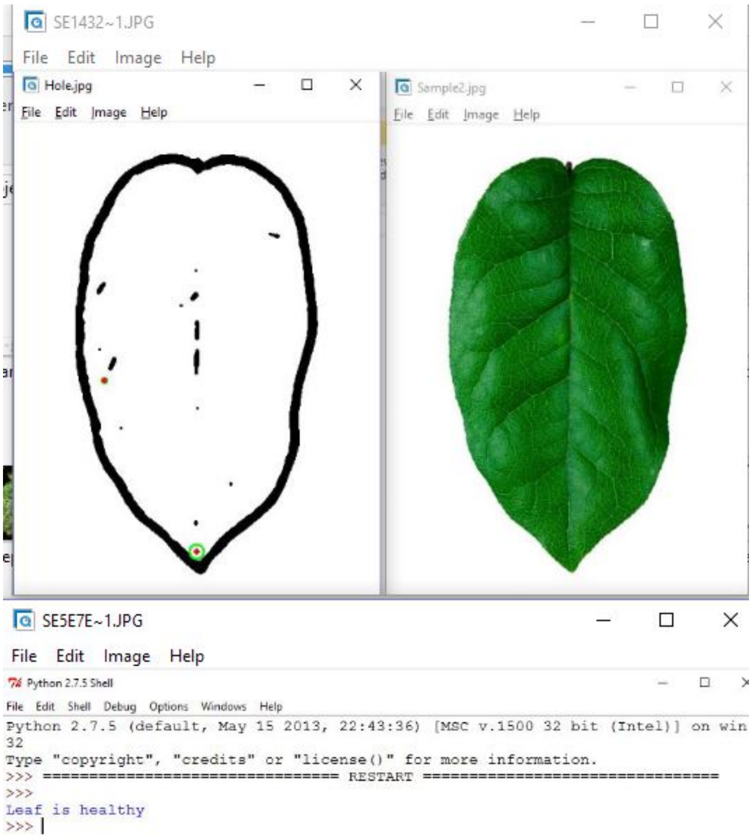


FIGURE 4.15: Analysis-3 of Python Program to detect Septoria

Usage of Thresholding to Differentiate between Septoria and Leaf Mold:- This is a comparative study between the two diseases i.e Septoria and Leaf Mold. Usage of the attribute- threshold in different levels is providing us with several small thumbnails with different filters. These filters are very useful in spotting the holes, white patches, damaged portions of the leafs. In this comparative study, we have taken two tomato leaves. One with septoria and the other with leaf mold. Septoria leads to lot of holes in the leaf whereas the leaf mold leads to form large patches in the leaf. Threshold filter like THRESH-BINARY has made our analysis very much clear and transparent. The holes are highlighted very well through this filter. Similarly for the case of leaf mold, same filters are used to analyze the damaged portion of leaves.

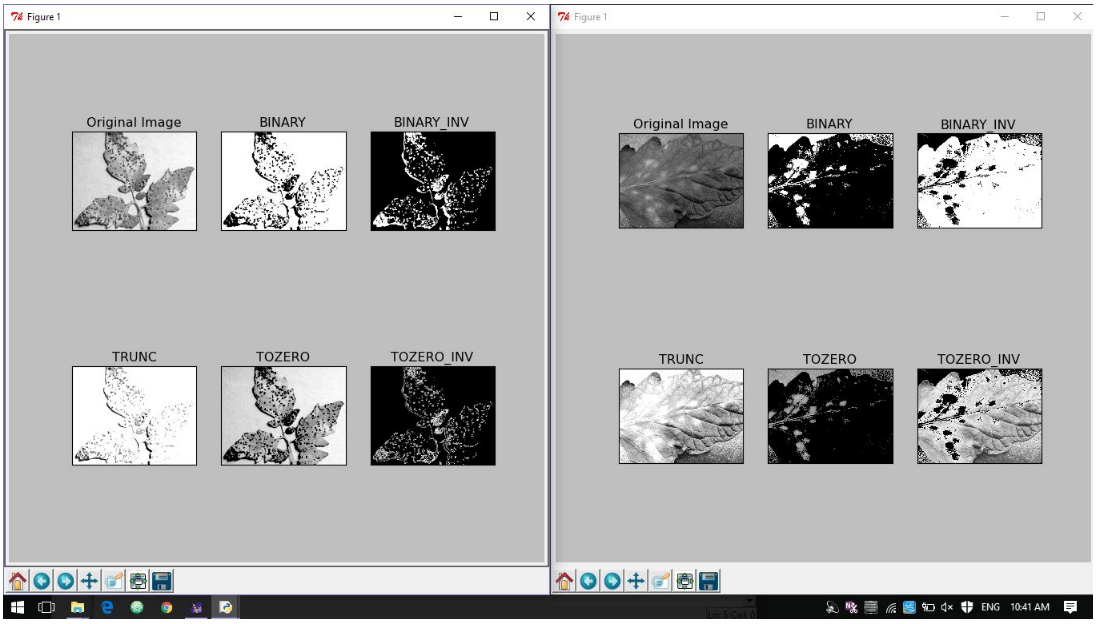


FIGURE 4.16: Comparative Analysis Leaf Mold and Septoria

4.5 Modeling & Design

The Drone and its Assembly:- Drone also known as unmanned aerial vehicle is designed and assembled with technical capabilities that can carry weight of 500gm including a drone mounted camera and pesticide sparing system. Drone is fitted with four 1000rpm motor that gives it ample thrust and lift to carry weights that can be used to carry pesticides and lift necessary weights. The propeller is swift and operates at 1000 rotation per minutes providing stability during flight and helps in capturing stable images that is unprocessed data used to extract useful information after processing it. The ESC (electronic speed controller) is the heart of the entire drone system. An electronic speed control or ESC is an electronic circuit with the purpose to vary a servo-motor's speed, its direction and possibly also to act as a dynamic brake. ESCs are often used on motors essentially providing an electronically-generated three-phase electric power low voltage source of energy for the motor. The basic function of ESC is to change the amount of power to the electric motor from the battery based upon the location of the throttle stick.

Flight microcontroller is an integrated circuit which is the CPU of the drone system. It receives signal from the transmitter (remote controlling device) and helps in flight of the drone. It is responsible for maintaining the balance of the drone during the flight. There are often two voltage ranges in the specification of a flight controller, the first being the voltage input range of the flight controller itself (most operate at 5V nominal), and the second being the voltage input range of the main microprocessor's logic (3.3V). It is internally wired using an integrated chip and is connected from battery to all the motor and is the power hub of the entire flight system. It also has GUI (graphics user interface) which displays various parameters including distance from ground, accelerometer to determine speed. It measures the distance in three axes. Gyroscope measures the rate of change of angular axis in the three axis. These components in the flight micro controller help in providing complete control using a transmitter or a remote control. Remote control(RC) communication usually involves a hand held RC transmitter and RC receiver. For operating a drone four basic channel, Pitch (translates forward and backward motion), Elevation (Closer and Farther from ground), Yaw (rotation clockwise and anti-clockwise), Roll (left or right movement). Additional capabilities include arming and disarming the rotor motor. Flight control completely depends on this hardware and it can also be used to deploy an additional system such as sprayer in this particular system. Most drone pilots prefer handheld control, meaning RC systems are still the number one choice for controlling a UAV. On its own, the receiver simply relays the values input into the controller, and as such, cannot control a UAV. The receiver must be connected to the flight controller, which needs to be programmed to receive RC signals. There are very few flight controllers on the market which do not directly accept RC input from a receiver, and most even provide power to the receiver from one of the pins.

The ESCs:- The Electronic Speed Controllers i.e ESCs usually consist of 3 varieties of wires. These are:- Power Wires, Signal Wires and Motor Wires. On certain ESCs, signal wires are connected behind the ESC board and the other set of wires are configured as given below.

Power Wires –As the name suggests, these wires are responsible to provide power to the ESCs. This action draws power to the motors. These wires are connected to the power source (battery/solar panel)through the PDB.Red wire indicates positive terminal and black wire denotes ground.

Motor Wires – These wires connect to the brushless motors of the drone or quadcopter. These wires not really have any polarity ordering. Thus we can connect any of these wires to each of the motors.You just need to have all three connected to one of each of the motor wires.

Signal Wires – Signal wires are meant to controls the ESCs. Particularly, the Signal Wires are useful in telling the appropriate speed to turn the propellers. Thats why these wires are attached directly to the flight controller – which gives these wires the instructions. The signal wire is white in color and the black wire is the ground wire. We can ignore the black wire while connecting the signal wires as everything works normal. But this action is not recommended.

FIGURE 4.17: An ESC (Photo Courtesy: Google Images)

KV1000 Brushless Motors Hex Rotor Multicopter: The purpose of the motors is to spin the propellers. The 1000Kv Brushless Motor is a Brushless DC powered electric motor. This is a synchronous motor which gets power through an integrated inverter mechanism. This produces AC electrical signals that drive the motor. The AC (Alternating Current) here does produce any sinusoidal waves. Instead, it produces a bi-directional current with no definite waveform.

The motor contains a permanent magnet rotor and wire wound stator poles. Electrical energy gets converted to mechanical energy. This happens between the magnet's rotor and the rotating magnetic field. There are three magnetic circuits in total. These three circuits are connected into a common point. The Electro magnetic circuit is divided in

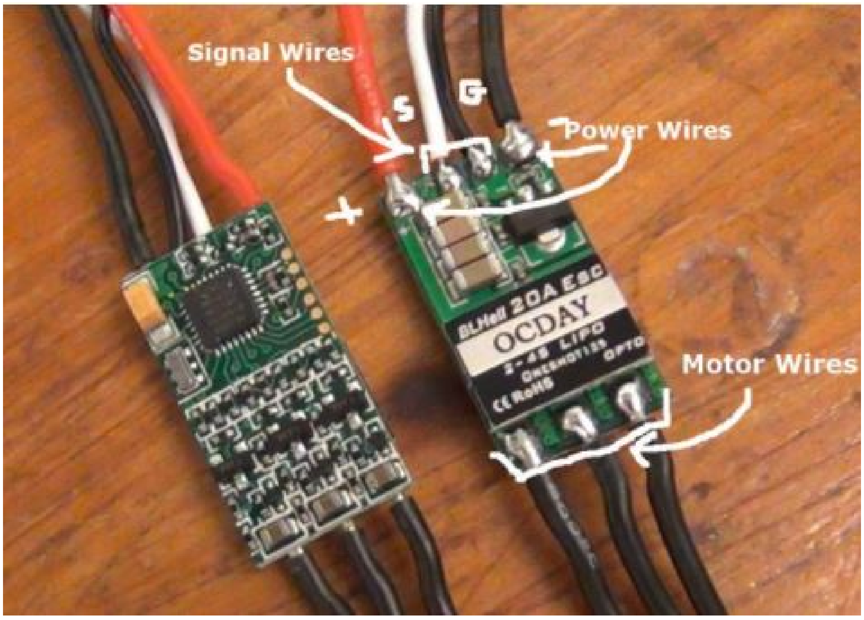


FIGURE 4.18: Structure of the ESCs (Photo Courtesy: Google Images)

the center. This permits the magnetic rotor to move in the mid of the magnetic field. The Brushless Motors consists of a three-phase winding architecture. The motors with this topology are driven by powering its two phases at a given time. The alignment is static. The electric current is made to flow from one terminal to another terminal say from A to B. The rotor's direction of rotation can be from A to B clockwise 60 degrees by changing the path.

FIGURE 4.19: Brushless Motor (Photo Courtesy: Google Images)

Propellers: A propeller is a fan. It transfers energy by converting the rotational energy into motion. It results into a pressure difference in between the front and back area of the aerodynamic-shaped blade, and the medium of propagation(it can be air or water) is being accelerated just behind and around the blade. Propeller dynamic studies of an aircraft can be presented by the principles of two renowned scientists Bernoulli and Newton. We may apply either or both Bernoulli's principle and Newton's third law. A marine propeller of this kind is sometimes referred as a screw propeller or screw. But there are different classes of propellers known as cycloidal propellers– they differentiate by the more propulsive output averaging 0.72 which compared to the screw propeller's average of 0.6 and the ability to deliver rotation thrust in any direction at any time. The disadvantages of these propellers are higher mechanical complexity and higher cost.

FIGURE 4.20: Sample Propellers (Photo Courtesy: Google Images)

Flight Controller:- Flight controller is the heart of the drone. It is a small computer which controls the drone, and understands the signals that the remote transceiver sends to control the drone. One who makes a drone, selecting the flight controller is actually one's own choice in many ways. It not like choosing between various models of PC processors in the same power range. The flight controllers comes from various manufacturers which may or may not be modifiable.

The controller receives signal from the radio receiver. It contains a component which is fitted to the flight controller, to receive signals. Most of them supports four channels if not as high as eight or nine.

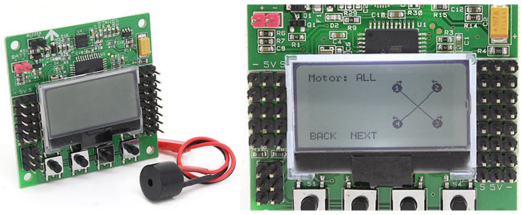


FIGURE 4.21: Flight Controller (Photo Courtesy: Google Images)

Battery:- To power up the drone, the power source is a LiPo (Lithium Polymer) battery. LiPo batteries often use a C rating, that means its ability to discharge. Typically a LiPo battery has 20C. If a 25C 4000mAh LiPo battery is seen, it means that you can get a maximum of 25C * 4 = 100A (A standing for Amps). The power of the battery is usually supplied by the energy draw required from the ESCs. For instance, if the motor's maximum draw is 19A, at the very least you'll want a 30A ESC to be safe. Now multiply that by the number of propellers you have (4 in this case) and you'll get the maximum draw for your entire quad – 4 * 19A = which is 76A. Your 4000mAh 25C LiPo would definitely be enough for this quadcopter. A lot of battery types can be fully discharaged, but the LiPos have a minimum voltage requirements, which if gone beyond can cause damage to the battery. In most cases it's 3.0 volts, but can vary from battery to battery. This is generally about 80 – 85 percentage usage of your battery. Once past this mark, battery power drops fairly quickly. So make sure you're landing or are about to land when you hit this mark.

FIGURE 4.22: Lipo Battery (Photo Courtesy: Google Images)

4.6 Prototype & testing

Implementation of the project right from the beginning to the final stage witnessed immense prototyping and testing activities. Each prototype developed was further tested and analyzed to decide on how the next prototype should work and what it should look like. Every stage of project work- processing images each individual module, having the quadcopter fly and stabilize it further and the motor configurations, analyzing the location for each flight, the motor configurations, all these were evolved from one prototype version to other. The developed python modules initially caused multiple confusions in training them to differentiate between the diseases. These modules were found to be working smoothly with accurate disease detection.

FIGURE 4.23: Drone on the air with Camera

FIGURE 4.24: Drone along with sprayer

Chapter 5

RESULTS, DISCUSSIONS AND CONCLUSIONS

5.1 Results & Analysis

This report is based on the experimental activities that we have conducted during our developmental phase of our agricultural project. We have conducted several tests. The tests includes checking the capacity of payload(weight) carrying capacity of the drone, capturing live pictures through phone camera(Sony Xperia Cybershot). We also tested a bottle attached to the drone which acts as a prototype of a fertilizer sprayer.

Test Number	Test Description	Stability Level	Height	Safe Landing	Result
1	Test flight to check the assembled drone for the first time.	Poor	Too High(Drone wasn't under Control)	No(Crash Landing)	Failed(Collision with a cocunut tree)
2	Drone flight carrying Sony Xperia Camera to capture Pictures	Intermediate	Mudium High(Drone was under control)	Yes(Not that soft landing but a safe one)	Passed
3	Test to check the IP Camera of the Phone while the drone is on air.	Good	Mudium High(Drone was under control)	Yes(Not that soft landing but a safe one)	Passed
4	Test to check the flight carrying liquid.	Good	Mudium High(Drone was under control)	Yes(Not that soft landing but a safe one)	Passed

FIGURE 5.1: Results of various Tests

The tests preceding drone tests are image processing of the captured pictures. The pictures captured from the sony camera fitted on the drone are in relatively low height.

The images were captured in the College Campus. There were certain plants which were diseased. Mostly with fungas and bacteria.

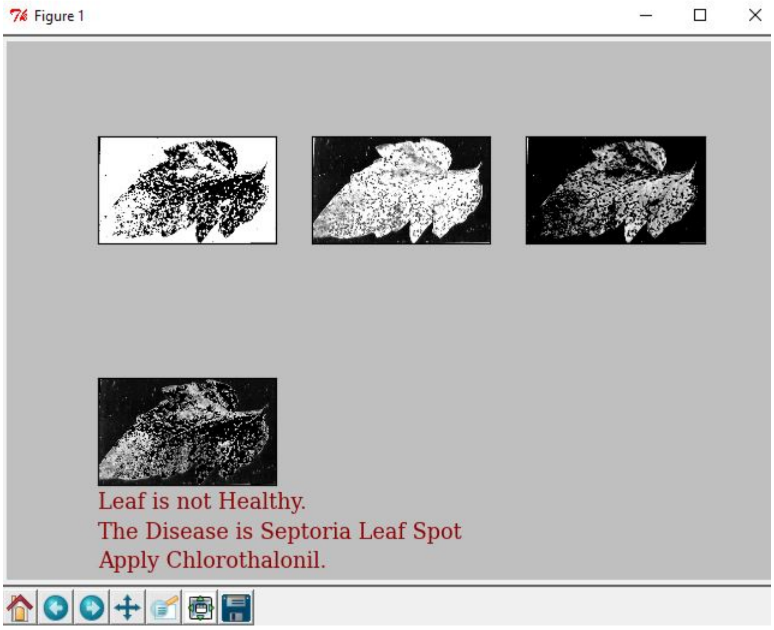


FIGURE 5.2: Results of Image Processing (Disease Type: Septoria)

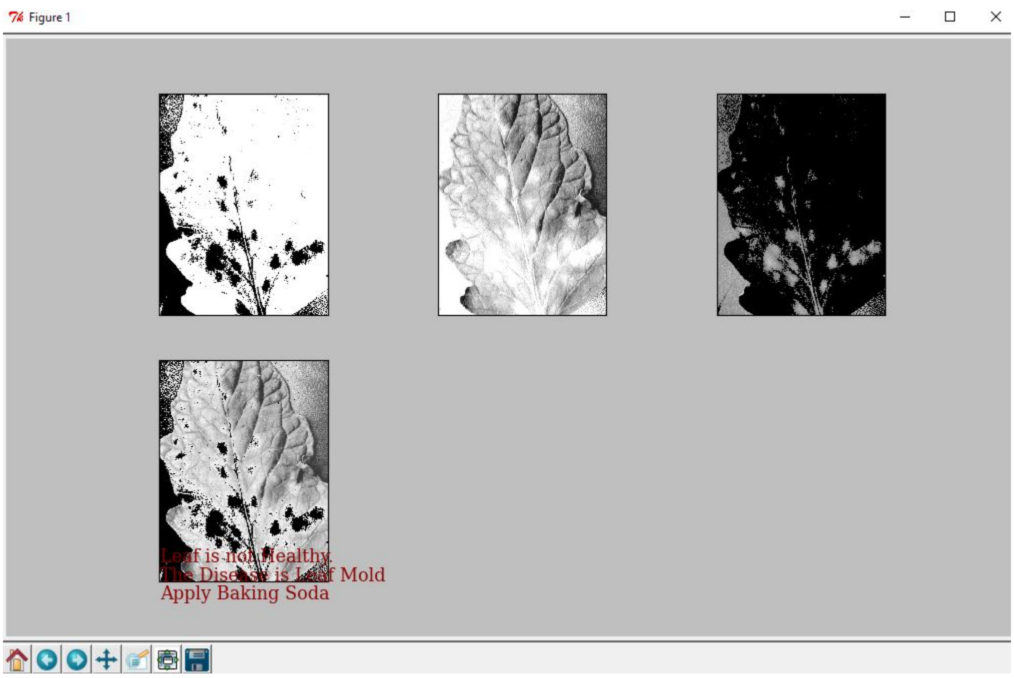
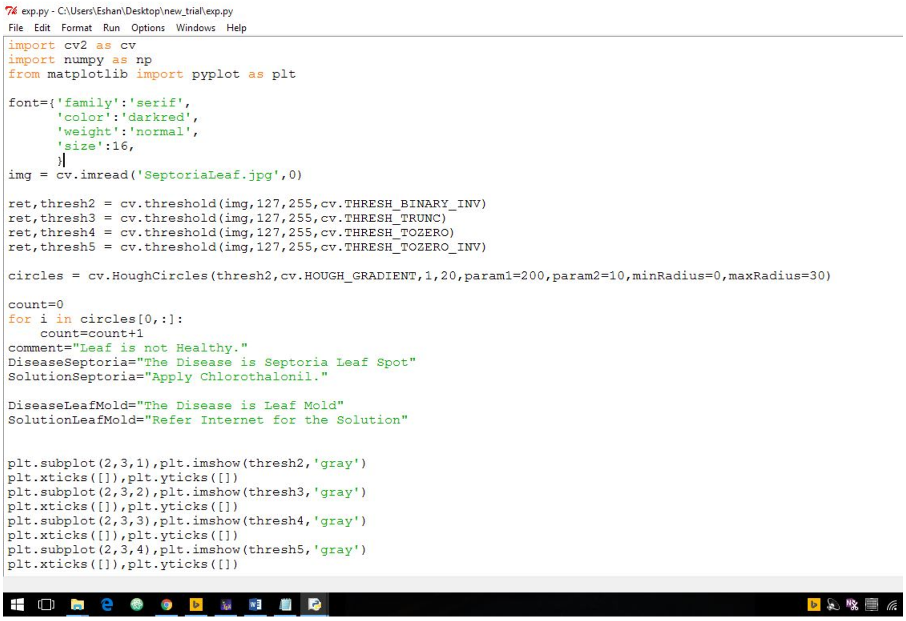


FIGURE 5.3: Results of Image Processing (Disease Type: Leaf Mold)

On executing the above program, different varieties of threshold produces these visually varying images. Septoria is a disease where the leaf contains lots of circular holes. The visually varying images are making it possible to identify the affected areas. Similarly, for leaf mold, the spots in the leaf are less and much bigger than septoria. Thus we determine the type of disease on the basis of holes/spots count.




```python
import cv2 as cv
import numpy as np
from matplotlib import pyplot as plt

font={'family':'serif',
      'color':'darkred',
      'weight':'normal',
      'size':16,
      }
img = cv.imread('SeptoriaLeaf.jpg',0)

ret,thresh2 = cv.threshold(img,127,255,cv.THRESH_BINARY_INV)
ret,thresh3 = cv.threshold(img,127,255,cv.THRESH_TRUNC)
ret,thresh4 = cv.threshold(img,127,255,cv.THRESH_TOZERO)
ret,thresh5 = cv.threshold(img,127,255,cv.THRESH_TOZERO_INV)

circles = cv.HoughCircles(thresh2,cv.HOUGH_GRADIENT,1,20,param1=200,param2=10,minRadius=0,maxRadius=30)

count=0
for i in circles[0,:]:
    count=count+1
comment="Leaf is not Healthy."
DiseaseSeptoria="The Disease is Septoria Leaf Spot"
SolutionSeptoria="Apply Chlorothalonil."

DiseaseLeafMold="The Disease is Leaf Mold"
SolutionLeafMold="Refer Internet for the Solution"


plt.subplot(2,3,1),plt.imshow(thresh2,'gray')
plt.xticks([]),plt.yticks([])
plt.subplot(2,3,2),plt.imshow(thresh3,'gray')
plt.xticks([]),plt.yticks([])
plt.subplot(2,3,3),plt.imshow(thresh4,'gray')
plt.xticks([]),plt.yticks([])
plt.subplot(2,3,4),plt.imshow(thresh5,'gray')
plt.xticks([]),plt.yticks([])
```

FIGURE 5.4: Results of Image Processing(Python Program)

5.2 Comparative Study

A bird's-eye view is a project which is viewing the world's object from above.They view them, with a perspective of a bird for often making the structural designs of buildings, bridges, etc. Its usually an aerial image, but also a drawing. Before manned flight was in peak use, the word ”bird's eye” used to differentiated opinions drawn from direct observation at a high altitude area (for example a mountain or tower), from those constructed from an imagined (bird's) perspectives. Bird's eye views as a trend have existed since classical times. The last great flourishing of the same was in the mid-to-late 19th century. Late then, bird's eye view prints were popular in the nations of United States and Europe.
GHSC-PSM is working with USAID to explore the potential of incorporating unmanned aerial vehicles (UAVs) for moving health commodities through public health supply chains, with a goal of undertaking a pilot by the end of 2017. There are few practitioners using UAVs for cargo delivery in the development context. With the size of the project and its focus, GHSC-PSM is in a unique position to begin incorporating UAV technology. As a frst step, GHSC-PSM completed the UAV Landscape Analysis to assess the various technologies, UAV actors, regulations, pilots undertaken, and lessons learned from existing use of UAVs in the development context. This analysis is being used to inform the project's work toward a pilot project. GHSC-PSM anticipates that incorporating UAVs into its supply chains could have signifcant benefcial impact on how commodities, emergency cargo and lab tests are moved around countries in the future.

5.3 Conclusions

The main objective of the project was to detect and identify crop diseases. My results meet these objectives. The tests that we conducted went fair enough and had no problems except stability of the drone. The image processing programs and algorithms using various attributes of OpenCV in python yielded smooth and appropriate results. An interesting study might involve making the system scan diseases of leafs while the drone is on air. This will not only make the process faster but also will save the power consumption of the drone since scanning and detecting process will happen instantaneously. Initially we planned to do the image processing part using Matlab. But then these are the reasons why python was a more smarter choice. Python is a light software. It runs on various small devices(mobiles, tablets, netbooks). Basically its compatibility ranges from very low configured devices to super computers. It can run well in an Andoird phone, iphone etc. It can run in high configured PCs too. This has actually increased the reliability a lot. But when it comes to Matlab, it demands computers with high computational power. Thus our project has fulfilled the required chores for which it was planned for.

5.4 Scope for Future Work

The project is based on disease detection and providing solutions to agricultural diseases. On looking into its future scope, it has enough to discuss through. The whole automation system can become a way too faster if we can implement a GPS module with the drone. GPS module can exactly record the coordinates of an area where a certain disease was found. And thus it can be more precise to send the drone to that exact geographical coordinate. Further, the camera view could be used to instantly capture the disease of an affected area though the use to advance image processing algorithms and then spray appropriate pesticides/medicine at that very moment. This will bring an immense difference in the reliability of the whole automation system. Most importantly, the drone wont have to be bought back for image processing in an external Computer Device. Thus these two improvements can really make this project unique and we believe that if everything works out well the whole idea will yield a successful product in the farming market.

Bibliography

[1] Haiguang Wang, Guanlin Li, Zhanhong Ma and Xiaolong Li, "Image Recognition of plant Diseases Based on Backpropagation Networks," *IEEE Trans. Disease Detection*, pp. 894-900, 2012.

[2] Maged Wafy, Hashem Ibrahim and Enas Kamel, "Identification of weed seeds species in mixed sample with wheat grains using SIFT algorithm," *IEEE Trans. Spot Weed Seeds(SIFT)*, pp. 11-14, 2013.

[3] Zehra Karhan, Aykut Karakaya, Nurettin Senyer and Gokhan Kayhan, "Bird's-Eye View Images taken plant material and counting," *IEEE Trans. Aerial View capturing*, 2015.

[4] Jagadeesh D. Pujari, Rajesh Yakkundimath and Abdulmunaf S.Byadgi, "Identification and Classification of Fungal disease Affected on Agriculture/Horticulture Crops using Image Processing Techniques," *IEEE Trans. Image processing*, 2014.

[5] Preetha Rajan, Radhakrishnan B and Dr. L.Padma Suresh, "Detection and Classification of Pests from Crop Images Using Support Vector Machine," *IEEE Trans. Disease Detection* , 2016.

[6] Amrita A. Joshi and B.D. Jadhav, "Monitoring and Controlling Rice Diseases Using Image Processing Techniques," *IEEE Trans. Image processing*, pp. 471-478, 2016.

[7] Pankaja K and Dr. Thippeswamy G, "Survey on Leaf Recognization and Classification," *IEEE Trans. Image processing*, pp. 442-450, 2017.

[8] Manojkumar P, Surya C M and Varun P Gopi, “Identification of Ayurvedic Medicinal Plants by Image Processing of Leaf Samples,” *IEEE Trans. Image processing*, pp. 231-238, 2017.

Appendix A

Code Snippets

A.1 Appendix A Section 1

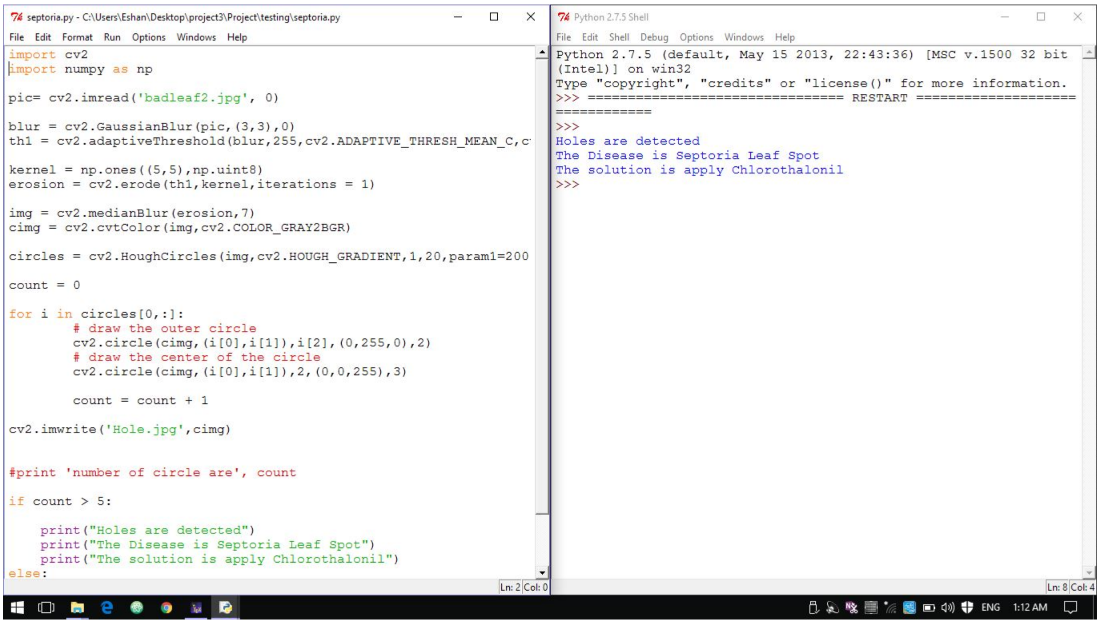


FIGURE A.1: Python Module of Septoria

```
bruteforce.py - Z:\project3\Project\BruteForce\bruteforce.py
File Edit Format Run Options Windows Help
import numpy as np
import cv2
import matplotlib.pyplot as plt

img1 = cv2.imread('leaf1.jpg',0)
img2 = cv2.imread('diffleaf.jpg',0)
orb = cv2.ORB_create()
kp1, des1 = orb.detectAndCompute(img1,None)
kp2, des2 = orb.detectAndCompute(img2,None)
bf = cv2.BFMatcher(cv2.NORM_HAMMING, crossCheck=True)
matches = bf.match(des1,des2)
matches = sorted(matches, key = lambda x:x.distance)
img3 = cv2.drawMatches(img1,kp1,img2,kp2,matches[:10],None, flags=2)
plt.imshow(img3)
plt.show()
```

FIGURE A.2: Python Module of Brute Force Matcher

```
exp.py - C:\Users\Eshan\Desktop\new_trial\exp.py
File Edit Format Run Options Windows Help
import cv2 as cv
import numpy as np
from matplotlib import pyplot as plt

font={'family':'serif',
      'color':'darkred',
      'weight':'normal',
      'size':16,
      }
img = cv.imread('SeptoriaLeaf.jpg',0)

ret,thresh2 = cv.threshold(img,127,255,cv.THRESH_BINARY_INV)
ret,thresh3 = cv.threshold(img,127,255,cv.THRESH_TRUNC)
ret,thresh4 = cv.threshold(img,127,255,cv.THRESH_TOZERO)
ret,thresh5 = cv.threshold(img,127,255,cv.THRESH_TOZERO_INV)

circles = cv.HoughCircles(thresh2,cv.HOUGH_GRADIENT,1,20,param1=200,param2=10,minRadius=0,maxRadius=30)

count=0
for i in circles[0,:]:
    count=count+1
comment="Leaf is not Healthy."
DiseaseSeptoria="The Disease is Septoria Leaf Spot"
SolutionSeptoria="Apply Chlorothalonil."

DiseaseLeafMold="The Disease is Leaf Mold"
SolutionLeafMold="Refer Internet for the Solution"


plt.subplot(2,3,1),plt.imshow(thresh2,'gray')
plt.xticks([]),plt.yticks([])
plt.subplot(2,3,2),plt.imshow(thresh3,'gray')
plt.xticks([]),plt.yticks([])
plt.subplot(2,3,3),plt.imshow(thresh4,'gray')
plt.xticks([]),plt.yticks([])
plt.subplot(2,3,4),plt.imshow(thresh5,'gray')
plt.xticks([]),plt.yticks([])
```

FIGURE A.3: Python Module for Diseased Tomato Plants