THE MONITORING SYSTEM FOR PADDY CROP YIELD FROM THE HOPPERBURN

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OOI GUAN LEE

This report is submitted in partial fulfillment of the requirements for the

Bachelor of Computer Science (Artificial Intelligence)

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
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DECLARATION

"I declare that the following is my own work and does not contain any unacknowledged work from any sources. This Final Year Project was undertaken to fulfil the requirement of the Undergradute Research Project for the Bachelor of Computer Science (***Artificial Intelligence***) academic program in University Teknikal Malaysia Melaka.

STUDENT : ________________________________ Date : ____________
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SUPERVISOR : ________________________________ Date : ____________
(ABDUL SYUKOR BIN MOHAMAD JAYA)

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ABSTRAK

Dalam Kepintaran Pembuatan (Artificial Intelligence) , untuk mencipta sebuah alat elektronik atau robot, mestilah ada bahagian elektronik yang memainkan peranan sebagai otak untuk mengontrol dan memberi perintah kepada robot itu. Sama dengan sebuah *drone* atau *quadcopter* yang diminati oleh orang ramai, dalam drone juga ada sebuah otak yang digelarkan sebagai *flight controller* yang mengatur sistem dan memberi perintah kepada drone untuk memjalankan tugasnya. Dalam *drone*, terdapat bahagian sensor yang boleh menerima data. *Unmaned Aerial Vehichle (UAV)* adalah *drone* wahana terbang tidak berawak. Terdapat banyak tujuan untuk menggunakan *drone* misalnya mengambil gambar permandangan yang besar dari udara. Untuk meningkat kebolehan UAV, seperti control otomatis, dimana mengontrol *drone* tanpa pilot dengan mengunakan sensor yang terdapat dalam *drone*.

Dengan *drone* otomatik, memberi banyak manfaat dan penelitian status pertanian padi kepada seseorang petani. *Drone* akan mengambil gambar dari udara dan menganalisis gambar dengan software untuk mengira kerosakan atau kehilangan padi dari penyakit *Hopper Burn*.

ABTRACT

In Artificial Intelligence, the process of the building electronic devices or robot, there is a must to have a controller, is a part of the brain to control all the things and give the task to the robot. Same as the drone, or quadcopter that are very famous nowadays, it also have the brain called "flight controller", there is variety types of the flight controller in the drone. The flight controller control all the movement of the drone and give task to the drone. In the drone, there is a lot of the sensor installed in the drone to sense the environment, and collect the data. Unmanned Aerial Vehicle (UAV) is the drone without pilot. Many uses of the drone like take the aerial photo. To enhance the ability of the drone, the use of the system to make the drone undergoes autopilot mode with using multiple sensor that installed on the drone.

With the automated drone, there is a lot of benefits and details for the paddy farmer to survey their crop in paddy field. Drone can take the photo from the air then collect the data yield and undergoes analysis to calculate the loss of the crop yield from the Hopper Burn Disease.

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CHAPTER I

INTRODUCTION

1.1 Introduction

The topic of this project is build the system that will count the approximately yield collected by the paddy farmer. Recently, all the farmer are having the risk of many diseases, the common disease that occur every season is hopper burn in paddy field. The main problem of the disease is BrownLeaf Hopper. This insect are harmful for paddy and it's occur every season. The nymph and adults both harbour in lower portion of plants and suck the cell sap from stem and excrete poisonous matter in plants causing drying up of leaves and stems. The infestation appears in circle shapes, in non-uniform manner at different places in the field. Then the heavy infestation whole field appears as burnt.

Figure 1.1: The brownhopper insect

Figure 1.1 shows the image of the brownhopper that harm the paddy plant. From the mapping from the UAV (Unmanned Aerial Vehicle), the calculation of loss of the crop are use in Artificial Intelligence (AI) technique. This project will build the system that will calculate the approximately yield collected by the paddy farmer. The drone are using the component that are suitable in this project, more professional in survey the map, the autonomous drone will fly along the waypoint was set and take the picture along the map. The picture will be taken from the sky by a camera that are installed at the drone, the picture taken will be saved and processing in the computer. All the data of flight of drone will be record in the 'mission planner' software when communicate with drone in the sky by telemetry. The GPS module on this drone also play as important role, the autonomous drone's mission will be more efficient and successful if the GPS module works well. The Figure 1.2 and 1.3 show the difference when the paddy plant are infected and healthy paddy plant.

Figure 1.2: The paddy plant infected by hopperburn

Figure 1.3: The healthy paddy plant

1.2 Problem Background

The hopperburn disease kill the paddy and cause the crop yield decreased every season of the paddy farming. This cause the income of the farmer decreased due to the loss of the crop yield. The disease happened every season for every paddy field, the different just is the quantity of the loss of the crop yield by hopperburn disease. This depends on the farmer how to take care of the hopperburn disease, take action after discovery. The adult brownhopper will live in the paddy plant base, kill the paddy plants. However, the farmer discovers the disease are still late that will cause the disease spread more widely and causes the further losses. So for now there is no existing system that are better to overcome this problem. The help of latest technology nowadays will enhance the performance to overcome the hopperburn disease.

1.3 Problem Statement

The disease of hopperburn are occurred every season of the paddy farming, so in every season of the crop yield, the farmer doesn't know how much the crop lost because of this disease. In the wide area of paddy field, the paddy farmer doesn't know where the disease occur immediately, until the disease spread wider and cause further lost. The farmer hard to observe the paddy status of the centre of paddy field.

1.4 Objectives

i. To identify the hopper burn characteristic.
ii. To design full autonomous drone with way-point based navigation to collect images of the infected area of paddy field.
iii. The quantity of the lost crop will be recorded every season as reference.

1.5 Scope

The scope of this project is battery life of the drone, the drone capacity of this project is only 2500 MaH (Milliamp Hours). Normally the drone with this capacity only will last 10 minutes in the sky, so the survey must be done within 10 minutes. In this project, there is no insurance for any damage or accident, so this monitoring system must done carefully and prepared. This monitoring survey also only in one environment, the environment survey only involved the paddy plant field.

1.6 Significant of the Study

The significant of this project is study about the relationship between autonomous UAV with the image processing technique, to help decrease of loss of the crop yield. The Arducopter will works with the software to complete the complicated task. The post-process of the study will be image processing of the image taken by drone. The processed image will separate the healthy paddy plant and unhealthy paddy plant, so the hopperburn disease is categorized as unhealthy paddy plant. The analysis of the image will show the area size of the infected area to enhance the productivity of the farmer.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

The references from the other sources are important to the project, all the information will be used to enhance the project productivity. The sources of review mainly is from internet, journals and citations. All the information are reviewed to compare or reference to the project, to improve the performance of the system.

2.2 Hopperburn Disease

The brown planthopper (BPH), widely occurs in South, Southeast and East Asia, as well as the South Pacific islands and Australia. It has been a threat to rice production in Asia for several decades. It sucks the sap from the rice phloem using its stylet. The disease will harm the paddy plant and cause the less of the crop yield of paddy farmer. The disease also happened in Malaysia, especially in growing of the paddy plant, all the paddy farmer in Malaysia face this problem and until now have no best solution for this disease.

2.2.1 Hopperburn Characteristics

The brown planthopper (BPH, Nilaparvata lugens) is one of the most serious rice pests in East Asia and Southeast Asia. Besides sucking sap from the vascular bundle, it can transmit severe viruses to rice plants, such as rice ragged stunt virus

(RRSV) and rice grassy stunt virus (Hibino, 1996) . It is a small pes that will harm the paddy plant, the infected area of paddy plant will turn yellow and brownish because the virus kill the plant.

2.2.2 Hopperburn Effects

Feeding by numerous BPHs generally results in the susceptible plants yellowing, browning, and drying, a phenomenon called 'hopperburn' in the fields. There is hopperburn disease happened in Malaysia too, especially the state of Kedah. Kedah is a state that full of paddy rice farming state, but raising the paddy plant is not easy works. Every year the farmer only can plant the paddy for two times only, so the quality and quantity of crop yield are important to them. There is no way to save the infected plant, the only solution is prevent the disease is further spread, because the brownhopper will harm the healthy paddy plant surround the infected paddy plant, the infected area will spread wider if there is no action taken.

2.2.3 Traditional Technique and Disease Control

The farmer have to face with the problems that occur in paddy plant every year, so the common disease is caused by 'brownhopper'. Paddy farmer have no chances to cure it with agrochemical, just can avoid it from further spread, because the paddy plant that was killed by the 'brownhopper' that means dead, there is no way to make infected paddy plant become the healthy plant. During the feeding process, BPH stylet transiently probes the rice epidermis, penetrates the cell walls; and secrete the gelling saliva and watery saliva into rice plant cells. The BHP will kill the base of the paddy plant and affect the paddy plant growing, cause the plant cannot growing well and turn brown, then dead, then will no more photosynthesis ability. The Figure 2.1, shows the different of the infected plant and resistant paddy plant.

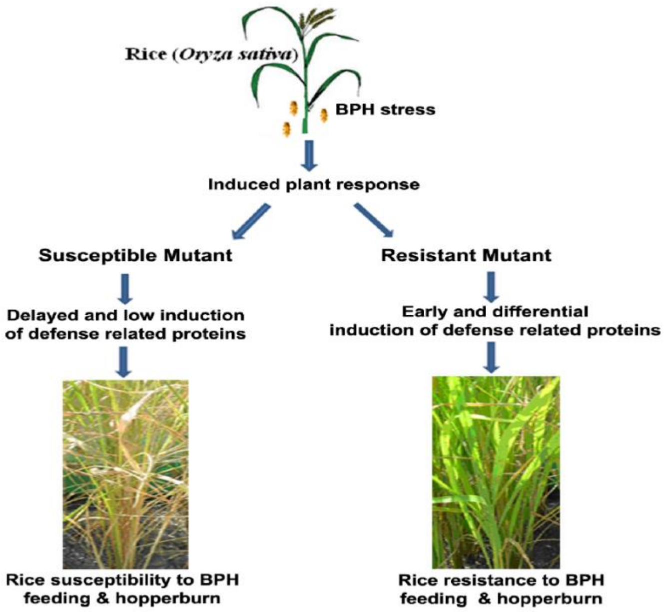


Figure 2.1: The flow of the hopperburn that affect the paddy plant

2.3 Unmanned Air Vehicle (UAV)

Unmanned Air Vehicles (UAVs) have gained much interest due to their various applications. These applications include surveillance, rescue missions, military operations, film making, and agriculture. Also, the rapid technology developments in embedded systems, sensors and actuators technologies have contributed to their popularity and success. UAV is a small aircraft that can fly in the sky for several times to complete the task. UAV complete the task by the controller of the pilot and receiver of the UAV receive the signal from the transmitter.

2.3.1 Types of Unmanned Aerial Vehicles

A drone's "grade" is a measure of the quality of construction, sophistication, and the use of more advanced technologies in its creation. Over time, the price of some technologies, and quality building materials has gone down, and so there are often hobby grade drones that can do most of the things a professional grade drone can do and vice-versa. There is many different types of the UAV, mostly the toys grade are sized small, and it is headless, but for professional grade, the size are bigger and capacity of the battery are bigger, because the battery consume by the motor are increased. The bigger sized UAV can do the difficult task than toys grade UAV, the bigger UAV are more stable while arm in the higher altitude of the sky. Besides that, the bigger sized UAV have more function than the toys grade UAV, such as loiter, stabilise, and return to launch (RTL).

2.3.2 Advantages and Limitations

When you build a drone, there's nothing you can't change. Every part can be modified or replaced with something better. It's also a great learning experience because you're seeing how everything works and goes together. We can conclude that the advantages build the drone can modify anything we like, and replacement parts of the drone is cheaper. The build of drone can save a lot of cost compare to the drone in market, some of professional drone more expensive, too. The limitation of the diy drone is no assurance at any damage, even there is not human made damage, all the damage and cost have to bear our self.

2.3.3 UAV Applications

The application will use in this project with is Mission Planner. Mission Planner is a ground control station for Plane, Copter and Rover. It is compatible with Windows only. Mission Planner can be used as a configuration utility or as a dynamic control supplement for your autonomous vehicle. The drone will connect with the computer (Ground Station) and set the mission, to complete the complicated task by the drone. Waypoint navigation, flight modes, altitude, delay and so on can be set as a task for the APM drone.

2.3.4 Selected UAV in This Project

Arducopter is a quadrotor autopilot project based on the Arduino framework developed by individual engineers worldwide. A graphical-user-interface (GUI)-based software GCS is provided to tune control gains and display flight information. The drone is the aircraft that build up from hardware can fly in the sky. The drone nowadays are improved and enhanced its performance to complete the many task that bring convenience to human. Only ardupilot mega (APM) and pixhawk board that can only supported in GUI like mission planner. To maintain balance the Quadcopter must be continuously taking measurements from the sensors i.e Gyroscope and Accelerometer, and making adjustments to the speed of each rotor to keep the body level. These adjustments are done by a sophisticated control system like Arducopter on the Quadcopter in order to stay perfectly balance. The APM board has the gyro sensor that can collect the data to balance it when armed, it also can learn itself to stabilize it, a function in the software called 'autotune' let the drone learn itself and get the parameters to improve it to balancing. In APM board can also support many of the channel that can do a lot of task, like gimbal, GPS module.

2.4 Image Processing

Image processing techniques includes several methods namely enhancement, segmentation, detection of region of interest, pre-filtering method, thresholding technique and morphological operations. The image processing can process the image into information image for further study, can solve the problems and enhance the productivity in many area.

2.4.1 Image Processing Techniques

Metrics that use spectral reflectance pertinent to plants are called vegetation indices (VI), the most popular of which is NDVI. NDVI is sensitive to active photosynthetic compounds and is therefore a popular way to measure the productivity of vegetation, or "greenness," in a defined area. The NDVI image is process from the multispectral image, the multispectral image take from the camera of the drone in this project, then process the multispectral image and divide into threshold image with classic vegetation index. There is the formula to get the NDVI image with formula from different band of the multispectral image. The output of the image can clearly see the status of the paddy plant. The formula is NDVI=NIR-R/NIR+R. The NDVI is able to efficiently discriminate green vegetation from other features since the former contains chlorophyll that absorbs red light for photosynthesis and at the same time reflects the near infrared energy. Thus, high NDVI signifies high green vegetation. The NDVI separates green vegetation from other surfaces as the chlorophyll of green vegetation absorbs the visible red wavelengths for photosynthesis and reflects the near infrared wavelengths. Therefore, high NDVI indicate high vegetation. The paddy field in this project will show that the healthy paddy field will show high NDVI from the hopperburn disease and the low NDVI will prove that the paddy are not healthy, or photosynthesis status is not very well.

2.4.2 Image Processing Applications

Development of a MATLAB GUI for the algorithms studied increases the awareness of these algorithms and benefit the potential users. The user can input multispectral images and can select the algorithm in order to get the result. The MATLAB application can encode many type of algorithm, and toolbox to process the image in this study, the result will show that the vegetation index of the infected paddy plant and uninfected paddy plant.

2.4.3 Selected Image Processing Technique in This Study

The multispectral image of Vellore district is used to calculate the percentage of versatile features such as vegetation, hilly areas, water bodies, open area, scrub area, agricultural area, thick forest, thin forest are presented in this image, and to subsequently make these extracted features available to the public for further analysis in order to avoid any sort of natural disasters like flood. In this project, the project environment is paddy field in Kedah. The paddy field is too wide, so there is difficult to discover the infected area and take action immediately. This project is to enhance the crop yield by the farmer every season, with the help of drone take the multispectral image, and process the image to observe the vegetation image of the paddy plant.

CHAPTER III

METHODOLOGY

3.1 Introduction

The project involved the hardware and software. The design of the autonomous arducopter is the pre-process of this system, while software act as post-process of the system. This chapter will explain the flow of the system works. The pre-process is Arducopter will collect the data from the paddy field. The Arducopter is programmed to complete the task autonomously by using the software. The Arducopter will follow the waypoint, altitude, delay and flight modes of the Arducopter. Image processing also will convert the input image from the data collection to vegetation rate image. Then the result image can set the threshold to show the same rate of the vegetation of the image, followed by the area calculation of the rate. The area of the different rate also will result in an output for comparison.

3.2 Flow of the Study

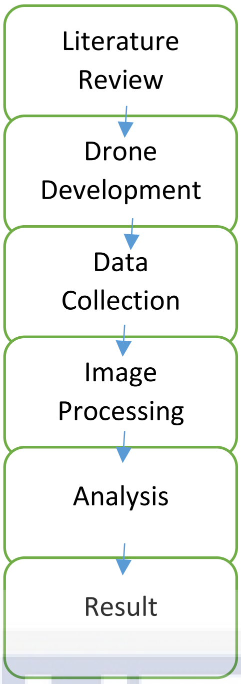


Figure 3.1 Flow of the Study

Figure 3.1 shows the flow of the study in this project. The first study is literature review, then the second is drone development, then the third is data collection, fourth and fifth is image processing and analysis, the last one is result.

i. **Literature Review**

The related citations or journals as references in this project.

ii. **Drone Development**

The process of build drone and how it help the monitoring process.

iii. **Data Collection**

The target image taken by the drone from the survey.

iv. **Image Processing**

The image taken will use for processing the vegetation image.

v. **Analysis**

The calculation of the area infected after image processing.

vi. **Detail of Drone Development**

UAV are assembled from many small parts, hardware.

Figure 3.2: Frame of the drone

Figure 3.2 shows Q380 frame kit with landing skid. This frame is the main part of the UAV, this frame allows all related hardware install on it. The landing skid install bottom of the frame and makes the drone easy landing after flight. The size of the frame are medium, so the requirement for motor and battery are low.

Figure 3.3: Motors for drone

Figure 3.3 shows 4 Brushless 960kv motor with 4 Electronic Speed Controller. The motors have 2 types, 1 type is clockwise (cw), 1 type is counter clockwise (ccw), the 960 kv motor are suitable for bring up the medium size drone. The power consumption is optimum and suitable for last longer.

Figure 3.4: Ardupilot Mega 2.8 board

Figure 3.4 shows Ardupilot Mega 2.8 flight controller or APM board of the drone. This is most important part in the UAV, it act as a brain or main component in UAV. It is connecting all hardware of UAV, to assembly all the hardware into aircraft that can arm in the sky.

Figure 3.5: The GPS module

Figure 3.5 shows the GPS module of the drone. The GPS module install in APM board of UAV, to make sure the coordinate or position of the drone. This GPS module helps in drone navigation, such as waypoint navigation and return to launch (RTL).

Figure 3.6: A set of propeller for quadcopter

Figure 3.6 shows 9443 propellers (2 CW and 2 CCW) for quadcopter. The propeller will install on the 4 axes of the drone, in the each motors, when the motors start and propellers spin, they will push the UAV from the ground, make the UAV arm. The direction of the propeller is important too, because it will cause the arm result of the drone. The UAV of the project is quadcopter, so the CW and CCW propeller must be install properly, as shown in Figure 3.7.

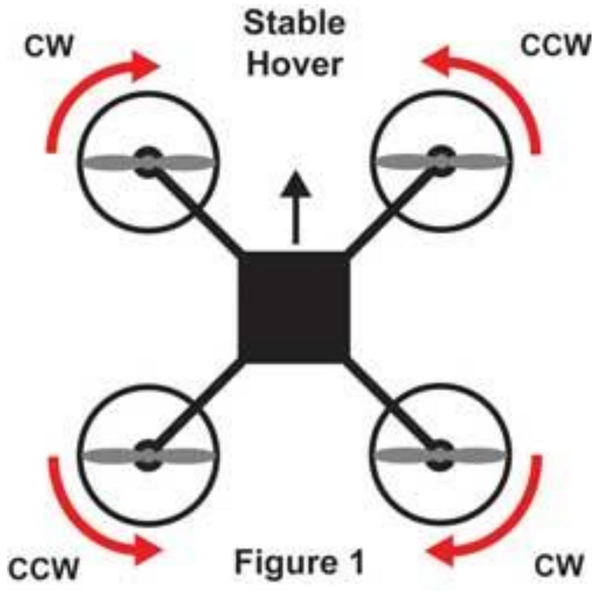


Figure 3.7: The rotation of propellers direction in quadcopter

Figure 3.8: The 3DR telemetry set

Figure 3.8 shows the 3DR telemetry of the drone. The 3dr telemetry set have two component, which is transmitter and receiver, the transmitter will install on the Ground station (computer), and receiver will install on the APM board of the UAV. The reason of assemble this on the drone and computer is make the connection and observe the status of the drone when armed. The ground station also can send the task to the drone and the drone will send the status when armed.

Figure 3.9: The LiPo battery pack for drone

Figure 3.9 shows the battery of the drone. The 3 cells battery is lithium-polymer battery (LiPo), are suitable for drone, because it can give enough power to calibrate the motor until the drone can arm, but the flight time for 2500mah is around 10 minutes for several flight test.

Figure 3.10: The modified camera for full spectrum image

Figure 3.10 shows the modified camera mount to the drone. The modified action camera can take the full/multispectral image when install on the drone. The drone will fly to suitable position to ensure the camera can the nice shot.

Figure 3.11: The transmitter and receiver of drone

Figure 3.11 shows RadioLink AT9 transmitter and R9D receiver set of the drone. The remote control (called as transmitter in RC world), will be control the drone when R9D receiver are installed on the drone, connecting to each channel in APM board. The 9 channels transmitter are suitable for advance using the drone, the channel 7 is a must to complete the autonomous flight.

Figure 3.12: The assembled drone

Figure 3.12 shows the assembled drone of this project. The drone will have the camera mount to install the camera on it, this will fix stabilize the camera from shaking and vibrate, to take the better image from the sky.

3.3 Data Collection

The data collection of this project is multispectral image taken by the modified camera. The normal camera cannot take the multispectral image because all wavelength from the light are filtered. So the multispectral image are important to process into any band of the wavelength, such as infrared. The area of the each image also calculated by Ground Sampling Distance method (GSD), to calculate the area of target. The concept of the applying formula as Figure 3.13,

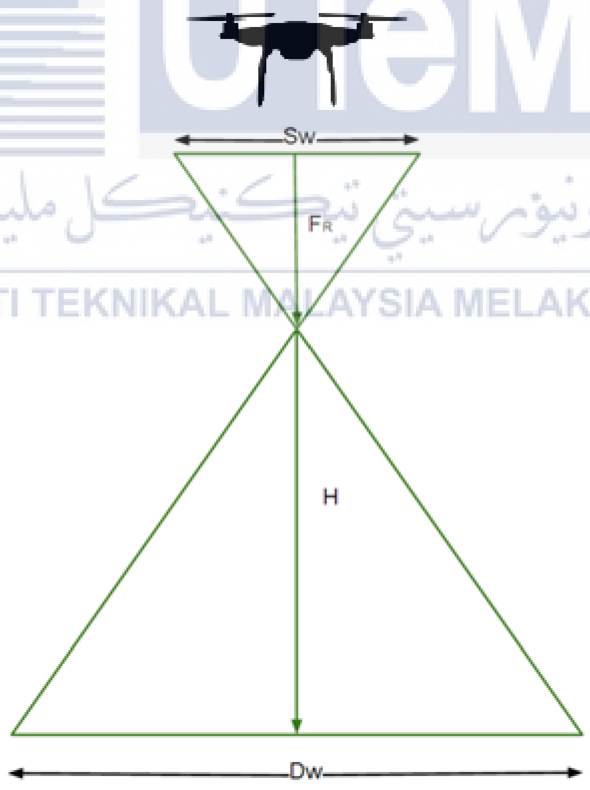


Figure 3.13: The concept of GSD

i. Sw is sensor width of the camera (millimetre).
ii. Fr is focal length of the camera (millimetre).
iii. H is flight height of the drone (metres).
iv. Dw is single image footprint (metres).

To obtain the GSD, the i) to ii) material and resolution of the image are required, for this monitoring system, the Sw is 12mm in, Fr is 20mm, the height is 50m. The formula of the GSD is (Sw*H*100)/(Fr*image width).

3.4 Image Processing

The image processing application is MATLAB, MATLAB is the application that can process the data like image. The use of MATLAB in this project is divide the multispectral image into vegetation Image, the output will be follow the NDVI scale.

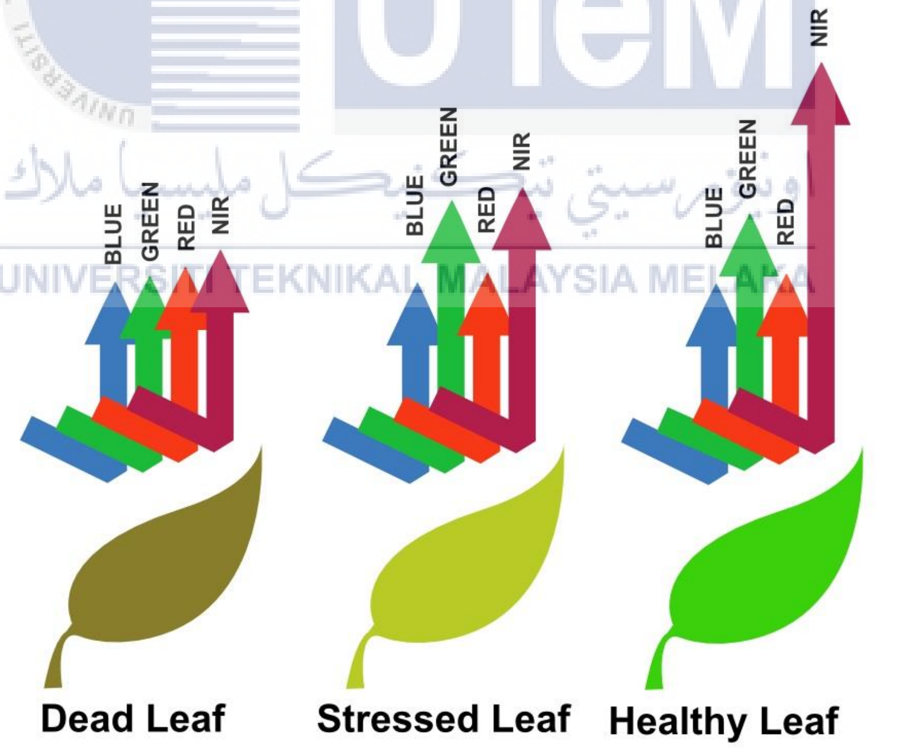


Figure 3.14: The difference of reflection band with leaves status

Figure 3.14 explain this concept from the sunlight to leaves, and then to camera. So the formula will apply in MATLAB to process the multispectral image into NDVI image.

3.5 Analysis

The output of the image, NDVI will be use to analysis the healthy paddy plant, and unhealthy paddy plant. The paddy plant with low vegetation image maybe the suspect to infect by 'hopperburn' disease. Then the estimated infected area will be calculated for reference to farmer to take immediately action before the disease are further spread.

3.6 Summary

The drone will be used to take the image from the altitudes, this is more efficient because the drone will take the larger area compare to farmer observation due to large paddy field. The system will help to analyse the image to observe the status of the paddy plant, so this will enhance the productivity of the crop yield by the farmer, because farmer can discover the unhealthy paddy plant and take the action immediately.

CHAPTER IV

PROJECT DEVELOPMENT

4.1 Introduction

In this chapter, the full of project development process will be discussed. The system development such as system architecture, hardware design and image processing will be included in this project based on high level design. Design phase is one of the basic stage in a project development. It used to fulfil the requirements mentioned in the analysis part and mapped into the framework design. It will choose how the framework will work by including a few function at the framework prerequisites, for example, functional and non-functional requirements. The unmistakable outline of the framework will be introduced in this section.

4.2 High Level Design

The High Level Design will describe whole system and relationship between the function. This involved the system architecture.

4.2.1 System Architectures

Figure 4.1 shows that the monitoring cycle of the system, mostly start of the farming season, the drone will take the first action first, the drone will take the multispectral image and go for the second process, the suitable image are used to process in MATLAB to divide the multispectral image into the Near-Infrared band and

Red band, because this two bands image have to apply into NDVI formula to find the vegetation image. Then the third step is the output of the image processing, the output will show the vegetation image of the paddy field, besides also will calculate the disease area. The farmer can observe the result as reference to take the action immediately, they will observe the suspect infected area to confirm the disease and decide what agrochemical should be use. The early discovery will help in saving use of agrochemical quantity, maybe liquid or powder.

Figure 4.1: The monitoring cycle of the system

4.2.2 Data of Multispectral image

The requirement of the project is multispectral image, the multispectral image taken by modified camera, will be the target to process into NDVI image by MATLAB application. The sample of the multispectral image are taken by camera.

Figure 4.2: Random shot in Bukit Beruang Area

Figure 4.3: The shot from paddy field in Kedah (Altitude: 50m)

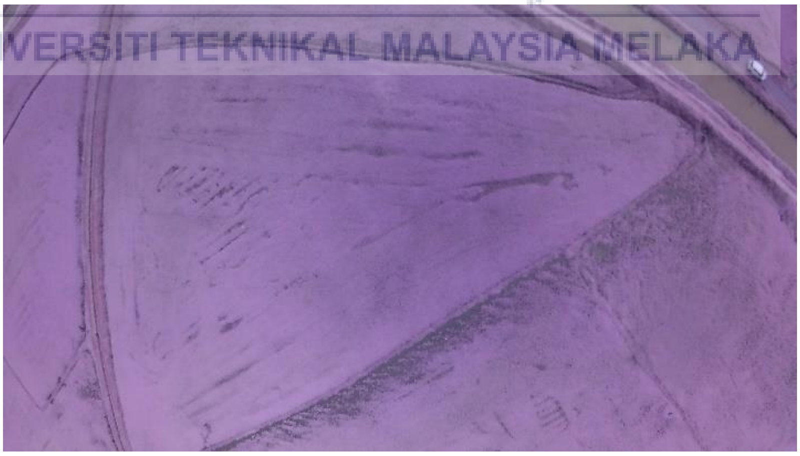


Figure 4.4: The 2nd shot from paddy field in Kedah (Altitude: 50m)

Figure 4.2, Figure 4.3 and Figure 4.4 shows the sample of multispectral image. The MATLAB will process the image to differentiate the plant and non-plant, due to the vegetation status in the image, which means everything that has photosynthesis process will be clearly differentiate. The image will be differentiate by the classic NDVI colormap, and scale is -1 to 1.

Figure 4.5: The scale of NDVI with Colormap

Figure 4.5 shows the scale of the NDVI. The Vegetation image that has the higher value or the colour is not blue, consider as the plants having the photosynthesis process, because they are reflecting the Near-Infrared (NIR) from the sunlight to modified camera. The lower value or colour is blue are consider as unhealthy plant and non-plant, or non- photosynthesis objects.

4.2.3 Hardware Design

The hardware design for remote sensing that are capable to collect the data from different angle are benefit for decrease the loss of the paddy crop yield. The hardware are used together to connecting each other to complete the task, the information collected will also process in the computer. The hardware are shown in Figure 4.6.

Figure 4.6: The hardware of remote sensing for ‘hopperburn’ disease

The Figure 4.6 shows that the hardware will be used in the monitoring process of 'hopperburn' disease. The hardware list is computer with 3DR telemetry receiver, modified camera, AT9 transmitter and assembled UAV. The 3DR telemetry are connected between the drone and computer to ensure the data armed from the drone can be collected into Mission Planner application in computer. The action camera will mount to the drone and take the image when arming. Besides, the AT9 transmitter will send the signal to control the drone, and trigger the autonomous flight.

4.3 Summary

This chapter provided the information about system architecture, data of multispectral image and sample image, and the hardware design. This chapter show the flow of the monitoring process of the project. Besides, the multispectral image will use for image processing to get the NDVI image with scale -1 to 1, so the output can show the healthy and unhealthy paddy plant, the unhealthy plant maybe is the 'hopperburn' disease when paddy plant is around 2-3 months old.

CHAPTER V

IMPLEMENTATION

5.1 Introduction

This chapter explain the whole implementation of this system. The Section 5.2 will explain about the Software Development Setup and Section 5.3 is about System Configuration Management. In this chapter, it review the implementation phase and the expected output of the system. This chapter will also mention about the implementation status and implementation conclusion in this chapter. The implementation of this project is collect the data from the autonomous drone to collect the data from the 50 metres high above the paddy field. The drone will be navigated by the Mission Planner Software, all the action will be autonomous. This remote sensing is collect the data in multispectral image, the vegetation index or vegetation image can be collected after processing the image by MATLAB software. The software will result the multispectral image into NDVI image and the estimated area of infected of Hopperburn disease.

5.2 Software Development Setup

In this project, two main software are used to complete this system. Two software act as the main role in this system, one of the software is Mission Planner, while another software is MATLAB. This two software setup process are shown below.

5.2.1 Mission Planner Environment Setup

The setup of this Mission Planner, user need to follow the following software and resources.

Table 5.1: Software and Resources version

Software and Resources	Version Required
Mission Planner	1.3.48
DirectX	9.0c

Table 5.1 shows the table of Software and Resources version that required.To setup the Mission Planner software, the download link is required by the user.

i. Mission Planner (Version 1.3.48)- http://ardupilot.org/planner/docs/common-install-mission-planner.html
ii. DirectX (Version 9.0c)- https://www.microsoft.com/en-us/download/details.aspx?id=35

After download the setup of this software, the file name is "MissionPlanner-latest.msi", just click on this file to install the Mission Planner software to the computer.

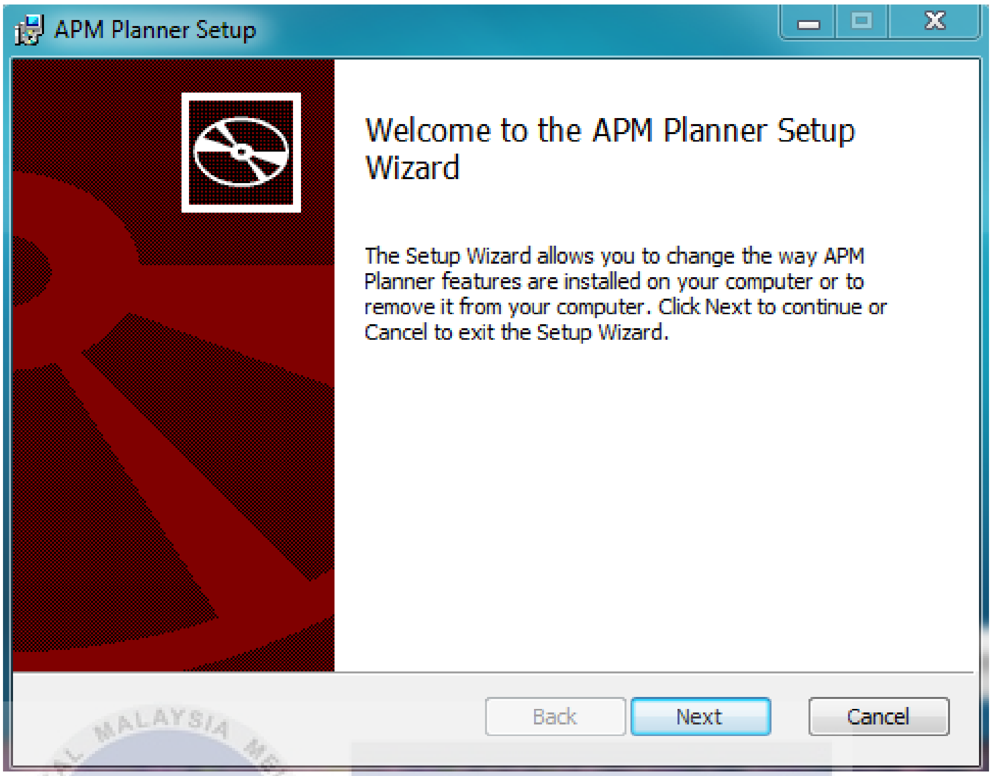


Figure 5.1: The setup page of the Mission Planner

In Figure 5.1, the installation will start when the user click on this file, the page pop out will be like Figure 5.1. In this installation, the necessary software or driver will automatically install in the computer, if the installation failed, we need latest version of the directX, the download link are provided at the beginning of this sub-chapter, after download the directX setup, the file name is "dxwebsetup", just click on the file and the installation will start with pop out the installation page.

Figure 5.2: The installation page of the DirectX

Figure 5.2 shows the installation page of the DirextX. Just click on the "I accept the agreement" and click "Next >" button, the installation will start automatically. After install the DirectX, continue to Mission Planner, click on "Next" button and the installation will start automatically. Normally the software of this Mission Planner will install in this path of the computer, **C:\Program Files (x86)\APM Planner** folder or **C:\Program Files\APM Planner** folder. Then start the Mission Planner.exe, the software installed in the computer.

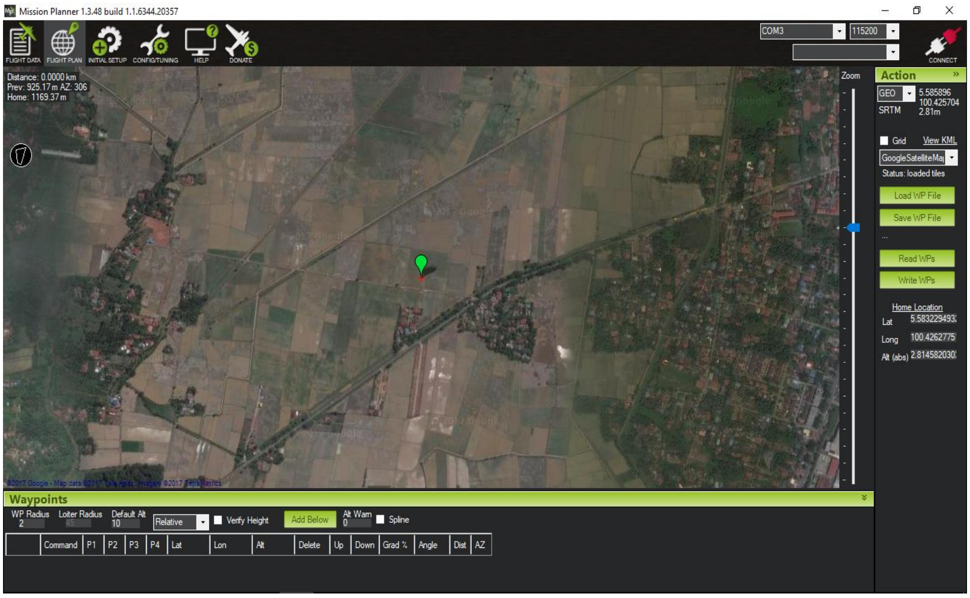


Figure 5.3: The interface of the Mission Planner

In Figure 5.3, after open the software, the interface will show as Figure 5.3, in this moment, we have to connect our drone with this computer, which is USB port of the APM board of the drone.

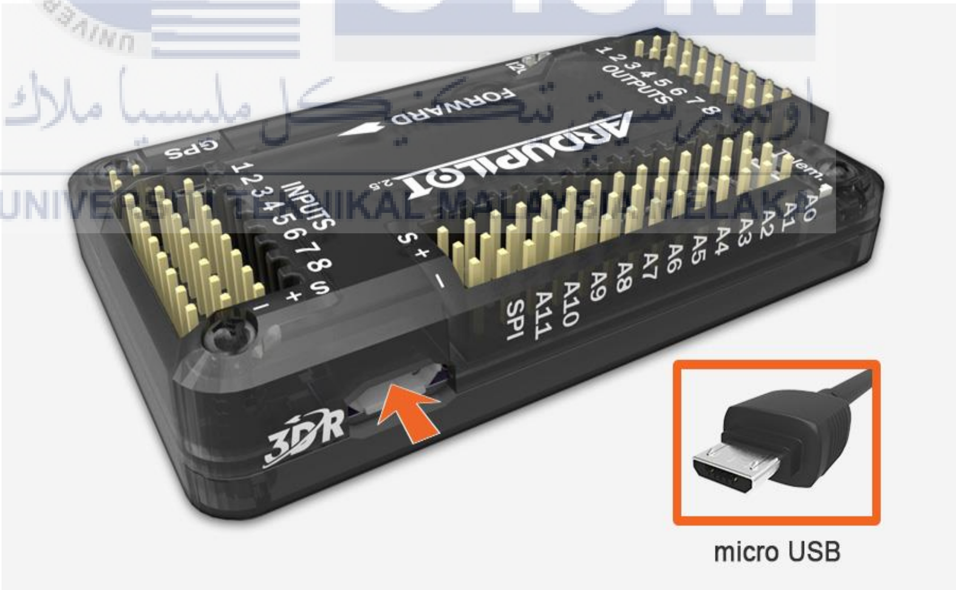


Figure 5.4: The detail of the USB port in APM board

Figure 5.4 shows the detail of the USB port in APM board. Then we click “connect” button on the top right of the software, this will connect this software and the drone. In this moment, the drone are not programed, yet. This software support several type of the Unmanned Vehicle, such as hexacopter, quadcopter, rover, octacopter. So, this system only use the quadcopter act as remote sensing to collect the data.

Figure 5.5: The firmware page of the Mission Planner

Figure 5.5 shows the firmware page of Mission Planner. Click the "INITIAL SETUP" button on the top bar, then go for install firmware, the page will pop out like the Figure 5.5 as shown above, we click "APM:Copter V3.5.0 Quad" to install the firmware that fits the drone used in this system. The user have to follow the instruction while install the firmware, like live calibrating. Then the drone setting and mission planner software are installed and ready to arm, to collect the data on site, which is paddy field.

5.2.2 MATLAB Environment Setup

The setup of this MATLAB, user need to follow the following software and resources. The version of MATLAB user required is R2016a. This software will helps to analyse the image that collect from the multispectral aerial photo from the 50 metres high when using autonomous drone armed. The result of using the MATLAB is multispectral image will convert into NDVI image, to show the photosynthesis status of the certain paddy field when growth, and check whether the paddy plant are infected by the Hopperburn disease. The steps following show the installation the MATLAB software in the computer.

i. Create the MathWorks Account in https://www.mathworks.com/mwaccount/register?uri=http://www.mathworks.com/help/install/ug/install-mathworks-software.html

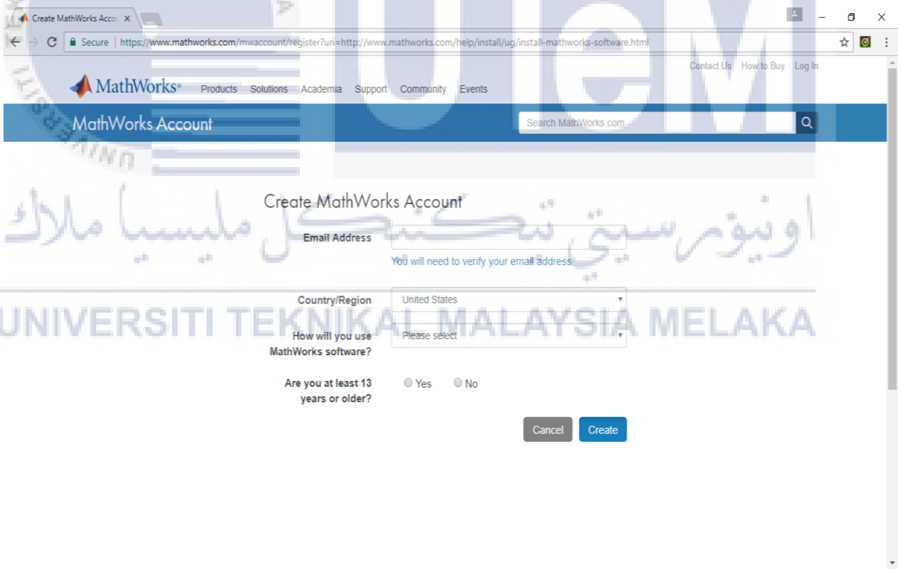


Figure 5.6: Create Account MathWorks page

ii. Then go for trial software in the website as Figure 5.6, https://www.mathworks.com/programs/trials/trial_request.html?prodcode=ML

iii. Choose the MATLAB 2016a version and download.

iv. Open the installer of the MATLAB downloaded.

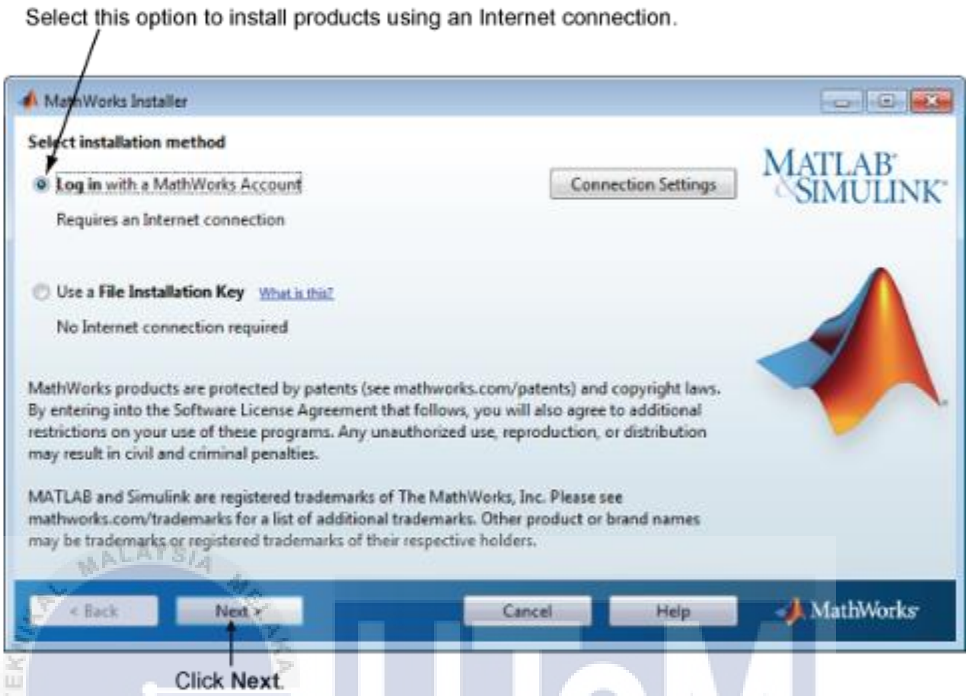


Figure 5.7: MATLAB setup page

v. Login with MathWorks Account, then click next button to continue installation.

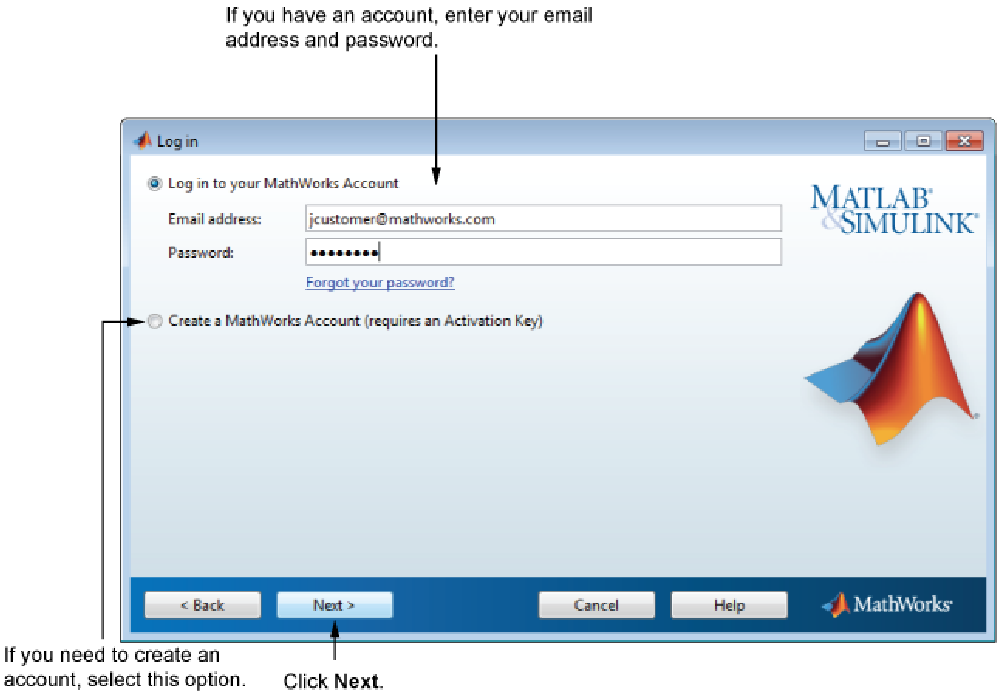


Figure 5.8: MATLAB Setup Login Page

vi. Login to the created MathWorks Account like shown in Figure 5.8 above.

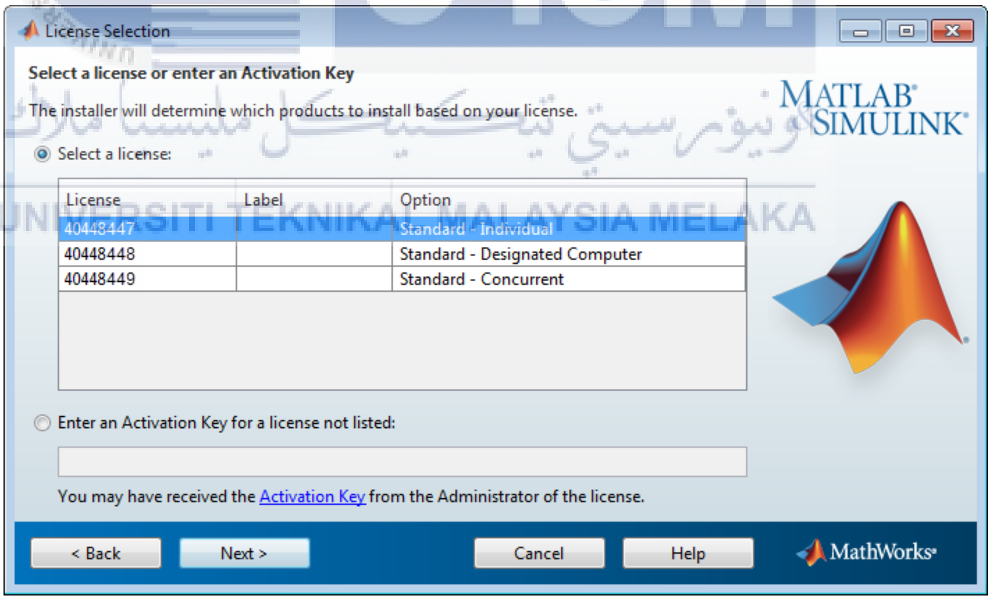


Figure 5.9: MATLAB Setup License Selection

vii. Select the type of the license which one to install and click Next button, as figure 5.9.

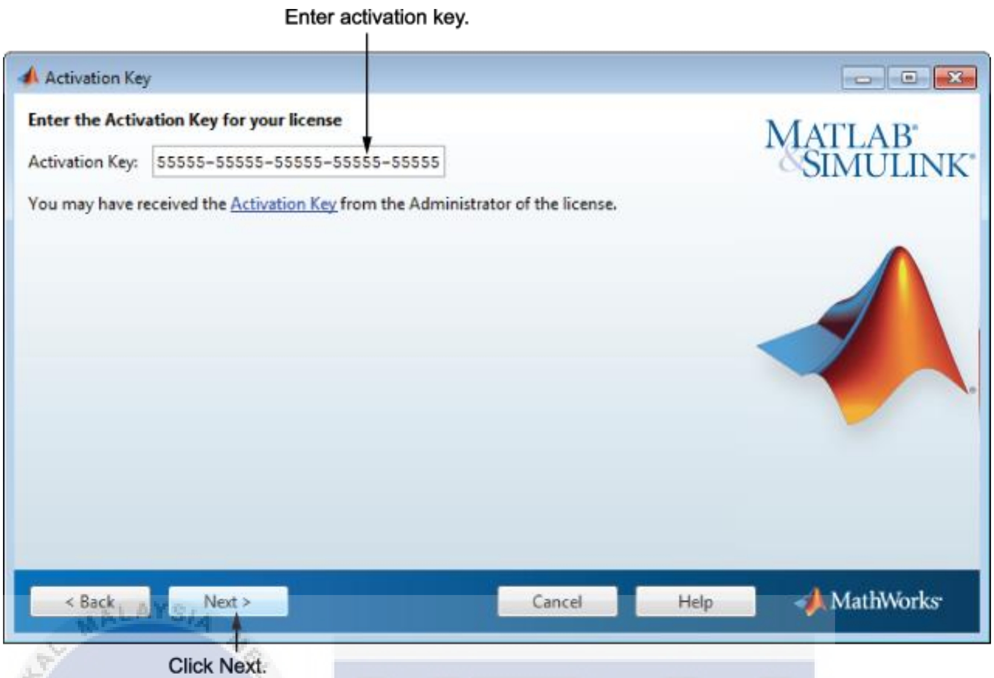


Figure 5.10: MATLAB Setup Activation Key page

viii. Enter the Activation Key and click on the Next button.

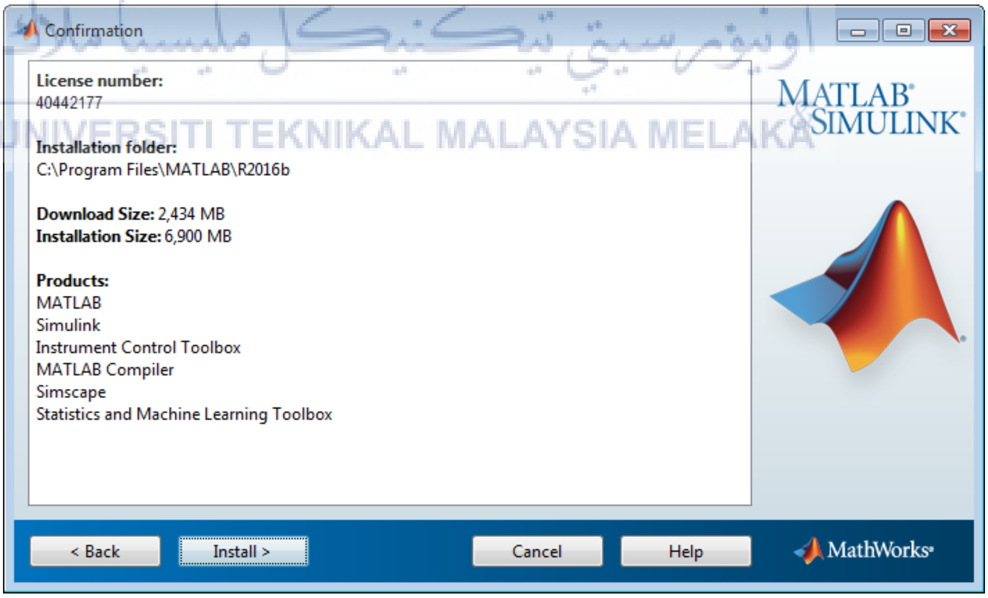


Figure 5.11: MATLAB Setup Confirmation Page

ix. The Figure 5.11 shows that the License number of the software, installation folder location, download size which need the internet connection and Product to be install. If confirm, just click install button at the bottom of the setup page.

Figure 5.12: MATLAB setup complete page

x. The installation complete as shown in Figure 5.12, the page will ask whether want to activate the MATLAB or not. If yes, mark up the box and click the next button then the installation complete.

5.3 Software Configuration Management

This Software Configuration Management is the management to control the changes of the software installed, like revision control and establishment of baselines. In this system, software installed in the computer. Mission Planner is the software to make the drone done the remote sensing task for multispectral image from the paddy field, while another software, MATLAB is the tool for analyse and process the multispectral image in to vegetation image of the paddy field, and analyse the approximate disease area of the paddy field.

5.3.1 Version Control Procedure

The procedure and control in managing the source code are important in this system, this is because we need to keep the change and record the documents and any program used in system. The redundant or excess unnecessary document should be deleted. The Table 5.2 will show the version control procedure in this project.

Table 5.2: Version Control Procedure

Type	Version
Draft of Proposal	0.1
Finalized of Proposal	0.2
Minor change of Project Report	1.0
Major change of Project Report	1.1
Finalized of Project Report	2.0

5.3.1.1 Backup Management

In backup management, this is the part to copy or prepare extra data in the computer, this is because some accident will happen anytime, anywhere. No one will take responsibilities on the any loss of the data in computer. So in this project, to prevent any missing the data like image collected, source code and some saved files. The important data in this project have to copy and backup to other hard drive from time to time, this make sure the data can restore back anytime if any incident happen.

Table 5.3: Backup Management

Backup	Activity
Storage Scope	All
Backup Media	Google Drive and USB drive
Backup Frequency	Weekly
Checking Backup Frequency	Weekly

5.4 Implementation Status

The implementation status is the process progress when applying the technique or solution and it will produce an output of the project. The time and duration of the each module are stated in the Table 5.4.

Table 5.4: Implementation Status

Progress	Duration Completed (Week)	Date Completed
Data and Information Collection	12	14 July 2017
Proposed Technique	6	21 Jun 2017
Analysis	5	25 July 2017
Other	4	9 Aug 2017

Table 5.5: Milestone of the Project

No.	Module	Description	Duration (Weeks)	Date Completed
1	Hardware Design	Assemble the drone model, modify the camera	12	15 March 2017
2	Mission Planner with drone	Install type of firmware, adjust all the input and output channel of the APM board and transmitter	1	25 March 2017
3	Drone stability adjustment	Read the 'autotune' mission to make the drone to learn stabilize itself	1	1 April 2017
4	Autonomous test flight	Read the waypoint set, and test flight	2	15 April 2017
5	Algorithm design	Understand the concept detail and how the implementation in MATLAB	1	22 April 2017
6	Image Pre-Processing	Read sample multispectral image, convert into NVDI image	3	10 May 2017
7	Image Post-Processing	Threshold of NDVI image, calculate the area of pixel by GSD method	2	25 May 2017
8	Remote Sensing	The real image of multispectral image collected when the paddy is 2.5 months old	1	20 July 2017

In Autonomous test fight from Table 5.5, the sample raw video also recorded and uploaded to YouTube, https://www.youtube.com/watch?v=2yZmwruh3G8&t=141s

5.5 Summary

The implementation chapter is the chapter that how the technique help to done in this project. With the help of hardware and software, the progress of this project runs smooth and produced an output.

CHAPTER VI

TESTING

6.1 Introduction

This chapter will describe the how to perform the technique into the system. With the combination of the hardware and the software, this technique can implement into the system to carry out the result. This procedure in this system is using the autonomous arducopter, as remote sensing to collect the data that needed by this system. The autonomous arducopter are navigated to waypoint that desired in the project. The Mission Planner will help the drone to fly any task waypoint if send into the arducopter. All the waypoint or task are followed by the longitude and latitude in the global map, so the GPS module in the arducopter can make sure the waypoint armed is correct. In this project, the multispectral image is a must to process into Normalized Difference Vegetation Image (NDVI).

The MATLAB is the software to help the image processing from full spectrum or multispectral image into NDVI image to clearly observe the vegetation status of the paddy plant in paddy field. The infected paddy plant by hopperburn will be clearly observe in the processed image. The Graphical User Interface (GUI) are planned to build to make it convenience for most user. The button also provided and output image will be convenient not only developer, and also farmer.

6.2 Test Plan

In the test plan, there is some compulsory or necessary for this application in this project is hardware and software. To done this project, the combination of the hardware and software are very important to carry out the early discover of hopperburn disease.

6.2.1 Test Organization

The hardware and software involved in this project are important to the result. The hardware involved Ground Control Station, Arducopter, and modified camera, and computer. The Ground Control Station is the computer will use with 3dr telemetry kit to build the connection with the arducopter, the 3dr telemetry kit have two parts, the ground module is connect to the computer, and the air module is assemble with arducopter. While the software part, the software involved Mission Planner and the MATLAB, Mission Planner will monitor the status of the arducopter and MATLAB will process the data collected.

Figure 6.1: Ground Control Station

The Figure 6.1 shows the GCS is the computer that create or build the new mission to the arducopter, the arducopter will receive the mission and the status of the flight at the real time also will show in the mission planner software too.

Figure 6.2: Assembled Arducopter

The Figure 6.2 shows that the assembled arducopter will use in this system. The drone will read the mission from the GSC, perform the autonomous flight while switch into auto mode in CH7.

6.2.2 Test Environment

The environment of the testing is paddy field area. Kedah is the state that have most paddy farming activities in our country, Malaysia. One of the part of the paddy field in Kedah are chosen to collect the data in this project. There is some issues are considered too, the flat land are preferred, this is because the drone can easy arming and landing during complete the data collection task. Hence, the weather is important during the data collection, the rainy day and cloudy day are not suitable to collect the data, this is because the sunlight cannot shoot at the plant and the reflection of the near infrared is less, this will affect the output accuracy. To proof the formulae of using the Ground Sampling distance are accurate, the sample image are chosen as comparison with the area calculator in online source based on the google map satellite.

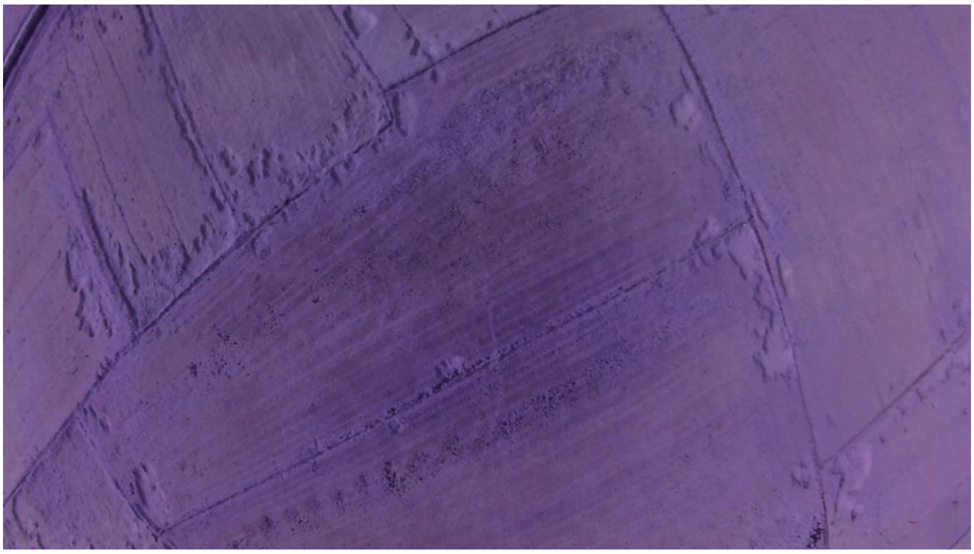


Figure 6.3: The paddy field image 438

The Figure 6.3 take the same parameters, the camera sensor width is 12mm, the focal length is 2.99mm, the flight height is 50m, the width pixels is 4608 and the height pixels is 2592. To obtain the GSD, the calculation is (12*50*100)/(2.99*4608)= 4.35 (centimeters/pixel). Then for the width of the image footprint on the ground is (4.35*4608)/100=201 meters, while for height of the image footprint on the ground is (4.35*2592)/100=113 meters. The footprint area on the ground is 22,713 meters^2. Now compare with the online source follow the google map satellite too, https://www.daftlogic.com/projects-google-maps-area-calculator-tool.htm this website have the calculator to calculate the area in the map.

Figure 6.4: The screenshot of area calculator online

Figure 6.4 shows the calculator can put the approximate coordinate follow the image collect by drone. The point set is closer with the Figure 6.4.The shape is rectangle because the action camera can take the wide angle image, 170 degrees, the resolution is also 4608 x 2592. The result of the area by this online calculator is shown in Figure 6.5

Output : Current Area

22378.00 m² | 0.02 km² | 5.53 acres | 2.24 hectares | 240874.75 feet² | 0.01 square miles | 0.01 square nautical miles

Current Perimeter

666.458m OR 2186.542feet

Figure 6.5: The result of the online calculator

The Figure 6.5 shows the result of the area. The area calculated by using GSD method is 22,713 meters^2, while this calculator is 22.378 meters^2. The different of this two result are less. So the GSD calculation is reliable in this system.

Figure 6.6: The target area of study from Google Map

The Figure 6.6 shows that the target of data collection area in Kedah. This area is suitable for data collection because there is one free field for easy arming and no electric tower in that area. For implement the task, the application of Mission Planner are needed to autonomous flight for data collection.

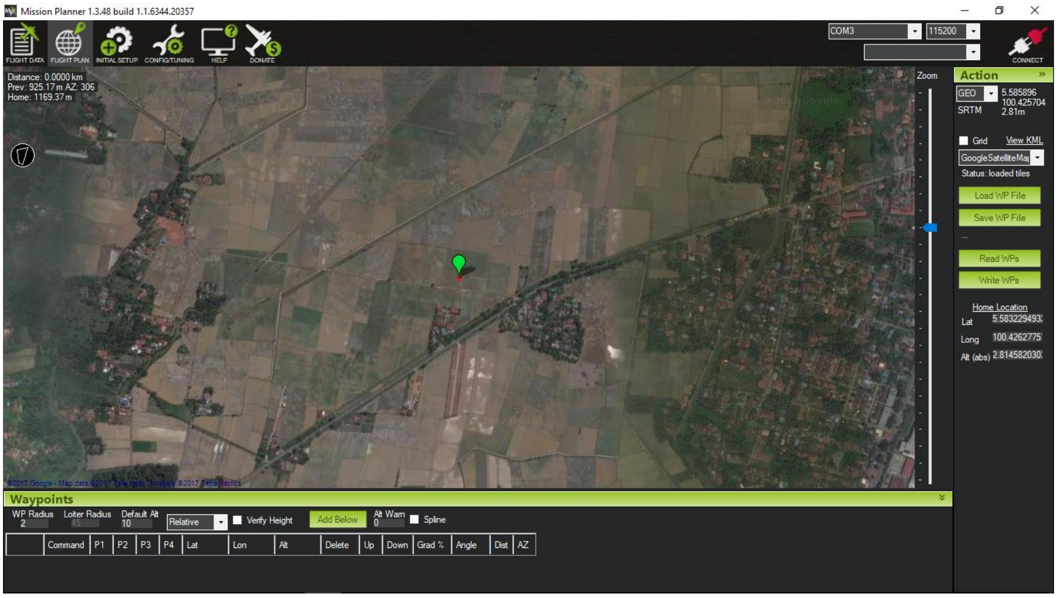


Figure 6.7: The Mission Planner Software interface

In Figure 6.7 shows the mission planner will send the task to the arducopter, then the arducopter will read the waypoint planned, it will navigate to the position as planned once the mode of the arducopter switch to "auto" mode. Is it convenient to user because manually control the drone are difficult, and the position and the altitude while arming is unknown. Mission Planner helps the precise control while collect the data from the paddy field.

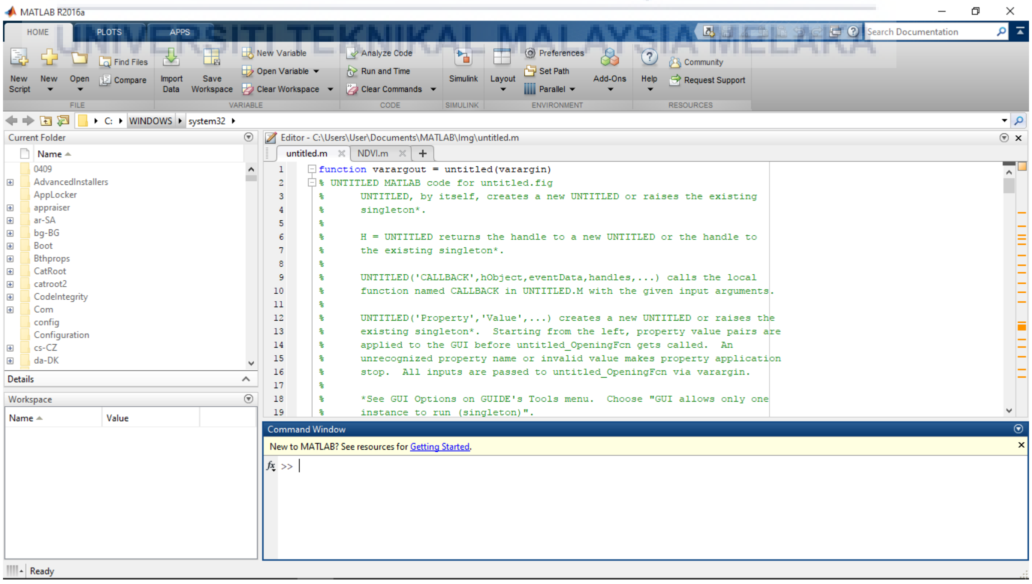


Figure 6.8: The MATLAB software interface

Figure 6.8 shows the MATLAB programming language is develop by the MathWorks, then the programming language can process the image of data collection in this system. The system will perform in GUI interface to enhance the convenient to user.

6.2.3 Test Schedule

The test schedule planned in this system is around 10 minutes per remote sensing. The date of the data collection is 17 July 2017 and 18 July 2017. The modes of the camera is 3 second per shot. The arducopter will loiter at a certain position for 10 seconds, then the camera will shoot the image within this 10 seconds.

6.3 Test Strategy

The strategy of test the disease is based on the NDVI, so if follow the jet colopmap in the scale in NDVI.

Figure 6.9: The scale of the NDVI colormap

Figure 6.9 shows scale of the NDVI is -1 to 1, the -1 is the weakest vegetation while +1 is the best vegetation in status. The target of this system is weak vegetation paddy plant in paddy field, not the weakest. So the test of the threshold of this system is 0 to -1, the strategy is top- down test. The testing threshold is 0, -0.2, -0.4, -0.6, -0.8, -1.0.

6.3.1 Classes of Tests

The output correctness is important is this system, the system can differentiate the plant and non-plant object by showing the vegetation image follow the NDVI. In data collection, the user still can see which object is the plant or non-plant even in multispectral image, the different is the image collection is reflected by infrared, this is different from our ordinary image in daily life. The functionality test is the system will ask the user to input the threshold, to separate the weak vegetation plant, with non-plant and healthy plant, the target of this system is infected plant maybe in weak vegetation plant.

6.4 Test Implementation

In this test implementation, the system will perform in interface that are simple and user friendly, the test description are clear explained. The detail of the process of the test also describe clearly.

6.4.1 Experimental / Test Description

For the beginning of the test, required the ready-to-fly arducopter, can perform the autonomous mode flight to complete the task in this system. To perform the autonomous flight, the drone required to programmed, this is because is it hard to control the drone manually, the height or altitude hard to adjust, the tiny arducopter hard to see by human eye when going too far. While data collection required the sunlight, the human eye and difficult to catch where the position of the drone if control manually, so the Mission Planner software are required to set the navigation plan to the arducopter.

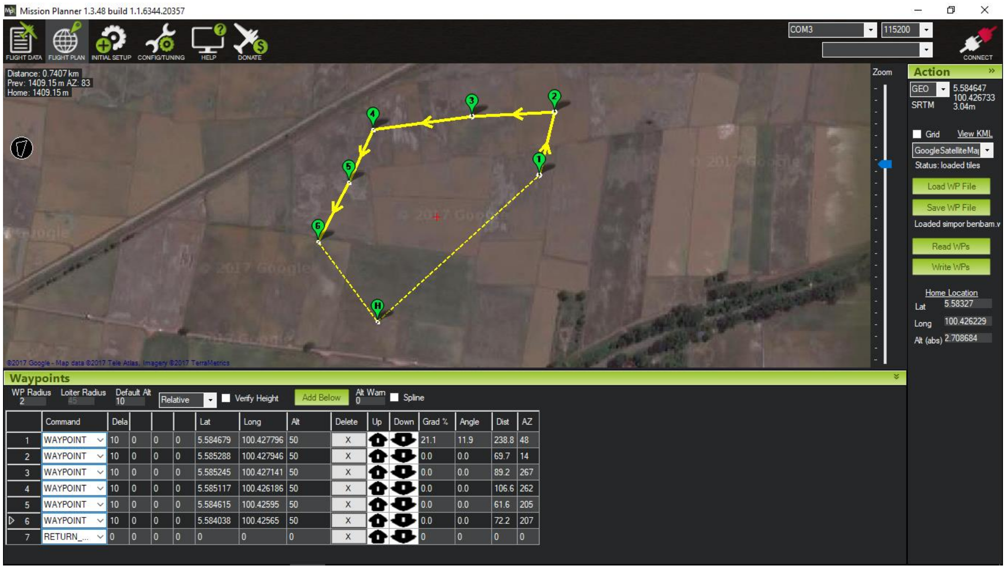


Figure 6.10: Mission Planner on target paddy field

From the Figure 6.10, the task will be set in the Mission Planner software then connect with the arducopter. After the Arducopter read the flight plan set in the Mission Planner, the Arducopter will follow the waypoint as set in the Mission Planner follow the coordinate in the global map. After the user armed the drone manually, switch to ‘auto’ mode will make the arducopter fly autonomously, as picture shown above, the arducopter will heading waypoint 1 first, then 2, 3, 4, 5, 6, and the 7 is the task to make the arducopter return to launch, which mean that the arducopter will return which place armed. In the waypoint 1, 2, 3, 4, 5, 6, the altitude set as 50 metres and delay is 10, the delay is the arducopter will loiter at that point for 10 seconds to take the better photo quality. After the remote sensing data collection, MATLAB will continue the task in this system.

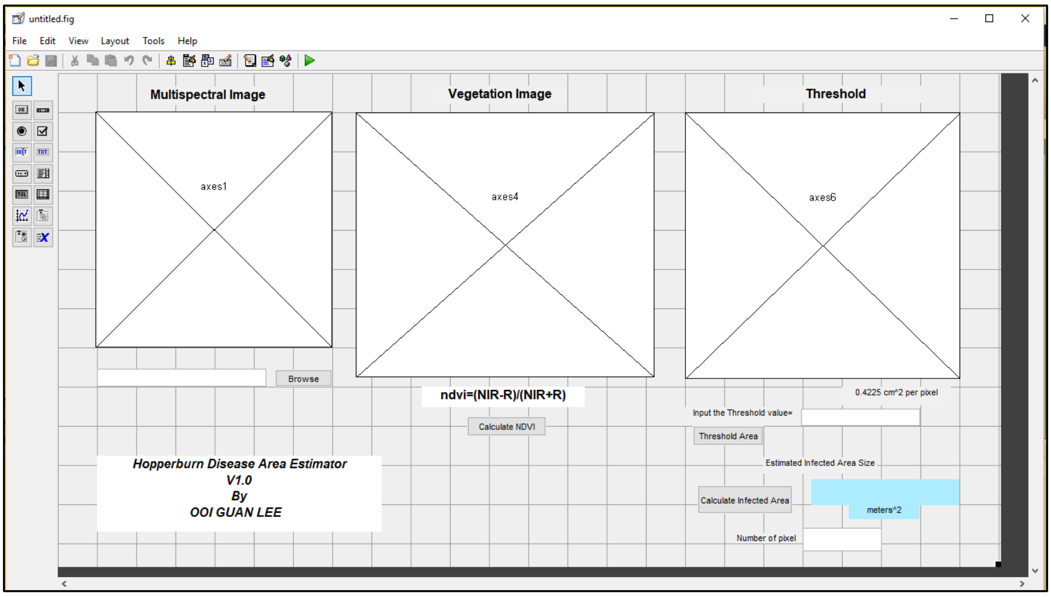


Figure 6.11: Hopperburn Disease Area Estimator GUI

In Figure 6.11, it is read the multispectral image from the image collection from the arducopter when click the 'Browse' button, then process into the vegetation image. When click the 'Calculate NDVI' button, the read multispectral image, will extract the Near Infrared, Red, and Green image, then each of the image will go for contrast enhancement for clearer detail of the image, then will apply the NDVI formula, NIR-R/NIR+R, the result is the vegetation image produced, in this output can differentiate the colour of the image, it is colormap to show that the status of the photosynthesis in paddy field.

The higher threshold according the colormap means the photosynthesis status is better while the lower threshold according the colopmap means the photosynthesis status is weaker. In the Threshold part, input the threshold value is separate the healthy paddy plant and the non-paddy plant, the weaker photosynthesis paddy plant is only needed in this project, this is because this group of paddy plant are the suspect infected by hopperburn. The process of the threshold is when the system read the input, the every pixel in the vegetation image will compare with the input, when the pixel is higher or same to the input, the output pixel is red colour in new output threshold image, else it become black. The last button is Calculate the Infected Area, the threshold image is convert into black and white image, then calculate black pixel, by applying the Ground Sampling Distance method, it calculate the area of all black pixel in metre^2. The result is the approximate infected paddy plant area for farmer as reference to take action immediately, because of different type of agrochemical in the market, farmer have to take action based on their experience, so there is no recommendation for farmer in this project. From the remote sensing data collection, the sample chosen multispectral image are shown in following figures.

Figure 6.12: Multispectral paddy image 609

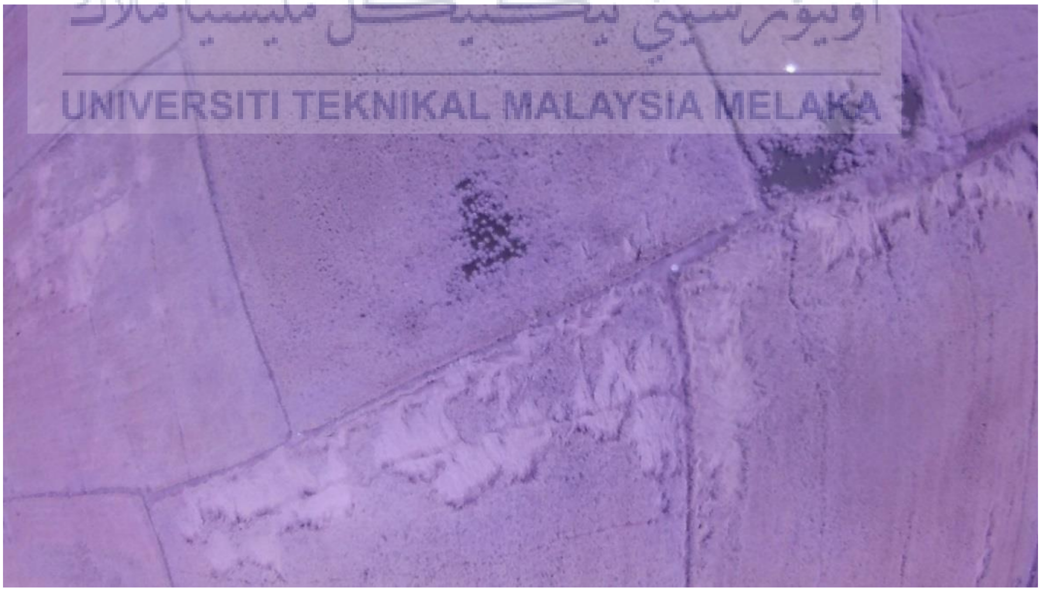


Figure 6.13: Multispectral paddy image 614

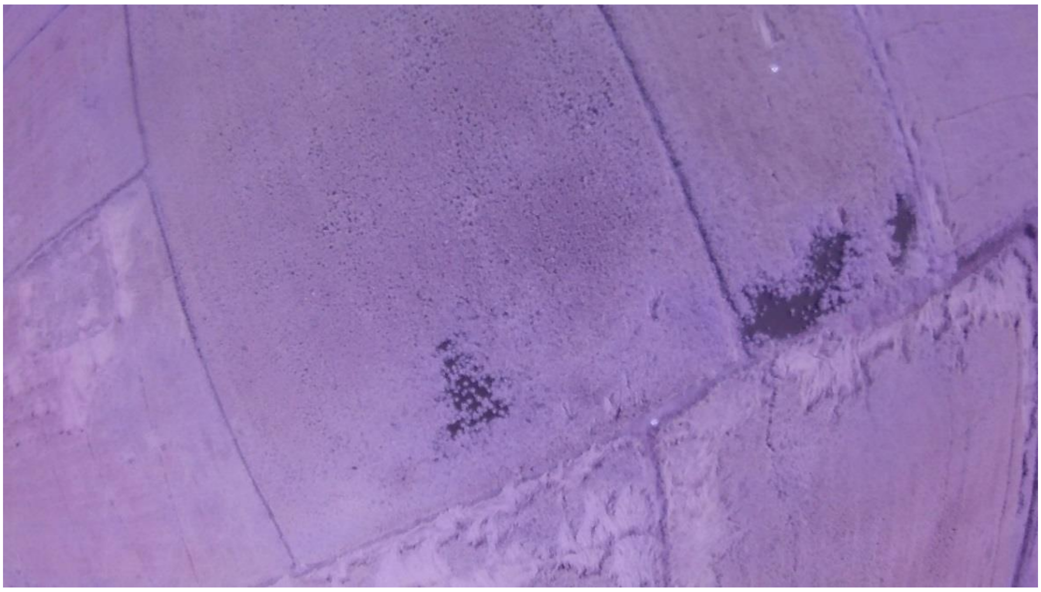


Figure 6.14: Multispectral paddy image 615

From the Figure 6.12, 6.13 and 6.14 show that the multispectral image from the data collection. The multispectral image is take from the 50 metres of altitude, then from the image, the dark spot was suspected after effect of hopperburn. So three of this multispectral image are used in this MATLAB for further image processing. The first process of the MATLAB is extract the Near Infrared (NIR), Red (R), and Green (G) image from the target image. Then the histeq function used to enhance the contrast of the NIR, R, G from the extracted image. After that the double function used too, the intensity of pixels in the NIR, R, G are doubled.

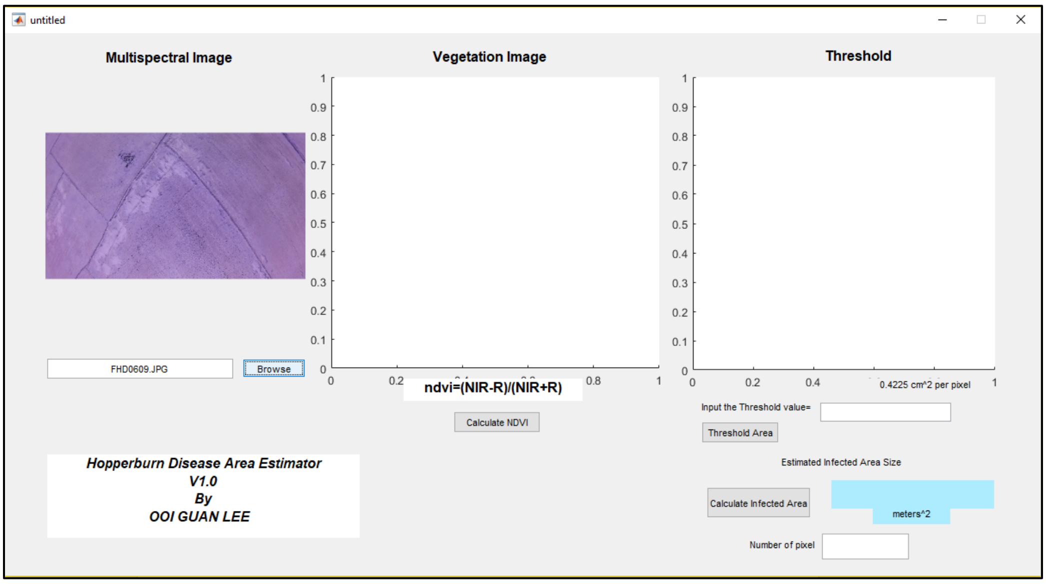


Figure 6.15: The browse function in GUI

From the Figure 6.15, after click the Browse button, choose the FHD0609 of data collection in the computer. The button1 (Browse) will read the target image, then the textbox1 will show the image file name, and axes1 will show the target image. Then the second process is the converting the multispectral image into NDVI image. When click the "calculate NDVI" button, the multispectral image will convert into the NDVI image to show the vegetation status on the paddy field. The multispectral image will firstly extract the NIR, R, G pixels in separate output image.

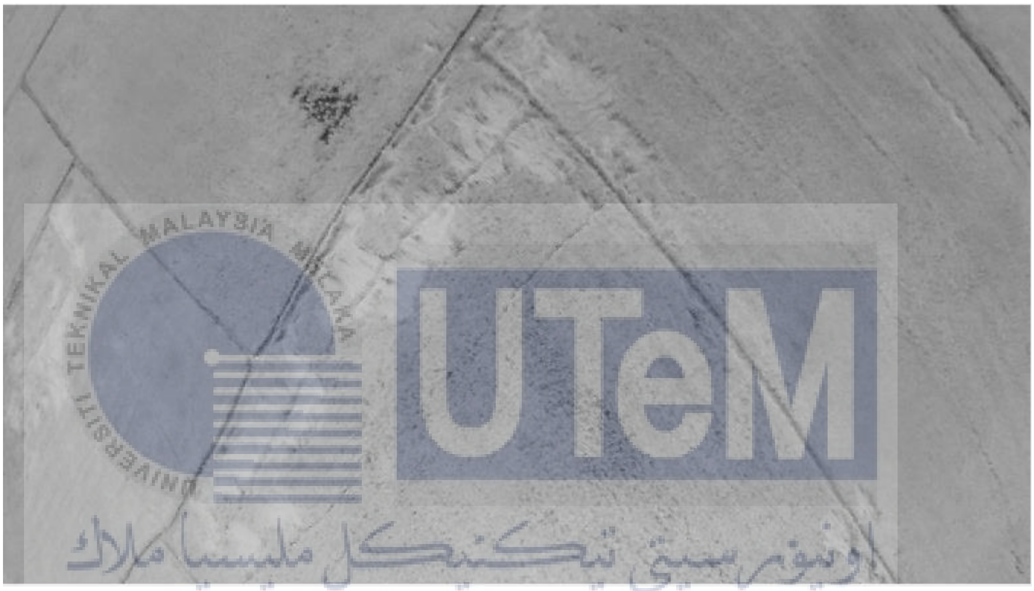


Figure 6.16: The extracted NIR image

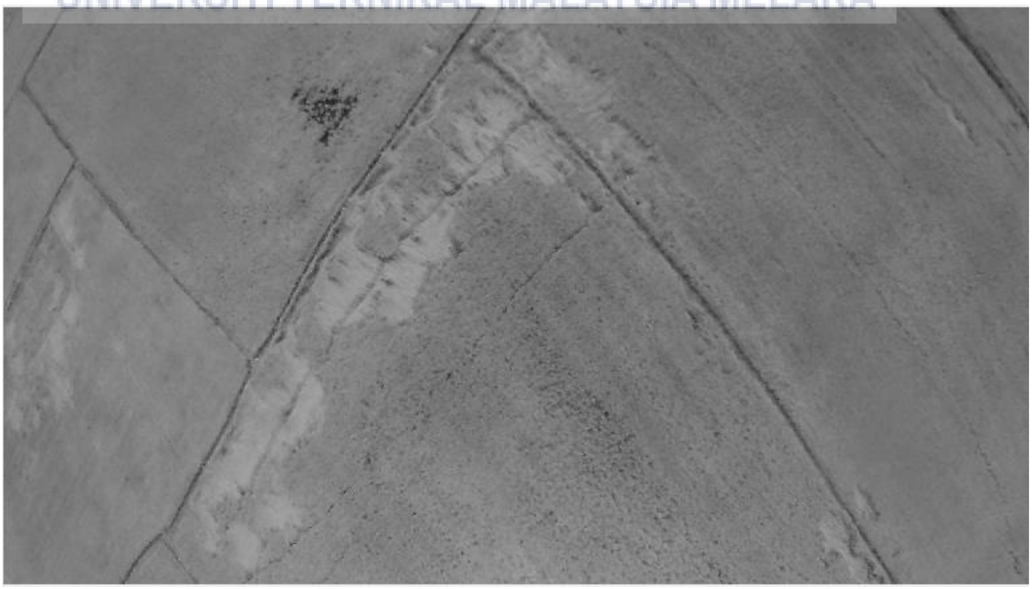


Figure 6.17: The extracted R image

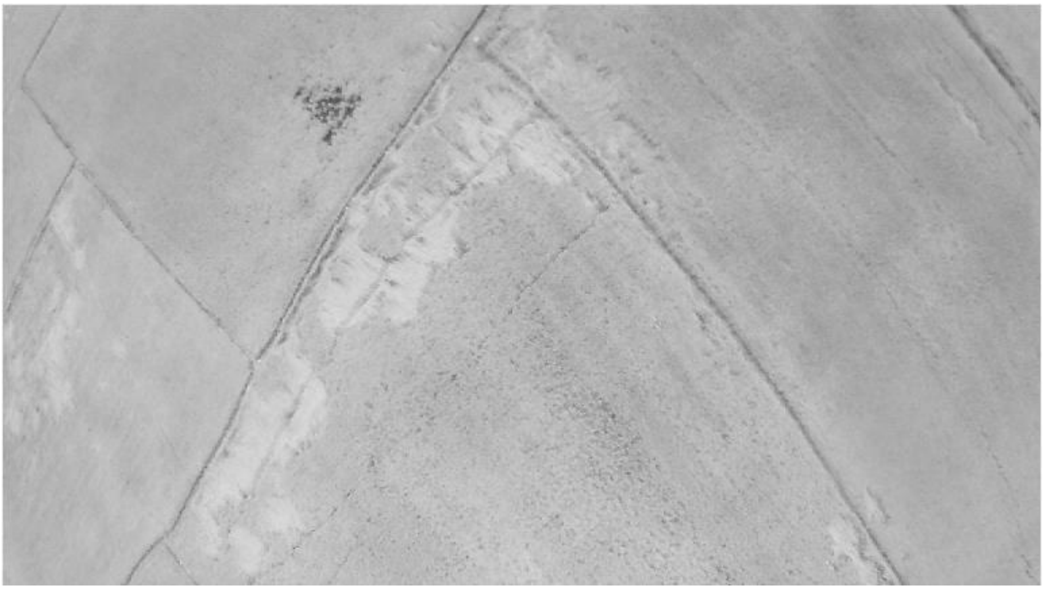


Figure 6.18: The extracted G image

Extracted NIR, R, G image from the Figure 6.16, 6.17, 6.18 are shown. The following process is enhance the contrast of the extracted image, this is because the extracted image are not much different between the neighbourhood pixels.

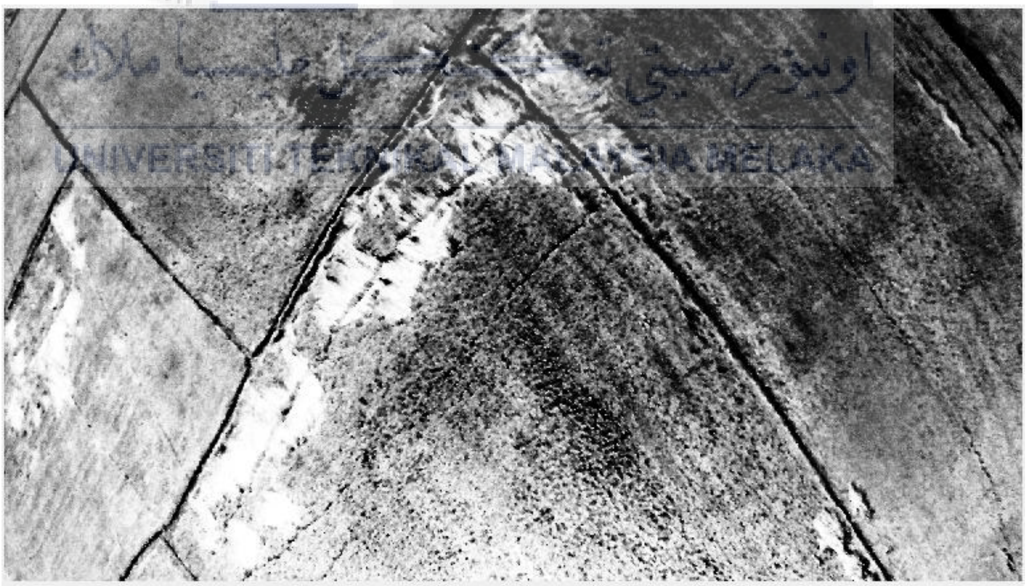


Figure 6.19: The enhanced contrast image in NIR

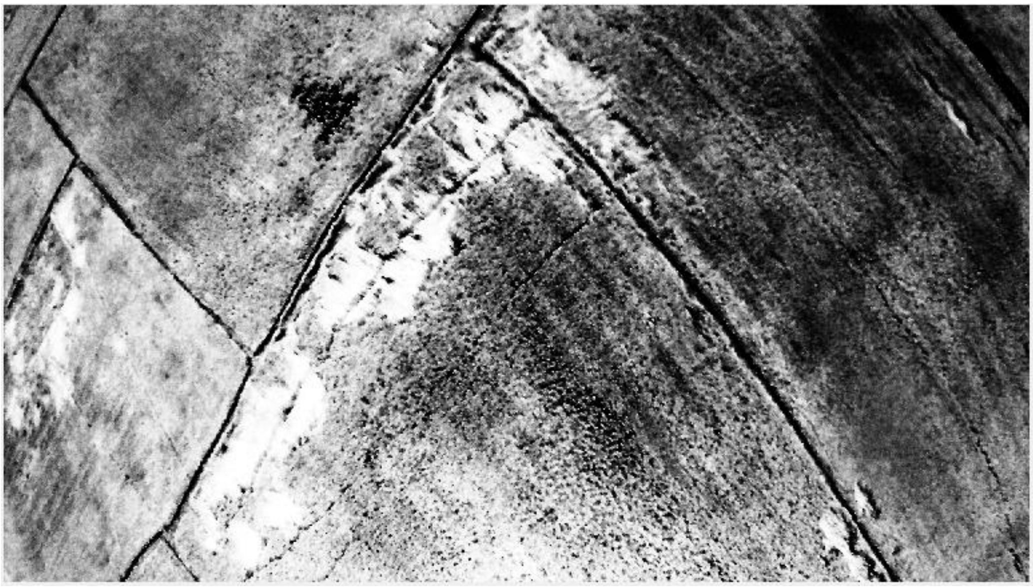


Figure 6.20: The enhanced contrast image in R

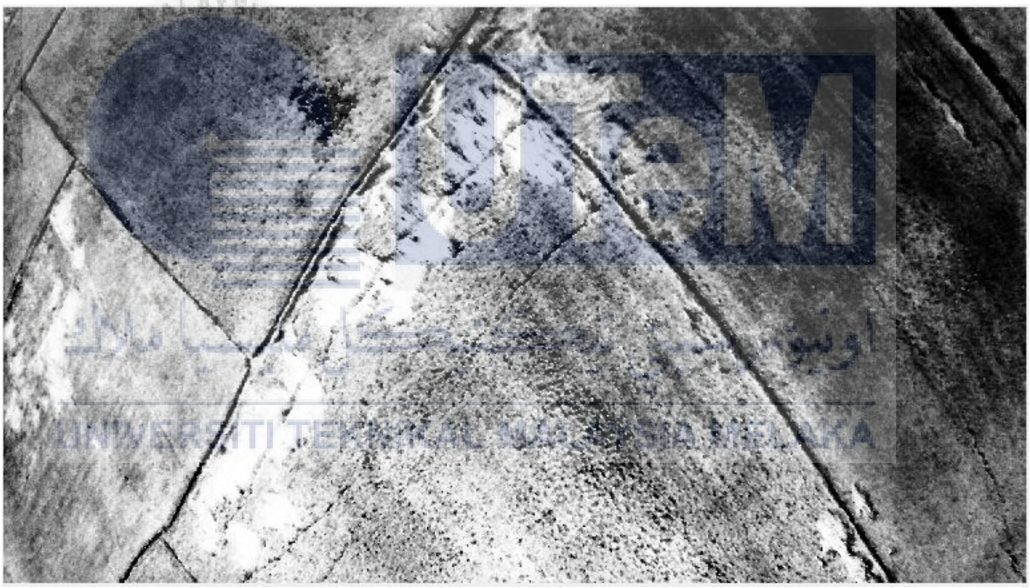


Figure 6.21: The enhanced contrast image in G

Figure 6.19, Figure 6.20 and Figure 6.21 shows that the enhanced contrast image in NIR, R, G image. The output of enhanced contrast images show that the different of the contrast between the neighbourhood pixels are increased. But the difference between the neighbourhood pixels still can increase, so the double intensity function are used in following process.

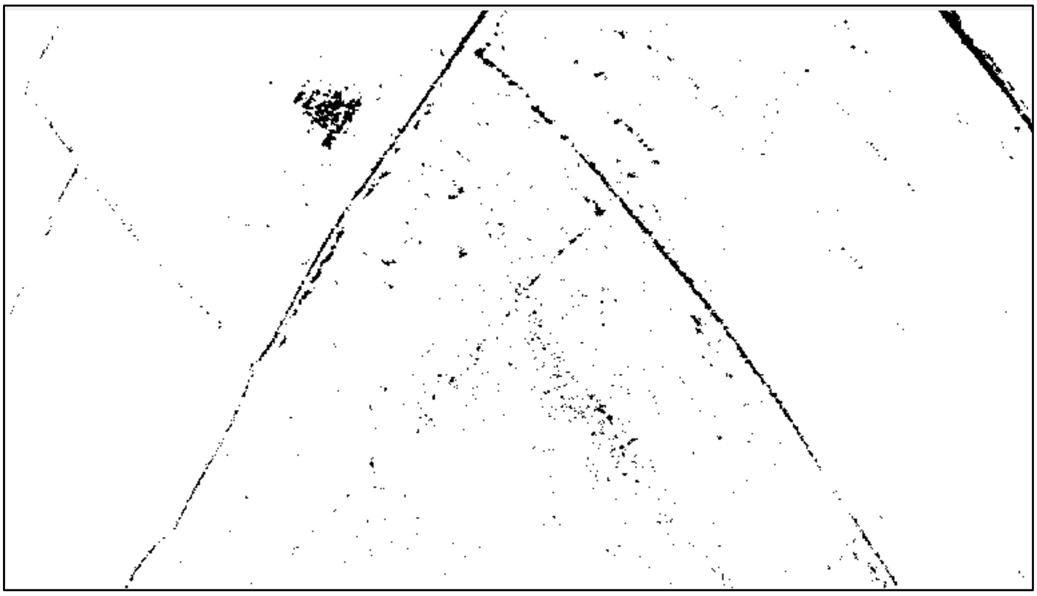


Figure 6.22: The doubled intensity image of NIR

Figure 6.23: The doubled intensity image of R

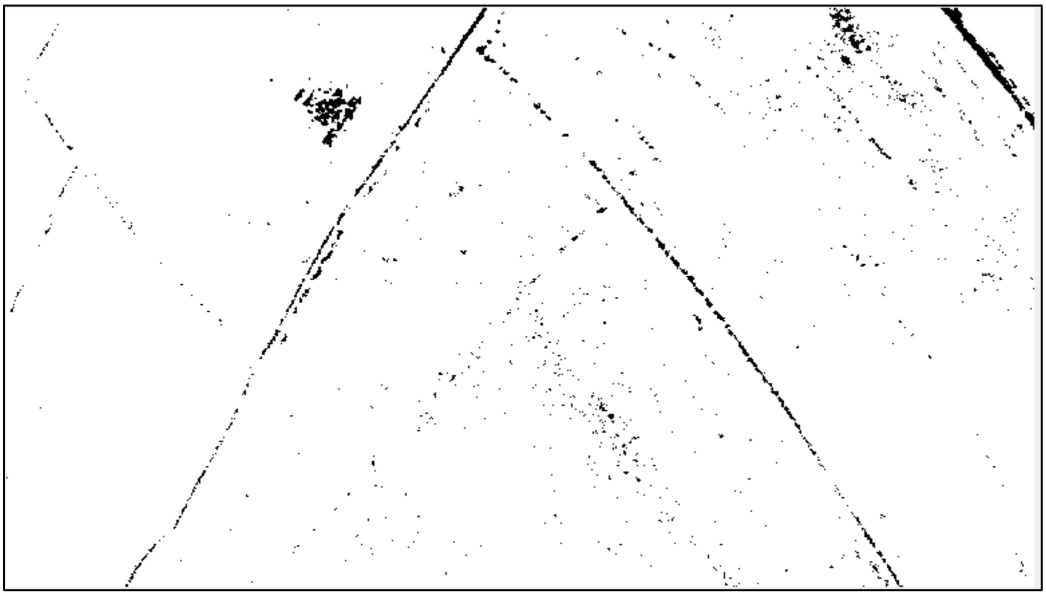


Figure 6.24: The doubled intensity image of G

Figure 6.22, 6.23, 6.24 shows the doubled intensity of NIR, R, G image. The difference of the neighbourhood pixels are clear and detail. After this, the NDVI formula are used in this 3 output image, NDVI= (NIR-R)/ (NIR+R). The jet colormap are used to show that the difference of the vegetation status in the image.

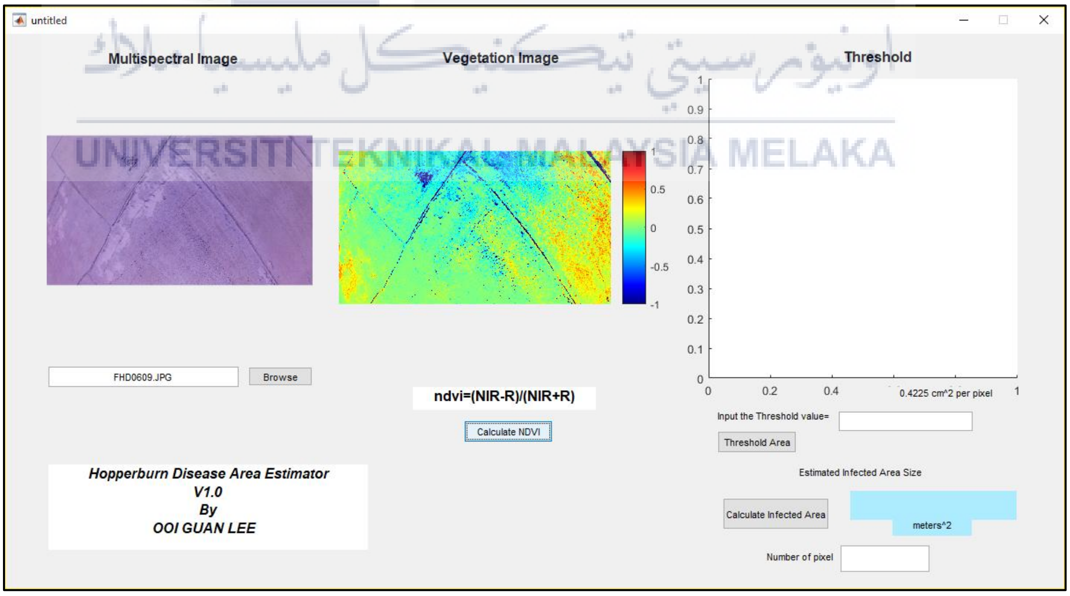


Figure 6.25: The Vegetation image in GUI

Figure 6.25 shows that the vegetation image in the axes2, the colour of the each pixels represent the photosynthesis status, the color above threshold 0 follow the colormap are having the better vegetation, while the threshold below considered weaker vegetation. This process already show the vegetation image and implement in the output image with difference colormap. The following process is the finding the disease area, the process will continue using the right part function in GUI. In the threshold part, this part is make the user put the threshold to find out the weaker vegetation paddy plant, and suspect it as affected by hopperburn, the reason to put the adjustable threshold value is because the every sunlight shooting strength are different, if the sunlight are strong, the better the vegetation status, while the sunlight are weak, the weaker the vegetation status. In this image, the -0.8 status are considered very weak and maybe the affected paddy plant. So -0.8 is the threshold of the vegetation image, the –0.8 will compare with the pixels of the vegetation image one by one.

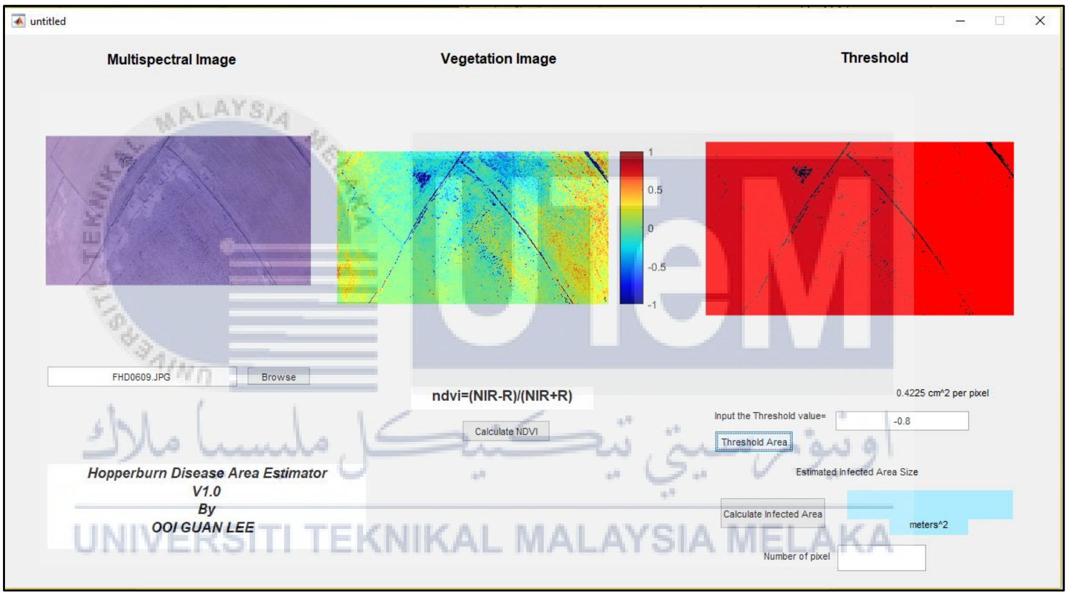


Figure 6.26: The threshold output image

From the figure 6.26, the reason to using the threshold is separate the weaker vegetation with healthy plant and non-plant, non-plant does not have photosynthesis, also the vegetation status. The target of the threshold is weak vegetation plant only. The output shows the red and black pixels in the output image, the black means the weak vegetation plant, red pixels is healthy plant and non-plant like soil, water, rock, sand. After the threshold output, the following the process is counting the approximate disease area of the hopperburn. Firstly convert the threshold image into grayscale image.

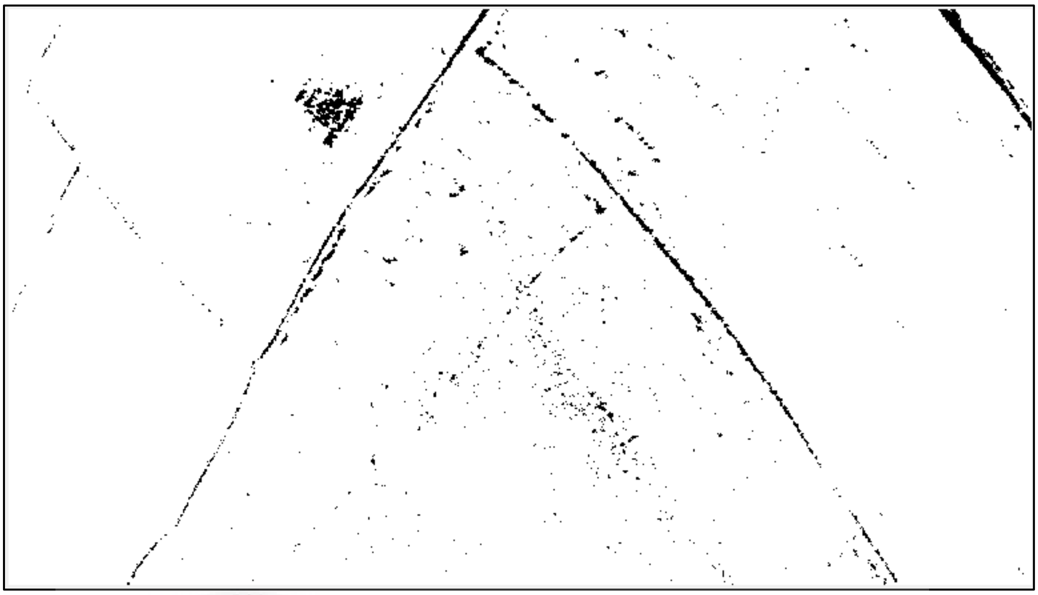


Figure 6.27: Output Threshold into grayscale image

Figure 6.27 shows the output of the threshold image, the reason convert the image is separate the threshold -0.8 vegetation paddy plant with healthy paddy plant and non-plant. The intensity of the grayscale are different, so to enhance the difference of the intensity, the grayscale image are convert into black and white image.

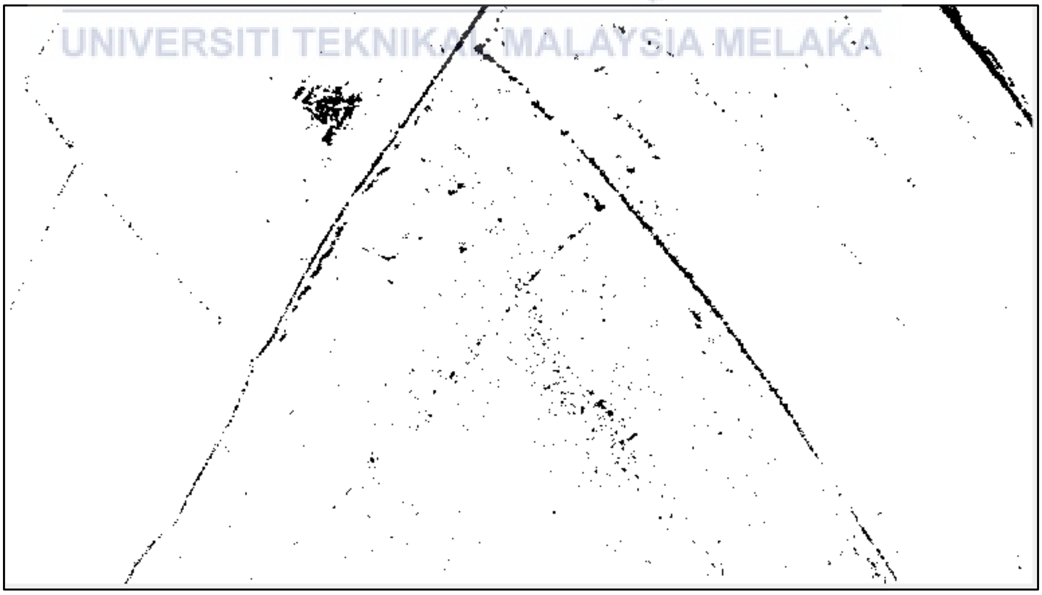


Figure 6.28: Output grayscale into black and white

In Figure 6.28, the reason to convert the grayscale image into the black and white pixel is the pixel counting required the black and white pixel.

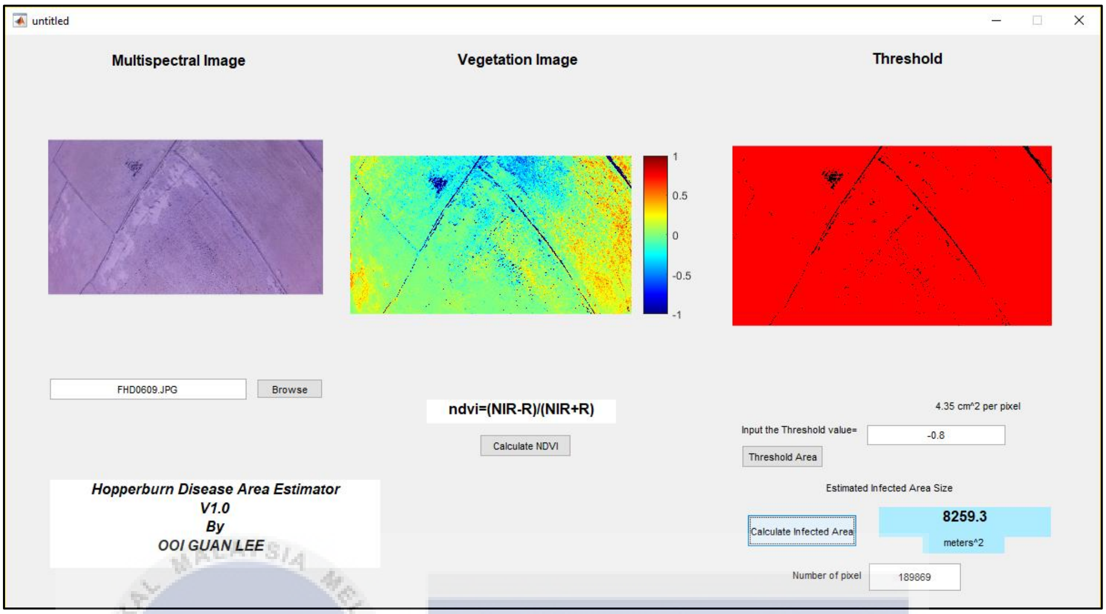


Figure 6.29.: The sample result of processed image in GUI

In Figure 6.29, after the system calculating the quantity of the black pixel, the total number of the black pixels are collected. The total number of the black pixel will multiply with the area per pixel. The area of the pixel is fixed because the altitude of the arducopter are same, 50 metres high while remote sensing. The result of the area of black pixel are considered as infected area because the vegetation of the paddy plant are weak.

6.5 Test Result and Analysis

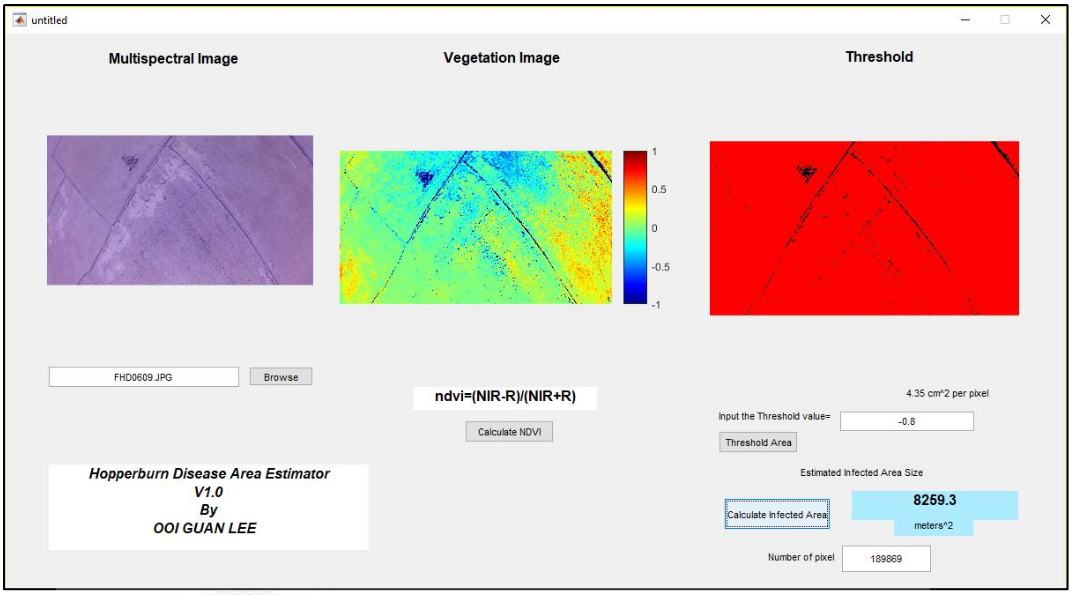
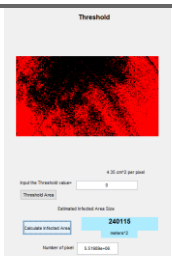
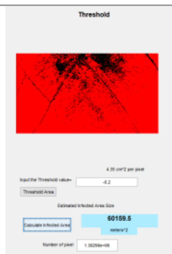
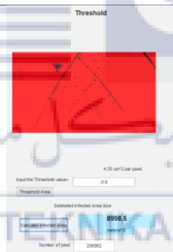


Figure 6.30: The testing result of image 609

Table 6.1 shows that the threshold set from 0 to -1, the result of the pixels and the area decreased. The threshold 0 shows that the majority of the paddy plant in same vegetation rate, cannot result the infected area. The threshold -1 shows that the paddy plant are already dead, the small drain shows the black pixels because there is no any vegetation. Those black pixels showed the after effect of the disease. But in this image a lot of the drain involved inside the result. This will affect the calculating the infected area.

Table 6.1: The Table of Result from Adjusted Threshold in image 609

Threshold	Output	Pixels	Area(metre^2)
0		5.51989e+06	240115
-0.2		1.38298e+06	60159.5
-0.4		427447	18593.9
-0.6		206862	8998.5
-0.8		189869	8259.3
-1		167920	7304.52

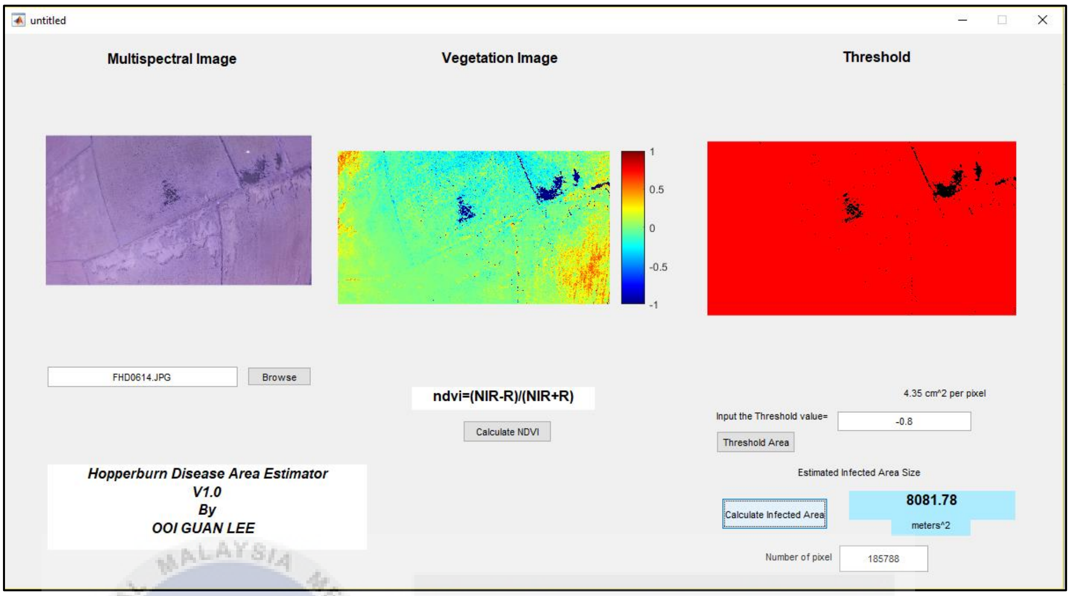
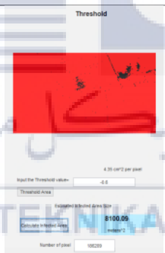


Figure 6.32: The testing result of image 614

Table 6.2 shows that the threshold set from 0 to -1, the result of the pixels and the area decreased. The threshold 0 shows that the majority of the paddy plant in same vegetation rate, cannot result the infected area. The threshold -1 shows that the paddy plant are already dead, the small drain shows the black pixels because there is no any vegetation. Those black pixels showed the after effect of the disease. In this threshold -1 also involved the less black pixels of the drain, so the calculating the area and the black pixels is reliable.

Table 6.2: The Table of Result from Adjusted Threshold in image 614

Threshold	**Output**	**No. of Pixel**	**Area (meters^2)**
0		5.94912e+06	258787
-0.2		1.13965e+06	49574.8
-0.4		240108	10444.7
-0.6		186209	8100.09
-0.8		185788	8081.78
-1		167948	7305.74

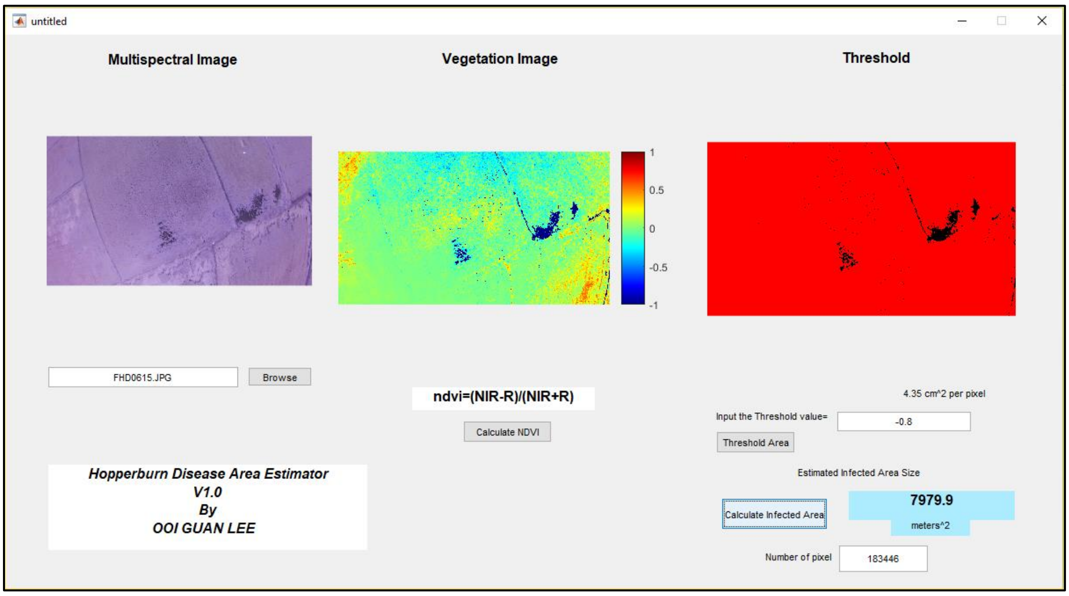
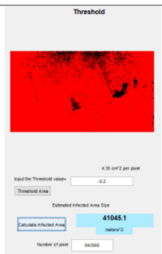
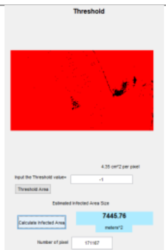


Figure 6.34: The testing result of image 615

Table 6.3 shows that the threshold set from 0 to -1, the result of the black pixels and the area decreased. The threshold 0 shows that the majority of the paddy plant in same vegetation rate, cannot result the infected area. The threshold -1 shows that the paddy plant are already dead, the small drain shows the black pixels because there is no any vegetation. Those black pixels showed the after effect of the disease. In this threshold -1 shows that the small area are the black pixels, small amount of the drain in black pixels only involved in the after processed image. So in this image 614, the result of the area is reliable.

Table 6.3: The Table of Result from Adjusted Threshold in image 615

Threshold	Output	No. of Pixels	Area
0		5.75868e+06	250503
-0.2		943565	41045.1
-0.4		216471	9416.49
-0.6		183498	7982.16
-0.8		183446	7979.9
-1		171167	7445.76

6.6 Summary

The testing and analysis part showed the result of the processed image. The all multispectral image from the data collection can be process in the system built, the image can be convert into vegetation image. The vegetation image shows the clearly difference of the vegetation among the paddy plants in the multispectral image. This vegetation image is the useful to show that the status of the paddy of the farmer. Besides, the vegetation image can be separate by input the threshold, this is because the target of the system is infected paddy plant by hopperburn, the weak vegetation image should be separate from the healthy plant and non-plant objects. The resulting in black pixels will also calculate the area of the disease area. The area is calculating through the number of pixels and area per pixels. In the result, the processed result of the image 615 is more reliable because there is small amount of the drain in black pixels are involved in this threshold result, because the black pixels of the drains will affect the result of area.

CHAPTER VII

CONCLUSION

7.1 Observation on Weakness and Strengths

The weakness of this project is the time of the data collection, the battery using on the arducopter are less, the time of the data collection are less, the area covered also less due to the large area of the paddy field. Besides, the weakness of this project is disease area while separate it from threshold, the non-target unnecessary object like drain, are included inside the same rate of vegetation, this will cause the calculation error in disease area, because the target in the project is hopperburn only. The reason the drain will same rate is the aquatic plant in the drains also reflect the same rate of infrared. The strengths of this project is the unmanned arducopter while using "auto" mode, this arducopter will follow the task using the mission planner without any mistake, the project will run smooth, mostly because of this "auto" mode. Besides that, the process of the multispectral image into vegetation image are very success, the different status of the vegetation rate or photosynthesis rate are clearly showed. This output is enough to farmer to see their how is the paddy field health, even not hopperburn disease, this can take early discovery and take immediately action.

7.2 Proposition for Improvement

The improvement of this project is the time. The time of the data collection and the time when process the multispectral image. The less milliamp hour (mAH) are limits the time of the drone to collect the multispectral image of the paddy field, the distance of the arducopter collect the data also less, the return of the arducopter will early because the limitation of the battery. The high mAH battery will help in the efficiency of the data collection. The limitation of the high-end hardware in computer increase the time of process the multispectral image. The user have to consume more time for waiting the result. This is decreasing the efficiency of the system.

7.3 Project Contribution

This system will provide the contribution to the agriculture world, especially the image processing technique from converting the multispectral image to the vegetation image. The farmer is very convenient to observe their farming status is it going right track or not. Farmer can enhance their farming skills as fast as possible when face the problem, also will decrease the yield loss.

7.4 Summary

This system brings a lot benefits to the farmer, not even in agriculture world. The precise of the vegetation image helps the farmer be careful of their farm from time to time. The farmer also can take early action before it becomes to worst. In this system shows the detail of the output in this disease. The disease are already spread a bit but already solved by the paddy farmer. The threshold of the vegetation image also can observe the same vegetation rate among the paddy plants. The difference of area of the disease are reliable because the GSD method and the area calculator is less. This reference can be use by the experience farmer to decide their amount of using the agrochemical while buying the agrochemical. This system can increase the crop yield of the paddy farmer, because the system can show the infected plant efficiently. The advice to the all people in the world, “every single grain is the fruit of hard work”, so appreciate the hard work of the farmer because they are provide us enough of rice, we will not feel dying because hungry.

APPENDICES

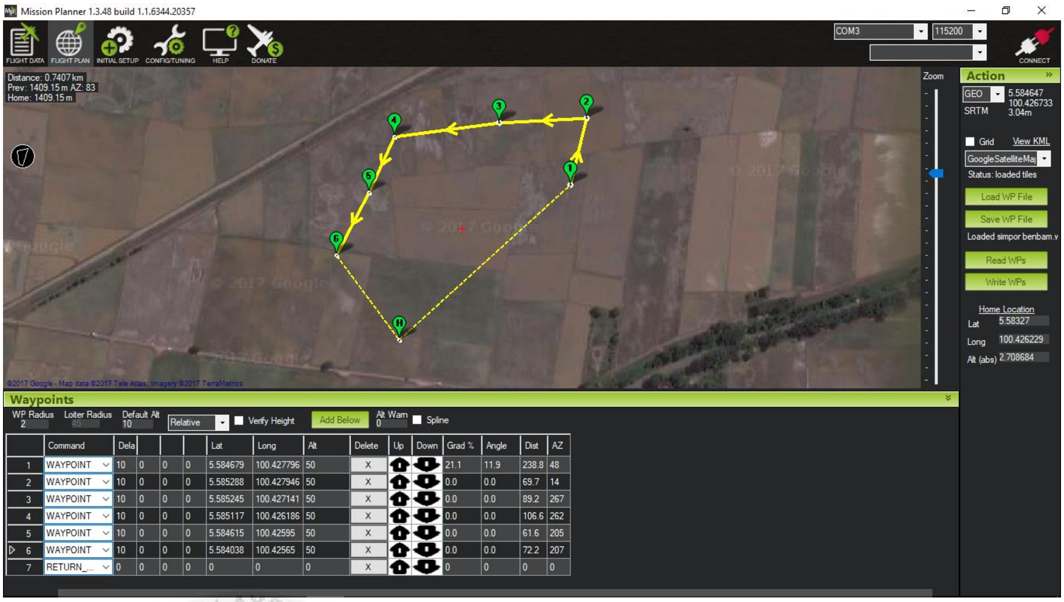


Figure 1: Mission Planner for Arducopter

Figure 2: Hardware design of remote sensing

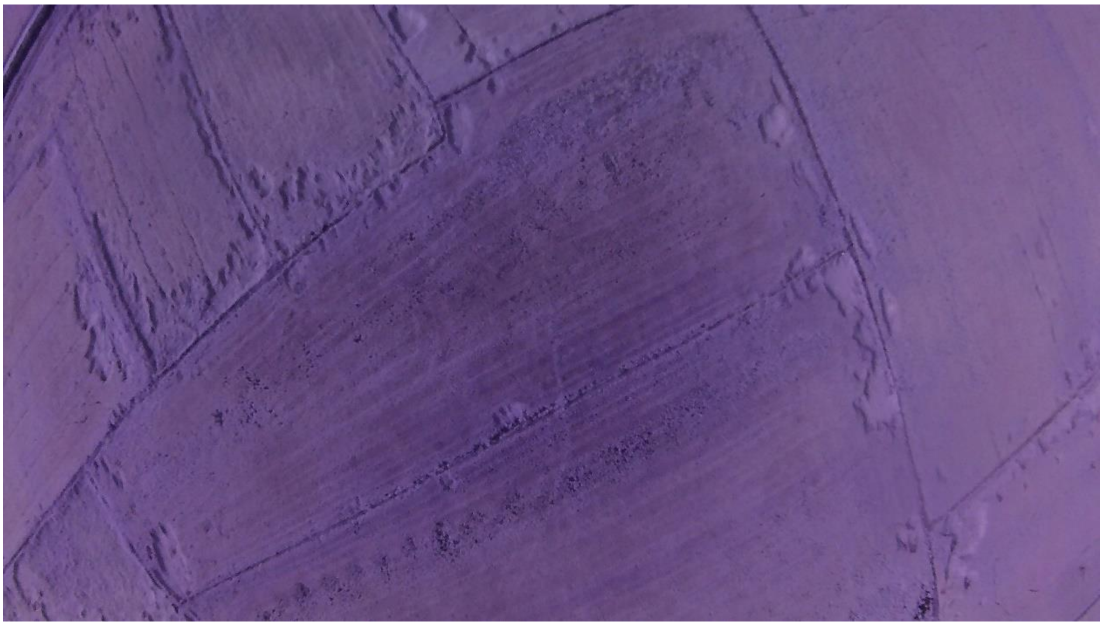


Figure 2: FHD0438

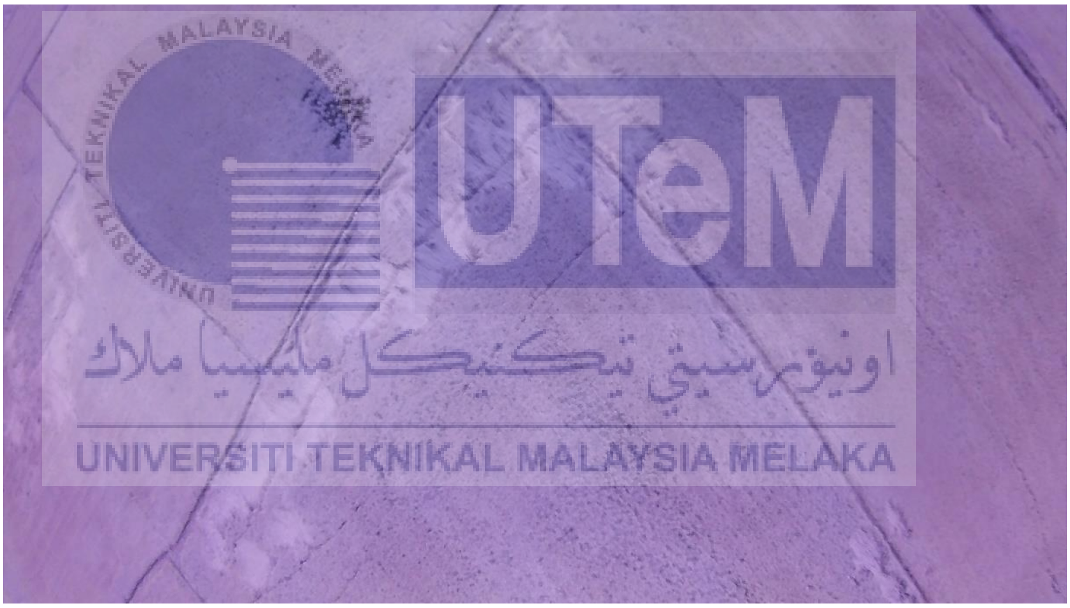


Figure 3: FHD0609

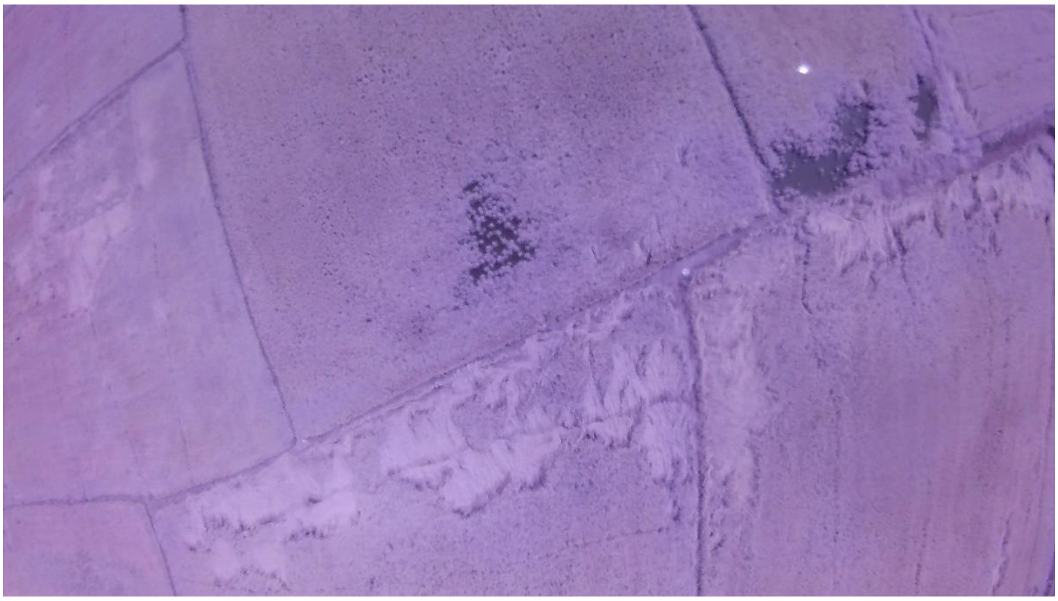


Figure 4: FHD0614

Figure 5: FHD0615

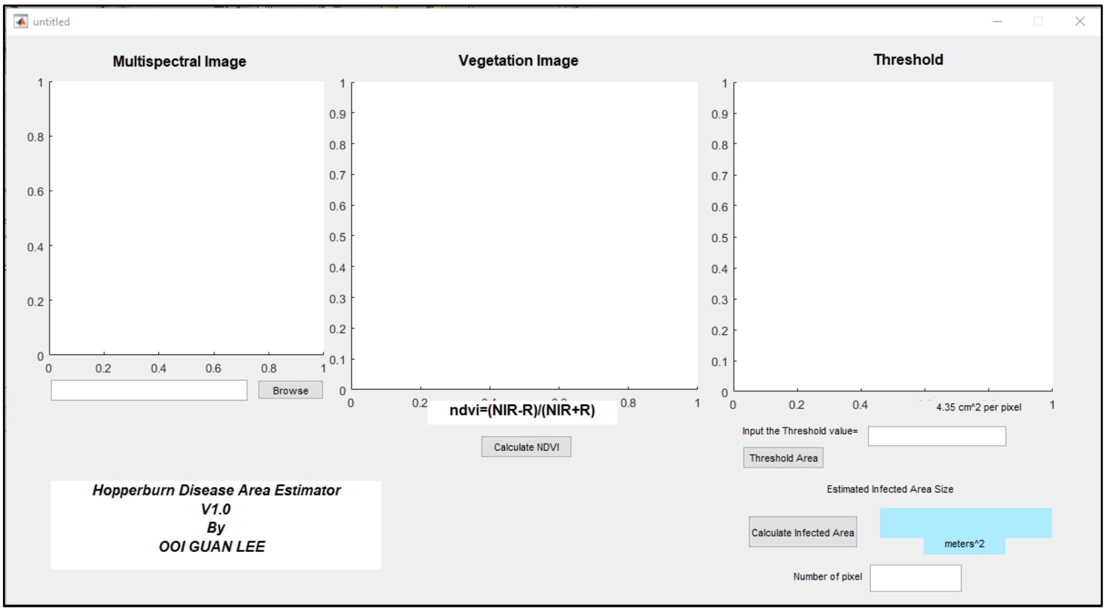


Figure 6: The testing system GUI

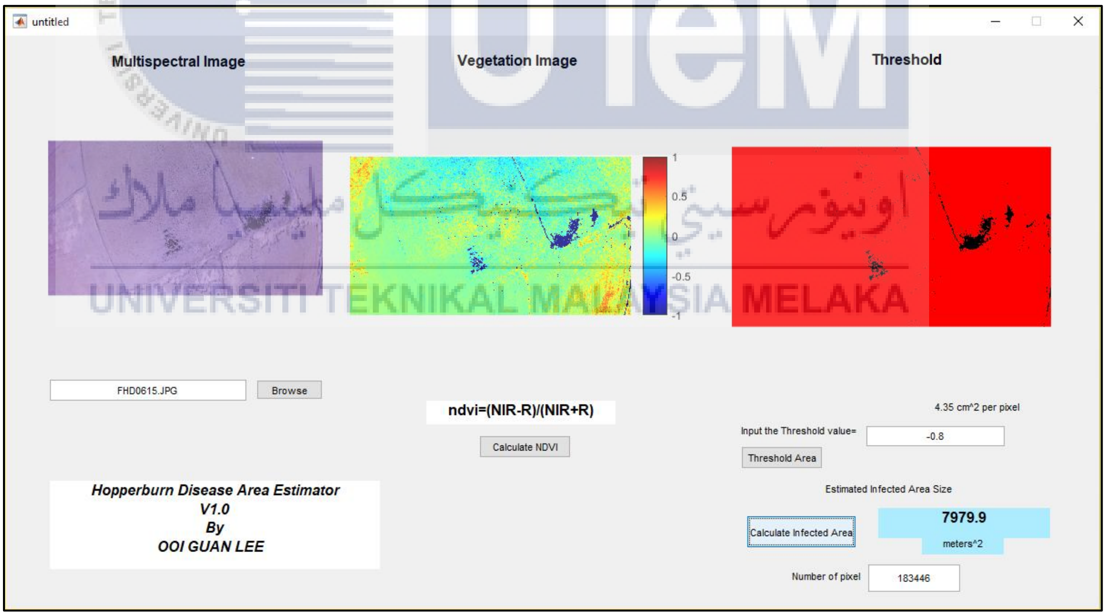


Figure 7: The Sample Output

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