

Real Time Vegetation Monitoring
Program for Register of Old and
Valuable Trees

LSGI 4391 Individual Project

Siu Carmen
09523480D

Land Surveying and Geo-Informatics Department
The Hong Kong Polytechnic University

To my dearest parents

Abstract

Urban Development of Hong Kong is getting faster and faster. For the sake of providing a better development, urban planning is becoming an important issue of urban renewal in Hong Kong.

One of the factors being spotlighted from the majority is the historical structure of the city. Trees are one of the elements of this issue. They grow together with the city of Hong Kong. They are also a significant factors which affecting our living environment. The health of the tree can directly affect to the damage to the majority or the beauty of the city. Hence, a good urban planning should have a good care on this environmental issue.

Trees in Hong Kong have a serious problem of aging, pollution to living environment, lack of nutrition and etc... A scientific and reliable system should be introduced to the government for protecting trees so as to keep our trees alive and provide the correct treatment to the problematic trees.

This dissertation is mainly aimed to design, develop and evaluate an effective and scientific method for the user who did not have the professional knowledge to diagnose trees. The newly developed program: “Vegetation Health Analysis”, a program which is designed to enhance the efficiency of the process of diagnoses a tree by providing a scientific, consistence and reliable result. This program can provide up to 85% accuracy for basic and advance diagnose of trees. And the design of the program had based on a user-friendly algorithm. Only a few clicks on the program can already bring textual and graphical results for the trees.

For assisting the tree management section for the health analysis of tree, field work had been processed for almost 8 months and about 50 and something of trees are measured.

For evaluating the health of trees, a study on Normalized Difference Vegetation Index and testing on Chlorophyll Index and Simple Vegetation Index had been developed. And for appraising the feasibility of the program, a “Tree Health Score” index had been introduced to convert the expert result into a comparable result of VHA.

Acknowledgement:

I would like to express my deep gratitude to Professor CHEN Wu, my research supervisor, for his patient guidance, enthusiastic encouragement and useful critiques of this research work. I would also like to thank Professor Li Zhi-lin, for his advice and assistance in keeping my progress on schedule, Dr. Man Sing WONG for providing professional advice and useful materials for me to tackle problem in the remote sensing topic and Mr. TSANG Chi-kong, Leisure Manager (Arboriculture) of Leisure and Cultural Services Department for providing the official information and assisting me to do the evaluation of the Register Old and Valuable Tree in Hong Kong.

My grateful thanks are also extended to the technicians of the laboratory of the Land Surveying and Geo-Informatics department for their help in offering me the resources in running the program.

Finally, I wish to thank my parents for all of their support and encouragement throughout my study all the time.

Content

Abstract	3
Acknowledgement:	5
List of figures	8
List of tables.....	10
Chapter 1 Introduction, aims and objectives:	12
1.1 Importance of health trees in Hong Kong.....	12
1.2 Aim and objective of the project.....	13
Chapter 2 Literature review on the existing analysis work in Hong Kong:.....	15
2.1 Governmental Duty and Related Policy	15
2.2 Present Trees' Problem	17
2.3 The insufficient of Register of Old and Valuable Trees.....	18
2.4 Technique in use and shortcoming.....	19
2.5 Vegetation index using in Vegetation Health Analysis	21
Chapter 3 Methodology in Program construction:.....	23
3.1 Program Language	23
3.2 Instrumentation	23
3.3 True Color Image	24
3.4 Near infra red Image	25
3.5 Data type	25
3.6 Function of correlation.....	25
3.7 Assigning an index range for CI and VI	28
3.8 Index Classification	30
3.9 Analysis of textual description from the government report	32
Chapter 4 Program Construction:	37
4.1 Vegetation Health Analysis	37
4.2 Basic Analysis.....	38
4.3 Advance Analysis.....	40
Chapter 5 User Manual of the Vegetation Health analysis:	42
5.1 Basic Analysis.....	42
5.2 Advance Analysis.....	44
5.3 Text File Analysis.....	46
5.4 Image Analysis.....	48
Chapter 6 Algorithm of the Vegetation Health analysis:	49
6.1 Algorithm of Welcome Page	49
6.2 Algorithm of Basic Analysis Page	50
6.3 Algorithm of Advance Analysis Page	51

Chapter 7 Data Result & Analysis of Vegetation Health Analysis52
 7.1 Data collection52
 7.2 Sample of Matched Case: CW/105.....52
 7.3 Sample of Matched Case: CW/11154
 7.4 Sample of Unmatched Case: CW/9156
 7.5 Analysis of All Data58
 7.6 Feasibility Test on VHA.....61
Chapter 8 Conclusion.....63
Chapter 9 Recommendation.....66
Chapter 10 Reference List68
Chapter 11 Appendix71

List of figures

Figure 1 showing the YTM/49, Ficus microcarpas lie on the road of Park Land.....	12
Figure 2 showing the true color image of CW/112.....	13
Figure 3 showing the near infra red image of CW/112.....	13
Figure 4 showing the website front page of the register of Old and Valuable Tree System.....	15
Figure 5 showing the reflectance of healthy tree and unhealthy tree which affect to the value of NDVI.....	21
Figure 6 Canon 450D.....	23
Figure 7 sigma len LH715-01	24
Figure 8 showing the structure of the lens	24
Figure 9 showing the visible blue, green and red captured by the Canon 450D	25
Figure 10 showing the visible blue, green and red captured by the Canon 450D Rebel	25
Figure 11 True color image of 4 different leave of LCSD YTM/84	28
Figure 12 False color image of 4 different leave of LCSD YTM/84.....	28
Figure 13 Front Page of Vegetation Health Analysis.....	37
Figure 14 GUI of Advance Analysis.....	37
Figure 15 GUI of Basic Analysis	37
Figure 16 Basic Analysis of Vegetation Health Analysis.....	38
Figure 17 Advance Analysis of Vegetation Health Analysis	40
Figure 22 NDVI image of CW/105	54
Figure 23 CI image of CW/105	54
Figure 24 NDVI image of CW/111.....	56
Figure 25 CI image of CW/111.....	56

Figure 26 NDVI image of CW/9158
Figure 27 CI image of CW/9158

List of tables

Table 1 showing the matching problem in the data processing	26
Table 2 showing the zooming problem in the data processing	27
Table 3 showing the testing CI data on LCSD CW/84	29
Table 4 showing the testing CI data on LCSD CW/85	29
Table 5 showing the testing VI data on LCSD CW/84	29
Table 6 showing the testing VI data on LCSD CW/85	29
Table 7 showing the testing result among all testing trees.....	30
Table 8 showing the NDVI range and the represented score.....	31
Table 9 showing the CI range and the represented score.....	31
Table 10 Table showing the VI range and the represented score.....	32
Table 11 showing the symptom, weighting and reason	35
Table 12 disease and corresponding score	35
Table 13 Table showing the sample mode data and the calculated accuracy of CW/105	53
Table 14 Table showing the sample mean data and the calculated accuracy of CW/105	53
Table 15 Table showing the average performance and corresponding accuracy and score of CW/105.....	53
Table 16 Table showing the sample mode data and the calculated accuracy of CW/111	55
Table 17 Table showing the sample mean data and the calculated accuracy of CW/111	55
Table 18 Table showing the average performance and corresponding accuracy and score of CW/111	55

Table 19 Table showing the sample mode data and the calculated accuracy of CW/91	57
Table 20 Table showing the sample mode data and the calculated accuracy of CW/91	57
Table 21 Table showing the average performance and corresponding accuracy and score of CW/91	58
Table 22 Average performance of from CW/44 to CW/98	59
Table 23 Average performance of from CW/99 to YTM/89	59
Table 24 Feasibility Test Result on the tree without the description of no significant detect observed	61
Table 25 Feasibility Test Result on all trees.....	61
Table 26 Feasibility Test Result on the tree that has disease	62

Chapter 1 Introduction, aims and objectives:

1.1 Importance of health trees in Hong Kong

The developments of Hong Kong in various aspects are very fast, for instance, the rise of population, the booming traffic network, the increasing building density and so on. Beyond the high speed development, the historical and environmental factors are essential to the



growth of urban. Trees are one particular issue. Some trees

Figure 1 showing the YTM/49, *Ficus microcarpas* lie on the road of Park Land

are landmark of a place, for example the *Ficus microcarpas* are land mark of Park Lane. This is a fact that healthy trees can bring advantage or support to the environment, however, unhealthy trees may possibly become damage to neighbor features. It is common finding out reports or news¹ that the unhealthy trees bring different kinds of damages to the society from hindrance of traffic to hazard of human life nowadays in Hong Kong.

¹ Ta Kung Pao, 2011; Apple Daily, 2011; Oriental Daily News, 2011 & 2010; Sun Daily News, 2010; am730, 2010; WenWei, 2010

1.2 Aim and objective of the project

To enhance the efficiency of the registration and consultation work of the trees, the project is aiming to develop a program for evaluating the health status of the trees. The program, named Vegetation Health Analysis, is very different from the program or methods that developed or for the similar issue.

This program is aiming to provide a fundamental idea of the health analysis for the tree. This general idea could help a first diagnose of the tree even the user did not have the professional knowledge of biology or vegetation health. The sources using in the program is the image result of the tree took by RGB camera and infrared camera. These two resources could help to calculate Normal Differential Vegetation Index (NDVI), Chlorophyll Index (CI) and Simple Vegetation Index (VI) by the giving the digital value of red, green, blue and near infrared. The presentation of the result of the program is in 2 ways:

1.2.1.1 Graphical

There are 2 graphical results which will be generated from the program. The first one is the NDVI image, and the other is the CI image.



Figure 2 showing the true color image of CW/112



Figure 3 showing the near infra red image of CW/112

1.2.1.1 Documentary

The program will also output a txt file with the health description of the tree.

The objectives of the project can be divided into the followings:

- 1.2.2.1 Design a user friendly program to evaluate the health status of the tree for common user using the technique of Normal Differential Vegetation Index (NDVI), Chlorophyll Index (CI) and Simple Vegetation Index (VI).
- 1.2.2.2 Develop a user friendly program with the output of NDVI image, CI image and a text description and analysis of the particular tree.
- 1.2.2.3 Evaluate the program result by comparing to different methods' and the official results provided from the trees management section.
- 1.2.2.4 Provide recommendation for the further development of the program to provide a more successful diagnose, hence to assist the work of tree management section

Chapter 2 Literature review on the existing analysis work in

Hong Kong:

2.1 Governmental Duty and Related Policy

In 2004, the government of the Hong Kong Special Administration Region (HKSAR) has established a tree management section which under the development bureau. The section is aiming to raise the public awareness of the issue of trees'



Figure 4 showing the website front page of the register of Old and Valuable Tree System

health problem and to provide service and guideline for the protection and monitoring of trees. And in the same year the HKSAR government has also developed a Register of Old and Valuable Trees System under the Leisure and Cultural Services Department.

The system is aiming to provide priority protection to Old and Valuable Trees. In the system, "...the Leisure and Cultural Services Department, Agriculture, Fisheries and Conservation Department and Housing Department have identified some 500 Old and Valuable Trees on un-leased Government land within built-up areas or tourist attractive spots in village areas..."².

The register of Old and Valuable Trees system is responsible for registered all the trees within their following criteria³:

² Register of Old and Valuable Trees, 2005

³ Register of Old and Valuable Trees, 2005

2.1.1.1 Large size

2.1.1.2 Precious or rare species

2.1.1.3 Particular old age

2.1.1.4 Cultural, historical or memorable significance

2.1.1.5 Outstanding form

The system mainly provides:

2.1.2.1 Registration number

The registration number of each registered tree is unique. The registration number contained a short form of the district of the tree, e.g. CW/101, CW means Central and Western district.

2.1.2.2 General information

The general information provided the registration no., registration date, maintenance department (e.g. LandsD is the short form of Lands Department), corresponding district and the location.

2.1.2.3 Tree detail

This part gives background information about the name of tree, age, height and so on.

2.1.2.4 Assessment

The assessment is slight different to the health report, the description provided in this part only focus on the recent medical treatment of the tree.

2.1.2.5 Album

Photo of the tree (may not be taken recently)

2.1.2.6 Location map (newly updated)

This function is newly added for the public to locate the tree precisely.

2.1.2.7 Health report / diagnosed result

This report is provided by the tree management section and generated by the expert in the office with field observation.

This system highly assists with the health issue of the trees. With the help of the registration record, government could cure or have protection on the trees before it causes any damage to the society.

2.2 Present Trees' Problem

Trees in Hong Kong have different kind of unhealthy issue. The main problems of the old and registered valuable trees may be concluded as the following:

2.2.1 Aging⁴

Some trees are growth with the city, and some are even born much early than the city. Hence, the aging problem will become much more serious as the city growth.

2.2.2 Poor living Environment

As the city is developed with trees, the development of the city is unavoidably to damage or cause different level of harm to the living environment of trees. For example, the renewal construction of the swimming pool in the Victoria Park in Hong Kong Island cause air pollution to the trees in Victoria Park near the

2.2.3 Historical problem

Some trees may suffer from the historical factors which highly affect their health. For instance, the Tree House in Shui Mei Village Playground, Kam Tin is affected by the historical structural of the house.

2.2.4 Lack of nutrition

Even though Hong Kong SAR Government already established a register system to record health status, age, type of trees in Hong Kong, the evaluation process is

⁴ Sun Daily News, 2010

really slow as the technique using in the system is not efficient enough. This may hinder the consultation and medical treatment to cure the illness of tree hence cause jeopardy to the society⁵.

2.3 The insufficient of Register of Old and Valuable Trees

2.3.1 Update rate of the tree health report

The average update rate of the health report of the trees is about 1 year or even more. Hong Kong, lies on the subtropical climate zone, has a very good climate factor for the tree to growth. The change of the tree health status is very fast, once a year for checking the health the tree is absolutely insufficient.

2.3.2 Textual description of the health report

In the report provided by the government, only the following adjectives are using in the report for classify the level of disease or symptom,

2.3.2.1 Good overall condition

2.3.2.2 No significant defect observed

2.3.2.3 Only the name of the symptom

2.3.2.4 Limited

2.3.2.5 Small

2.3.2.6 Minor

2.3.2.7 Severe

2.3.2.8 Moderate

These textual description are various among different people by their own judgment. A standard and scientific description or judgment is more reliable and consistent than the subjective description.

⁵ Ta Kung Pao, 2011

2.3.3 Lack of professional consultant

The lack of professional consultant may also be the reason of low update rate of the tree report.

2.4 Technique in use and shortcoming

2.4.1 Manual work on evaluation the health status of tree

The registration system give a big hand on the unhealthy tree issue, however, the manual evaluation work of it is very low in efficiency. As the evaluation of a particle tree requires a high standard of professional knowledge and there are only a few professional workers could do the evaluation work in Hong Kong for the government to tackle the problem, the process of work is very slow. Sometimes trees may already cause injury to the public before the registration has renewed its health status.

Hence, a solution could be made by applying a health monitoring program to the registration system. The program is user friendly and do not require a high level of professional knowledge to process the result. And before a deep inspection and consultation of the trees, government could use the program to firstly record all trees' health status and provide extra protection or consultation to those key trees.

2.4.2 Satellite image

Similar technique that applied in the program had already applied to the satellite image to evaluate the vegetation health status of an area by a lot of researches⁶. Nevertheless, the mix pixel effects that result from lots of satellite images limit the accuracy of the result. Satellite images only provide result of a particular area not a particular tree⁷.

2.4.2.1 Mix pixel effect

⁶ Nichol, J. & Lee, C. M. (2005)

⁷ Nichol, J. (2009)

The mix pixel effect will take an average number of the different value in a pixel. It always happened in the image which the detected object is displayed much smaller than the pixel size. A mix pixel effect could combine the data value of two different objects, for example if it combined the data of two crown of the tree, then the data will not be accurate.

2.4.2.2 Coverage

The coverage of the tree from the satellite is only the top crown of the subject tree. Fresh leave mostly located at the top crown of the tree. Especially the Bunya-bunya, they will bring all leave to the upmost part of the tree to absorb sunlight. In LCSD CW/44, the situation is that the tree only has healthy top crown leave and disease with lower layer, the analysis of data will only focus on the top view but not the front view.

Furthermore, Bunya-bunya, have the highest opportunity to cause dangerous as it will grow with the direction of sunlight and push all its nutrition to grow taller without a very good care to the lower layer. In Hong Kong, it is very dangers as the tree may be surrounded by buildings and the sunlight of lower part of the tree almost blocked by others. Lacking nutrition will eventually bring a high possibility of fall to the tree.

2.4.3 Existing program for analysis of vegetation health

There is a few of program which also provide analysis on tree or vegetation, however, these kind of program require a standard of biology or professional knowledge of plant. For example, the MVH from the Measuring Vegetation Health⁸ provide 3 programs for the related topic:

2.4.3.1 AnalyzingDigitalImages: only provide program for masking the

⁸ MVH, 2011

color of a image, not tree health analysis

2.4.3.2 ColorBasics: only for photogrammetry purpose, not for analysis the health of tree

2.4.3.3 Vegetation Analysis: only for satellite image to calculate the NDVI for analysis the health of tree, not for digital camera.

2.5 Vegetation index using in Vegetation Health Analysis

“Absorption centered at about $0.65 \mu\text{m}$ (visible red) is controlled by chlorophyll pigment in green-leaf chloroplasts that reside in the outer or Palisade leaf. Absorption occurs to a similar extent in the blue. With these colors thus removed from white light, the predominant but diminished reflectance

of visible wavelengths is concentrated in the green. Thus, most vegetation has a green-leafy color. There is also strong

reflectance between 0.7 and $1.0 \mu\text{m}$ (near IR) in the spongy mesophyll cells located in the interior or back of a leaf, within which light reflects mainly at cell wall/air space interfaces, much of which emerges as strong reflection rays. The intensity of this reflectance is commonly greater (higher percentage) than from most inorganic materials, so vegetation appears bright in the near-IR wavelengths (which, fortunately, is beyond the response of mammalian eyes). These properties of vegetation account for their tonal signatures on multispectral images: darker tones in the blue and, especially red, bands, somewhat lighter in the green band, and notably

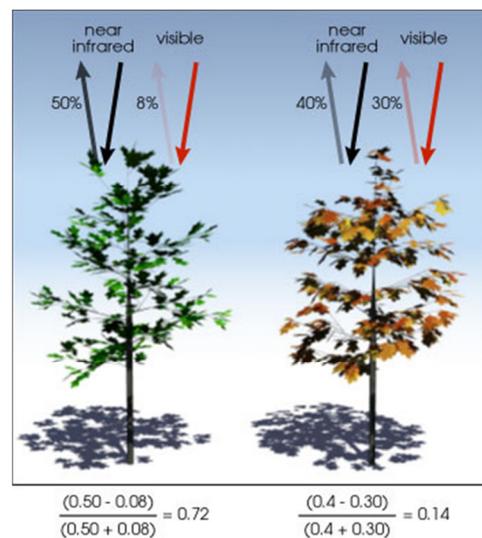


Figure 5 showing the reflectance of healthy tree and unhealthy tree which affect to the value of NDVI

light in the near-IR bands”⁹

2.7.1 Normal Difference Vegetation Index (NDVI)

“An index calculated from reflectances measured in the visible and near infrared channels. It is related to the fraction of photosynthetically active radiation” from Natural Resources Canada (2005).

Range: -1 to 1 (typically: 0.1 to 0.9), -0.1 to 0.1 = barren areas of rock, sand, or snow, 0.2 to 0.4 = shrub and grassland, ~1 = temperate and tropical rainforests (2009). According to NASA (2011), a healthy tree should have a higher NDVI value than the unhealthy one.

$$\text{Formula: } \frac{(\text{NIR}-\text{RED})}{(\text{NIR}+\text{RED})}^{10}$$

2.7.2 Chlorophyll Index (CI)

Useful for identify trees, but it may confuse with low albedo areas and shadow¹¹. Since the health vegetation will have high reflectance in green band and low reflectance, the higher CI represent the healthy vegetation by the formula.

$$\text{Formula: } \frac{\text{GREEN}}{\text{RED}}^{12}$$

2.7.3 Simple Vegetation Index (VI)

The reduction of multispectral scanning measurements to a single value for predicting and assessing vegetative characteristics. Examples of such characteristics include plant leaf area, total biomass, fresh and dry above-ground phytomass, chlorophyll content, plant height, percent ground cover by vegetation, grain or forage yield and general plant stress and vigour¹³.

$$\text{Formula: } \frac{\text{NIR}}{\text{RED}}^{14}$$

⁹ NASA, 2009

¹⁰ NASA, 2011

¹¹ Nichol, J., 2009

¹² Nichol, J., 2009

¹³ Natural Resources Canada, 2005

¹⁴ Natural Resources Canada, 2005

Chapter 3 Methodology in Program construction:

3.1 Program Language

The whole program developed base on the visual basic. Visual Basic (VB) is the third-generation event-driven programming language and integrated development environment (IDE) from Microsoft for its COM programming model. It is also a relatively easy to learn and use programming language, because of its graphical development features and BASIC heritage.

VB was derived from BASIC and enables the rapid application development (RAD) of graphical user interface (GUI) applications, access to databases using Data Access Objects DAO, Remote Data Objects RDO, or ActiveX Data Objects ADO, and creation of ActiveX controls and objects.

3.2 Instrumentation

2.5.1 True Color Camera Information¹⁵

The digital camera used was Canon EOS 450D with 12.20 megapixels (image size: 4272 x 2848 pixels in 3:2 aspect ratios). To



Figure 6 Canon 450D

calibrate the digital camera and avoid changing of the principal distance, the function of autofocus, sensitivity, focal length and shutter speed had been set and fixed respectively.

2.5.2 Near infra red Camera Information¹⁶

The digital camera is the same model of the true color camera. The only

¹⁵ Canon, 2009

¹⁶ Canon, 2009

difference of this camera is only the UV filter of this camera is installed in the camera.

2.5.3 Lens Information



Figure 7 sigma len LH715-01

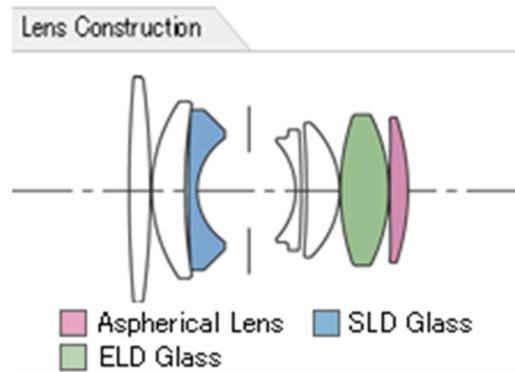


Figure 8 showing the structure of the lens

The lens for the project was Sigma 30mm F1.4 EX DC / HSM. According to the lens construction plan, the point just after the lens was assumed to be the principal point for object distance measurement. The minimum aperture is F16 and minimum focusing distance is 40cm.¹⁷

2.5.4 Camera setting:

When taking a pair of photos (true color image and infra camera), the camera must set on the same tripod with the same bearing and distance to prevent the mismatch of data. To keep the distance and bearing, tripod and fixed orientation tribach is in using to assist the matching. However, slightly shift still exist in the pair of photos due to the manual operation of changing camera for the data recording, hence, the geo-referencing function will be developed later on.

3.3 True Color Image

Photo taken by the Canon 450D can capture 3 types of data, red, green and blue. The data of red and green



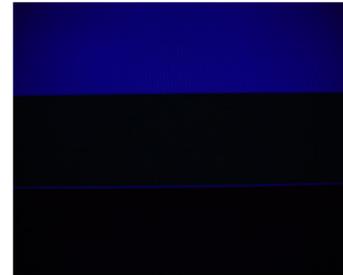
¹⁷ Sigma, 2010

band will be used for the calculation of different index.

Figure 9 showing the visible blue, green and red captured by the Canon 450D

3.4 Near infra red Image

According to the HD report, 2010, photo taken by the



Canon 450D Rebel can only capture 1 type of data, near infra red. Figure 10 showing the visible blue, green and red captured by the Canon 450D Rebel

The data stored in the red band is the infra-red data, hence only the red band will be used for the calculation of different index.

3.5 Data type

- 3.5.1 Digital Number of Visible Blue from Canon 450D (range from 0 to 255)
- 3.5.2 Digital Number of Visible Green from Canon 450D (range from 0 to 255)
- 3.5.3 Digital Number of Visible Red from Canon 450D (range from 0 to 255)
- 3.5.4 Digital Number of Near infra red from Canon 450D Rebel (range from 0 to 255)

As the data are come different camera, a pair of photos must be taken in the same position with same resolution for the matching of the pixel location to do the calculation.

3.6 Function of correlation

The correlation function is extremely important in developing “Vegetation

Health Analysis”.

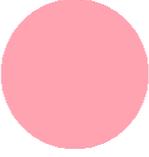
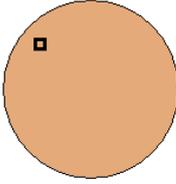
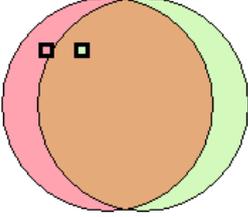
 <p>Figure 3.6. 1 model of near infra red data</p>	 <p>Figure 3.6. 2 model of green data</p>
 <p>Figure 3.6. 3 showing the perfect match of the model of near infra red data and model of green data</p>	<p>The matching of data acquired from both 2 camera can provide the correct data of the pixel in the same location.</p>
 <p>Figure 3.6. 4 showing a mismatch of the model of near infra red data and model of green data.</p>	<p>Even the location of the pixel in near infra red data is equal to the green data, they are not match to each other. Without the matching of data, the calculation result will be wrong.</p>

Table 1 showing the matching problem in the data processing

The correlation also needs a match with the same zooming in the pair of photos:

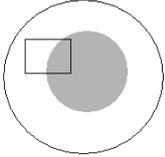
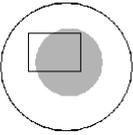
 <p>Figure 3.6. 5 showing the image taken by the same camera with higher resolution, a pixel could capture smaller part of the circle, the circle will be finer in this image</p>	 <p>Figure 3.6. 6 showing the pixel presentation of the object</p>	<p>Since the object will present differently due to the resolution of the camera, the lens setting of the camera must be the same.</p>
 <p>Figure 3.6. 7 showing the image taken the same camera with lower resolution setting, a pixel can capture large part of the circle, the circle will become rough</p>	 <p>Figure 3.6. 8 showing the pixel presentation of the object</p>	

Table 2 showing the zooming problem in the data processing

3.7 Assigning an index range for CI and VI

Since there is no standard range for classifying the CI and VI, a test that provides clear result of the range classification of healthy and unhealthy tree is important. The testing of CI and VI range is based on value that calculated through 4 types of leave: 1. New / Fresh leave; 2. Mature leave; 3. Old leave and 4. Dead leave on the healthy trees. The only criterion of the tree is healthy. As an unhealthy tree will bring unexpected or different level of noise to the data, only healthy tree can provide different level of index for different kind of leaves.

The test result is based on the healthy trees of LCSD YTM/84, LCSD YTM/85, LCSD YTM/86 and LCSD YTM/89, the following is example from LCSD YTM/84:



Figure 11 True color image of 4 different leave of LCSD YTM/84



Figure 12 False color image of 4 different leave of LCSD YTM/84

The test will only extract the part of a leave to evaluate the CI and VI value on different health level's leave. The range of the CI and VI will highly depends on the average of the mode and mean, and as the program acquired an acceptable number of standard derivations for the making the useful interval for the index range.

The following shows the sampled data from the testing.

	Mode	Mean	SD
New leave	1.94	1.5	0.31
Mature leave	1.23	1.41	0.14
Old leave	0.62	0.79	0.12
Dead leave	0.67	0.56	0.07

Table 3 showing the testing CI data on LCSD CW/84

	Mode	Mean	SD
New leave	1.38	1.17	0.15
Mature leave	1.03	1.15	0.09
Old leave	0.55	0.64	0.08
Dead leave	0.55	0.71	0.12

Table 4 showing the testing CI data on LCSD CW/85

	Mode	Mean	SD
New leave	5.87	3.79	1.46
Mature leave	3.52	2.84	0.5
Old leave	1.11	1.49	0.28
Dead leave	1.27	0.95	0.23

Table 5 showing the testing VI data on LCSD CW/84

	Mode	Mean	SD
New leave	2.7	1.9	0.57
Mature leave	2	2.97	0.75
Old leave	1.73	1.2	0.36
Dead leave	2.74	1.89	0.6

Table 6 showing the testing VI data on LCSD CW/85

Furthermore, with the test, the acceptable range of standard derivation can be found. The selection of healthy tree is to prevent the appearance of noise.

The Result of the test:

	CI	VI
Fresh / New leave	1.5	2.91
Mature leave	1.36	3.04
Old leave	0.81	1.28
Dead leave	0.71	1.28
Standard derivation	0.15	0.4

Table 7 showing the testing result among all testing trees

From the above results, the highest number of CI could be assigned around 1.5 to 2 and the lowest number of CI could be assigned around 0.5, however, there is quite a number of some independent data showing that the lowest of CI should around 0, hence, negative value could even applied to cover some amount of independent data. And an index interval should be according to the standard derivation, around 0.15 to 0.20.

And about the VI, the highest number of VI could be assigned around 3 to 4 and the lowest number of VI could be assigned around 0.5, however, there is quite a number of some independent data showing that the lowest of VI should around 0, hence, negative value could even applied to cover some amount of independent data. And an index interval should be according to the standard derivation, around 0.40.

And after further adjustment and noise reduction, the final classifications are presented in the following topic:

3.8 Index Classification

The detection range of NDVI value and CI value with the presented score:

NDVI Range	Represented score in Vegetation Health (By NASA, NOAA AVHRR image)
$X \leq 1.0$	10
$1.0 > X \Rightarrow 0.9$	9
$0.9 > X \Rightarrow 0.8$	8
$0.8 > X \Rightarrow 0.7$	7
$0.7 > X \Rightarrow 0.6$	6
$0.6 > X \Rightarrow 0.5$	5
$0.5 > X \Rightarrow 0.4$	4
$0.4 > X \Rightarrow 0.3$	3
$0.3 > X \Rightarrow 0.2$	2
$0.2 > X \Rightarrow 0.1$	1
$0.1 > X \Rightarrow 0.0$	0
$0.0 > X \Rightarrow -0.1$	-1
$0.1 > X \Rightarrow -$	-2

Table 8 showing the NDVI range and the represented score

CI Range	Represented score in Vegetation Health (By the test of CI & VI)
$X > 2$	10
$2 \leq X > 1.8$	9
$1.8 \leq X > 1.6$	8
$1.6 \leq X > 1.4$	7
$1.4 \leq X > 1.2$	6
$1.2 \leq X > 1.0$	5
$1.0 \leq X > 0.8$	4
$0.8 \leq X > 0.6$	3
$0.6 \leq X > 0.4$	2
$0.4 \leq X > 0.2$	1
$0.2 \leq X > 0.0$	0
$0.0 \leq X > -0.2$	-1
$-0.2 \leq X > -$	-2

Table 9 showing the CI range and the represented score

VI Range	Represented score in Vegetation Health Analysis (By the test of CI & VI)
$X > 4.0$	10
$4.0 \leq X < 3.6$	9
$3.6 \leq X < 3.2$	8
$3.2 \leq X < 2.8$	7
$2.8 \leq X < 2.4$	6
$2.4 \leq X < 2.0$	5
$2.0 \leq X < 1.6$	4
$1.6 \leq X < 1.2$	3
$1.2 \leq X < 0.8$	2
$0.8 \leq X < 0.4$	1
$0.4 \leq X < 0.0$	0
$0.0 \leq X < -0.4$	-1
$-0.4 \leq X < -0.8$	-2

Table 10 Table showing the VI range and the represented score

3.9 Analysis of textual description from the government report

As the record of the government report only contains the textual description of the health status of the tree and the program aims at providing a scientific result for assisting the evaluation of the health of the tree, a common and comparable index must be made for the following comparison.

For the sake of providing the common and comparable index for analyses the result from the program and the result from government report, the disease / symptom are assigned a weight for the score of unhealthiness of the tree. This weighting is highly depends on the program detectable level. Since the index that calculated by the program are all rely on the leaf information, any sickness that affect to the truck of the tree may not be easily detected and diagnosed by the program.

3.9.1 Type of disease / symptom described in the government report and the weighting that used in the calculation:

The diseases and symptoms using in the program are provided from the

government. And weight of the particular disease or symptom is self designed, reasons are provided separately for every symptom respectively in the following table.

Symptom : Amount of dieback twigs	Weight : 1
Reason	<p>The reflectance of old and die leave is lower than mature and fresh leave, without the fresh leave, the number of mature leave will decrease finally.</p> <p>Since the increasing amount of dieback twigs will increase the proportion of the old and die leave of the tree, this symptom can be detected in the program. However, this symptom may affect by external factor, such as lack of sun light of the tree or the construction site around the tree. The level of significant is smaller than others.</p>
Symptom : Abnormal defoliation	Weight : 2
Reason	The old and die leave have lower reflectance than others. The program can do the detection easily.

	And this symptom have stronger relationship with serious tree disease (e.g. tree cancer)
Symptom : Cavity	Weight : 0 (0.5 after adjustment)
Reason	The cavity normally appear on the truck of the tree, which is ought not to be detected by the program. However, the cavity may affect the eco-system of the tree and appear on the leave, also, the experiment show that a slight portion of the weight can provide a better data, especially when the trees only have the cavity syndrome.
Symptom : Decay	Weight : 0
Reason	Decay of the truck may highly affect by the external factor, such as the humid and warm condition of the living environment. And the program may not be able to detect the truck problem.
Symptom : Crack(s)	Weight : 0
Reason	Decay of the truck may highly affect by the external factor, such as the human activity or animal. And the program may not be able to detect.
Symptom : Amount of fungal fruiting bodies	Weight : 2
Reason	The fungal fruiting bodies can directly appear on the

	leave and the level of significant is the highest as this may also a symptom of the tree cancer ¹⁸ .
Symptom : Sign of pest and disease	Weight : 2
Reason	The sign of pest and disease can highly affect to the health of tree and directly appear on the leave and the level of significant is the highest as this may also a symptom of the tree cancer ¹⁹ .

Table 11 showing the symptom, weighting and reason

3.9.2 Type of description of the level of symptom / disease and the corresponding score:

Textual description	Score of the description that corresponding to the following calculation (self designed)
Good overall condition	0
No significant defect observed	0
Discovery (only the name of the disease)	-10
Limited	-20
Small	-30
Minor	-30
Severe	-40
Moderate	-50

Table 12 disease and corresponding score

3.9.3 The formula of transforming the textual description into a comparable

¹⁸ am730, 2010

¹⁹ am730, 2010

number:

$$\text{Tree Healthy score} = 100 - \text{disease weight} \times \text{score of significant level}$$

From the above formula, the range of the tree healthy score is from negative to positive. Since the negative value can be much far away from the program index, there are limitation settings of the Tree Healthy Score. For number lower or equal to -50, it will be defined to be -10 and for the number lower than it will be defined into -20. It is because the range of the program index only from -2 to 10. And from the observation of the tree report, it is often that tree with more than one moderate level of disease must suffer from a huge disease and extremely unhealthy (for example, no leave or only have a little leave left)

Since the program has a consistence value and also the report, the accuracy will highly depends on the difference of the two numbers, the following is the formula of calculating the accuracy of the program by:

$$\text{Difference between two number: } \frac{\text{Tree Health Score}}{10} \\ - \text{Index value generated from the program}$$

$$\text{Accuracy} = 10 - \text{Difference between two number}$$

Since the update rate of the government is really slow and subjective as explained before, a lot of trees already change the health condition due to time. Hence, it is meaningless to set the criteria too high for adopting the program analysis. An acceptable value would be about a half of the accuracy score, hence, 5 is adopted.

Chapter 4 Program Construction:

4.1 Vegetation Health Analysis

Provide the user with scientific description that calculated by the NDVI, CI and VI formula.

User may only need to input 2 images into the

program, and the program will calculate and analysis by a few button.



Figure 13 Front Page of Vegetation Health Analysis

The program is developed to have 2 different way of analysis:

4.1.1 Advance Analysis

Provide full report of analysis with NDVI, CI and VI, and also with 2 images. One is from NDVI and one

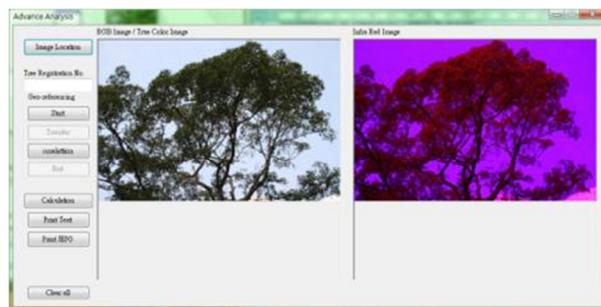


Figure 14 GUI of Advance Analysis

is from CI. The only criterion of this analysis is the user must use Canon 450D for the data analysis.

4.1.2 Basic Analysis

Provide report of analysis with CI and also

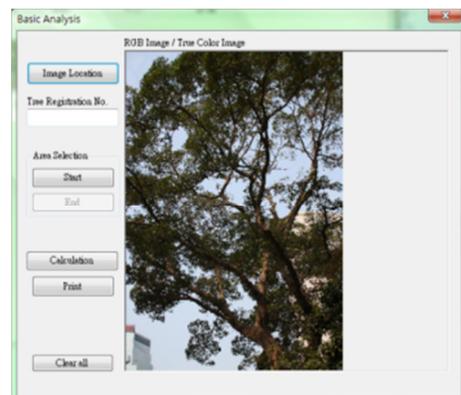


Figure 15 GUI of Basic Analysis

with a CI images. The only criterion of this analysis is the user must input one true color image.

4.2 Basic Analysis

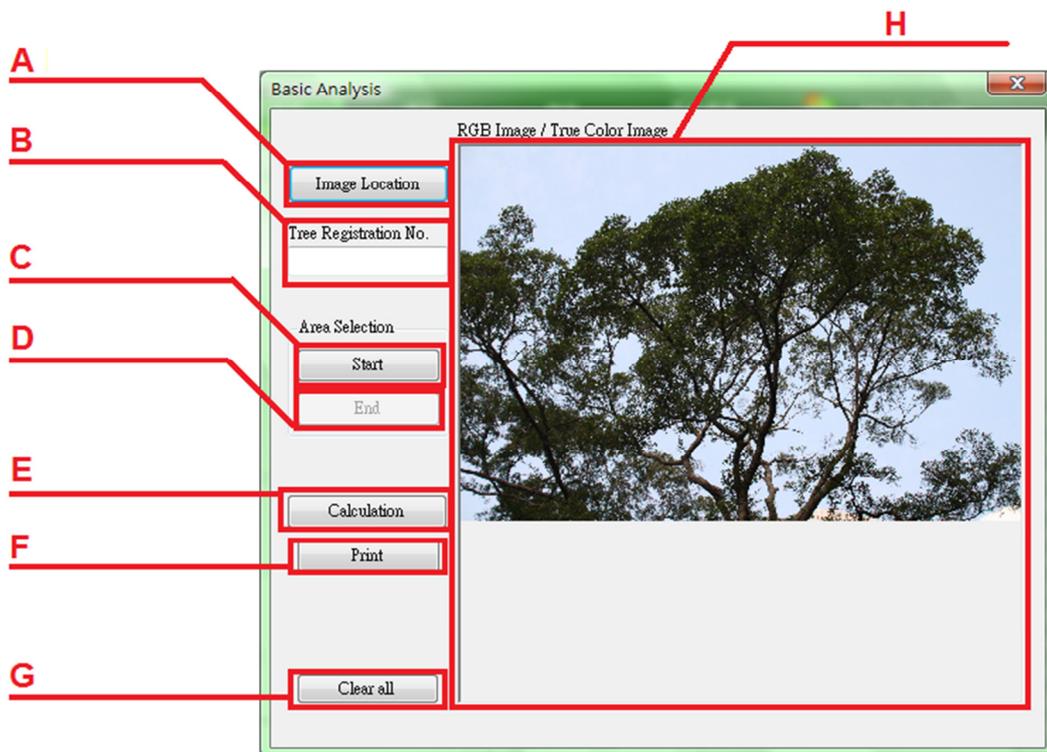


Figure 16 Basic Analysis of Vegetation Health Analysis

A. Button: Image Location

This button is for input the 2 images into the program, the image that input in the program will be rescale, nevertheless, only the original pixel size and data value will be processed in the calculation and also the data analysis.

B. Textbox: Tree Registration No.

For type in the registration number on the text report generated from the program.

C. Button: Start (Area Selection)

This button is for selecting the analysis area on the true color image, only the data in the selected area will be calculated and analysis. Caution: the area of analysis should only contain one element and not too big, this could prevent noise

interaction. And for obtaining the precise analysis and accurate result, the analysis should be done at different area of the image.

D. Button: End (Area Selection)

End the whole process of selection

E. Button: Calculation

Start the calculation. Caution: the time of calculation is highly depended on the size of selected area, the temporary memory of the computer. This may take a few second to more than 20 minutes.

F. Button: Print

The program will automatically generate a report and a CI image in the given directory.

G. Button: Clear all

The program will go back to the front page and all temporary data will not be saved. Caution: as the program will still whole some part of temporary data, the memory will only be free after closed. Please close the program to provide the best performance after a few analyses.

H. Picture Box: RGB / True Color Image

Display of true color image

4.3 Advance Analysis



Figure 17 Advance Analysis of Vegetation Health Analysis

A. Button: Image Location

This button is for input the 2 images into the program, the image that input in the program will be rescale, nevertheless, only the original pixel size and data value will be processed in the calculation and also the data analysis.

B. Textbox: Tree Registration No.

For type in the registration number on the text report generated from the program.

C. Button: Start (Geo-referencing)

This button is for selecting the analysis area on the true color image, only the data in the selected area will be calculated and analysis. Caution: the area of analysis should only contain one element and not too big, this could prevent noise interaction. And for obtaining the precise analysis and accurate result, the analysis should be done at different area of the image.

D. Button: Transfer (Geo-referencing)

This button will create a same size rectangle on the infra red image for the data selection. Caution: the data may not be fully matched as the swap of camera is done manually, slightly shift may still exist on the process.

E. Button: Correlation (Geo-referencing)

This button will allow the user to do geo-reference by using one control point.

F. Button: End (Geo-referencing)

End the whole process of geo-reference

G. Button: Calculation

Start the calculation. Caution: the time of calculation is highly depended on the size of selected area, the temporary memory of the computer. This may take a few second to more than 20 minutes.

H. Button: Print Text

The program will automatically generate a report in the given directory.

I. Button: JPEG

The program will automatically draw the image(s) in the given directory.

J. Button: Clear all

The program will go back to the front page and all temporary data will not be saved. Caution: as the program will still whole some part of temporary data, the memory will only be free after closed. Please close the program to provide the best performance after a few analyses.

K. Picture Box: RGB / True Color Image

Display of true color image

L. Picture Box: Infra Red Image

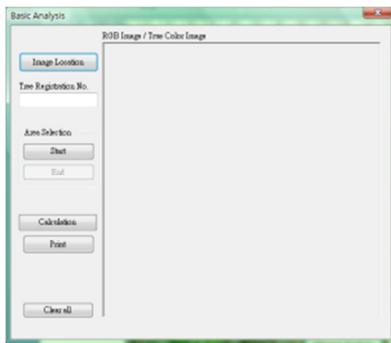
Display of infra red image

Chapter 5 User Manual of the Vegetation Health analysis:

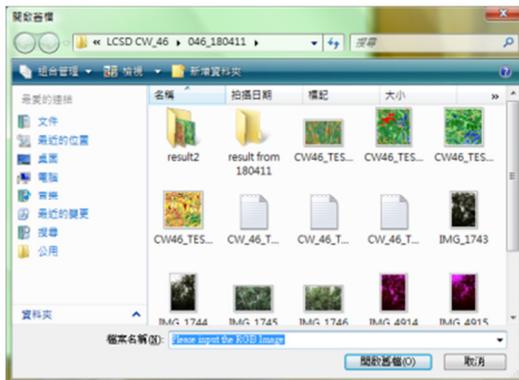
5.1 Basic Analysis



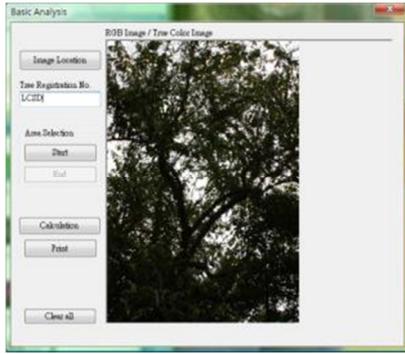
1. Into the VHA front page, select “Basic Analysis”



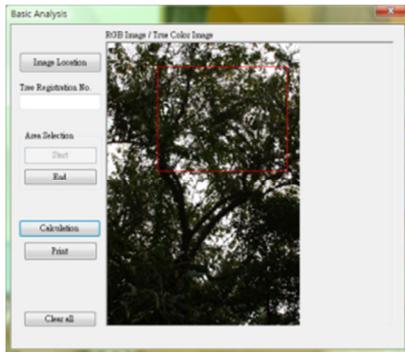
2. Into the “Basic Analysis”, click on “Image Location”



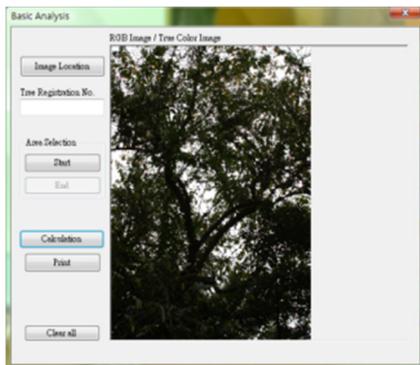
3. Input the RGB Image



4. Input the registration no. for the tree in the text box

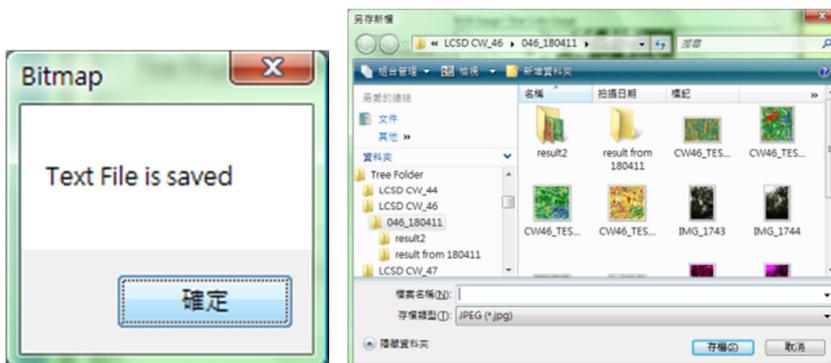


5. Click “Start” to select the area of analysis



6. Click “End” to end the selection

7. Click “Calculation” for calculate the selected area

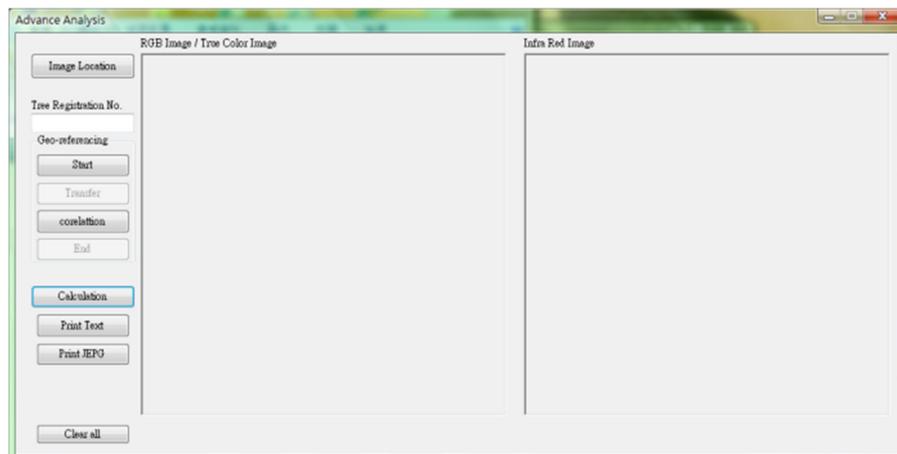


8. After the calculation, click on “Print” to save the text file and CI image
9. Click “Clear all” to go back to front page and start another calculation again

5.2 Advance Analysis



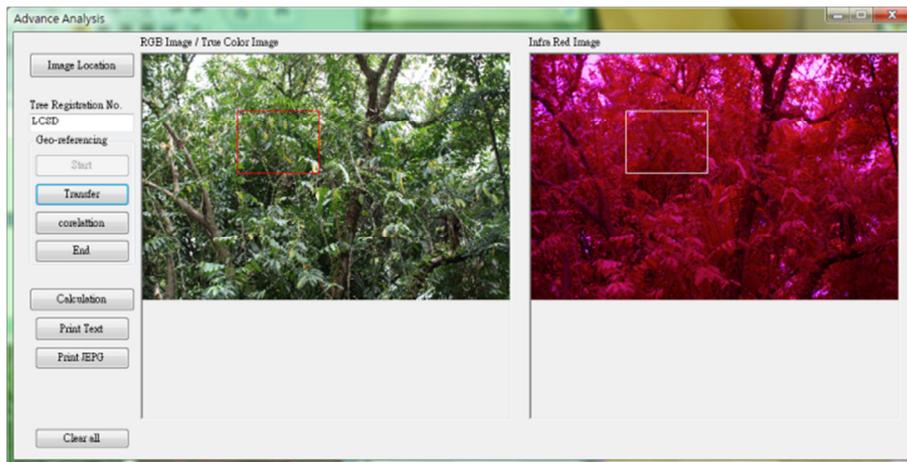
1. Into the VHA front page, select “Analysis Analysis”



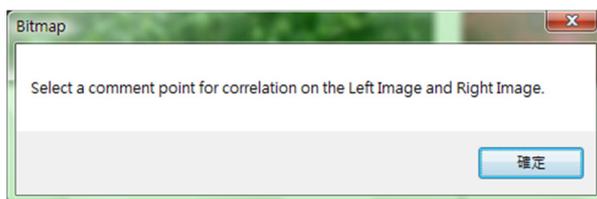
2. Click “Image Location” to input the images



3. Input the registration no. for the tree in the text box



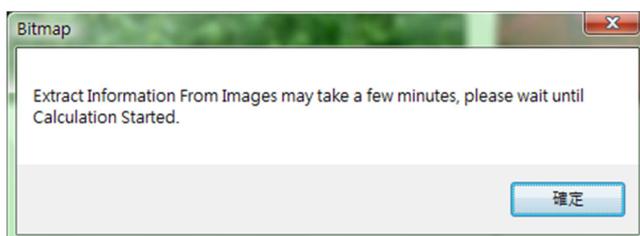
4. Click “Start” to start the area selection.
5. After selection, click “Transfer” to transfer the panel location from the RGB image to the false color image



6. Click “Correlation” to correlate RGB image and false color image



7. The program will calculate the offset of the correlation



8. Click “Calculation” to calculate the selected area
9. Click “Print Text” for saving the text file
10. Click “Print JPEG” for saving the NDVI image and CI image
11. Click “Clear all” to go back to front page and start another calculation again

5.3 Text File Analysis

The score description is generated by the mean or mode value, the meaning of the score is referring to the following table:

Score	Description
10	Extremely healthy tree
9	
8	Healthy Tree
7	
6	
5	The tree may in recovery stage or just over come with disease, please provide a follow up checking
4	
3	
2	The tree is extremely unhealthy, follow up treatment must be done as soon as possible
1	
0	
-1	This may probably a noise or no leave tree
-2	

The corresponding score of NDVI, CI and VI is as below:

NDVI Range	Represented score in Vegetation Health (By NASA, NOAA AVHRR image)
$X \leq 1.0$	10
$1.0 > X \geq 0.9$	9
$0.9 > X \geq 0.8$	8
$0.8 > X \geq 0.7$	7
$0.7 > X \geq 0.6$	6
$0.6 > X \geq 0.5$	5
$0.5 > X \geq 0.4$	4
$0.4 > X \geq 0.3$	3
$0.3 > X \geq 0.2$	2
$0.2 > X \geq 0.1$	1
$0.1 > X \geq 0.0$	0
$0.0 > X \geq -0.1$	-1
$0.1 > X \geq -$	-2

CI Range	Represented score in Vegetation Health (By the test of CI & VI)
$X > 2$	10
$2 \leq X > 1.8$	9
$1.8 \leq X > 1.6$	8
$1.6 \leq X > 1.4$	7
$1.4 \leq X > 1.2$	6
$1.2 \leq X > 1.0$	5
$1.0 \leq X > 0.8$	4
$0.8 \leq X > 0.6$	3
$0.6 \leq X > 0.4$	2
$0.4 \leq X > 0.2$	1
$0.2 \leq X > 0.0$	0
$0.0 \leq X > -0.2$	-1
$-0.2 \leq X > -$	-2

VI Range	Represented score in Vegetation Health Analysis (By the test of CI & VI)
$X > 4.0$	10
$4.0 \leq X < 3.6$	9
$3.6 \leq X < 3.2$	8
$3.2 \leq X < 2.8$	7
$2.8 \leq X < 2.4$	6
$2.4 \leq X < 2.0$	5
$2.0 \leq X < 1.6$	4
$1.6 \leq X < 1.2$	3
$1.2 \leq X < 0.8$	2
$0.8 \leq X < 0.4$	1
$0.4 \leq X < 0.0$	0
$0.0 \leq X < -0.4$	-1
$-0.4 \leq X < -0.8$	-2

5.4 Image Analysis

The following color bar shows the index of the NDVI and CI image:



Blue represent a 10 score from the calculated result and black represent -2 or noise.

Chapter 6 Algorithm of the Vegetation Health analysis:

6.1 Algorithm of Welcome Page

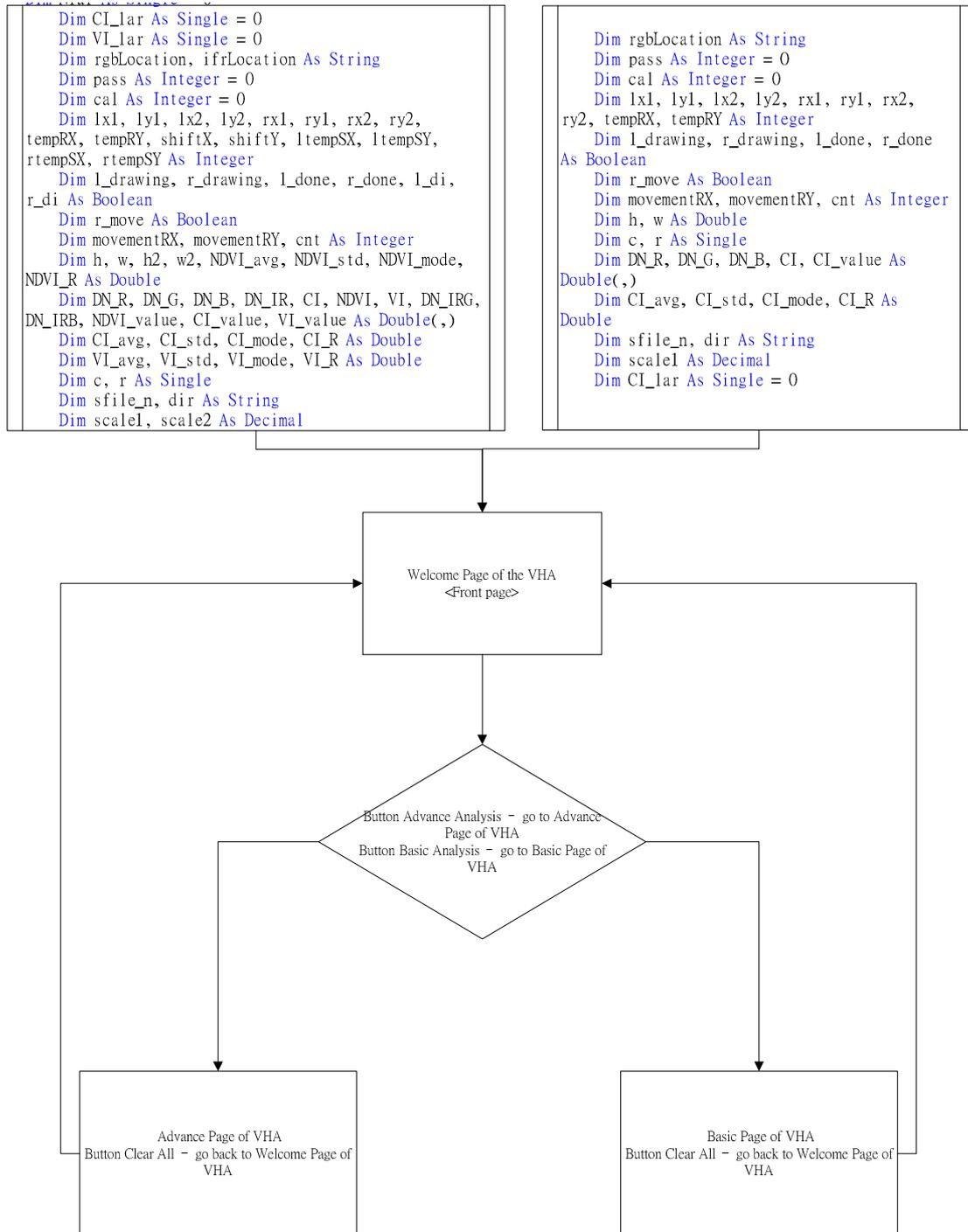


Figure 18 Algorithm Table of Welcome Page

6.2 Algorithm of Basic Analysis Page

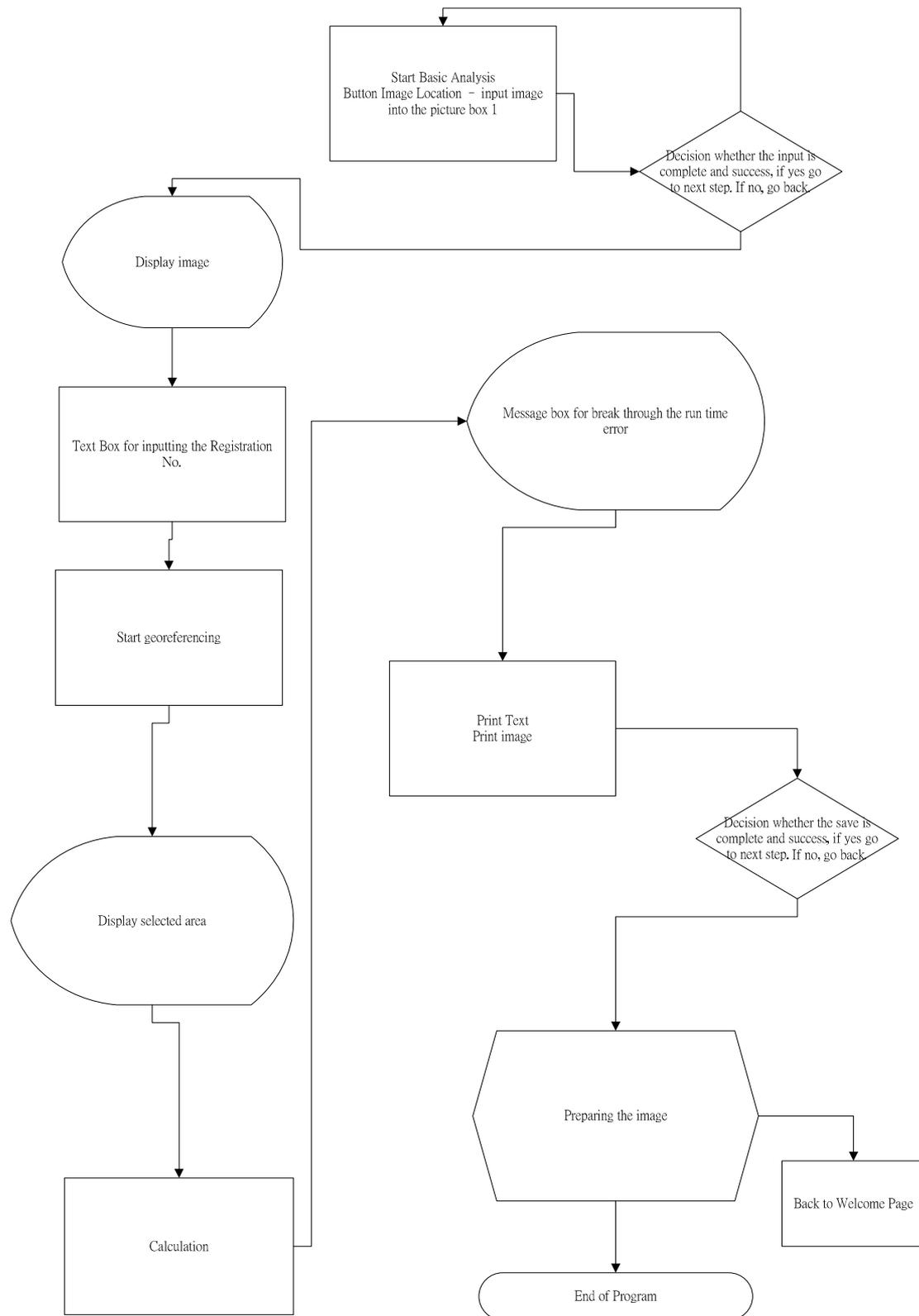


Figure 19 Algorithm Table of Basic Analysis Page

6.3 Algorithm of Advance Analysis Page

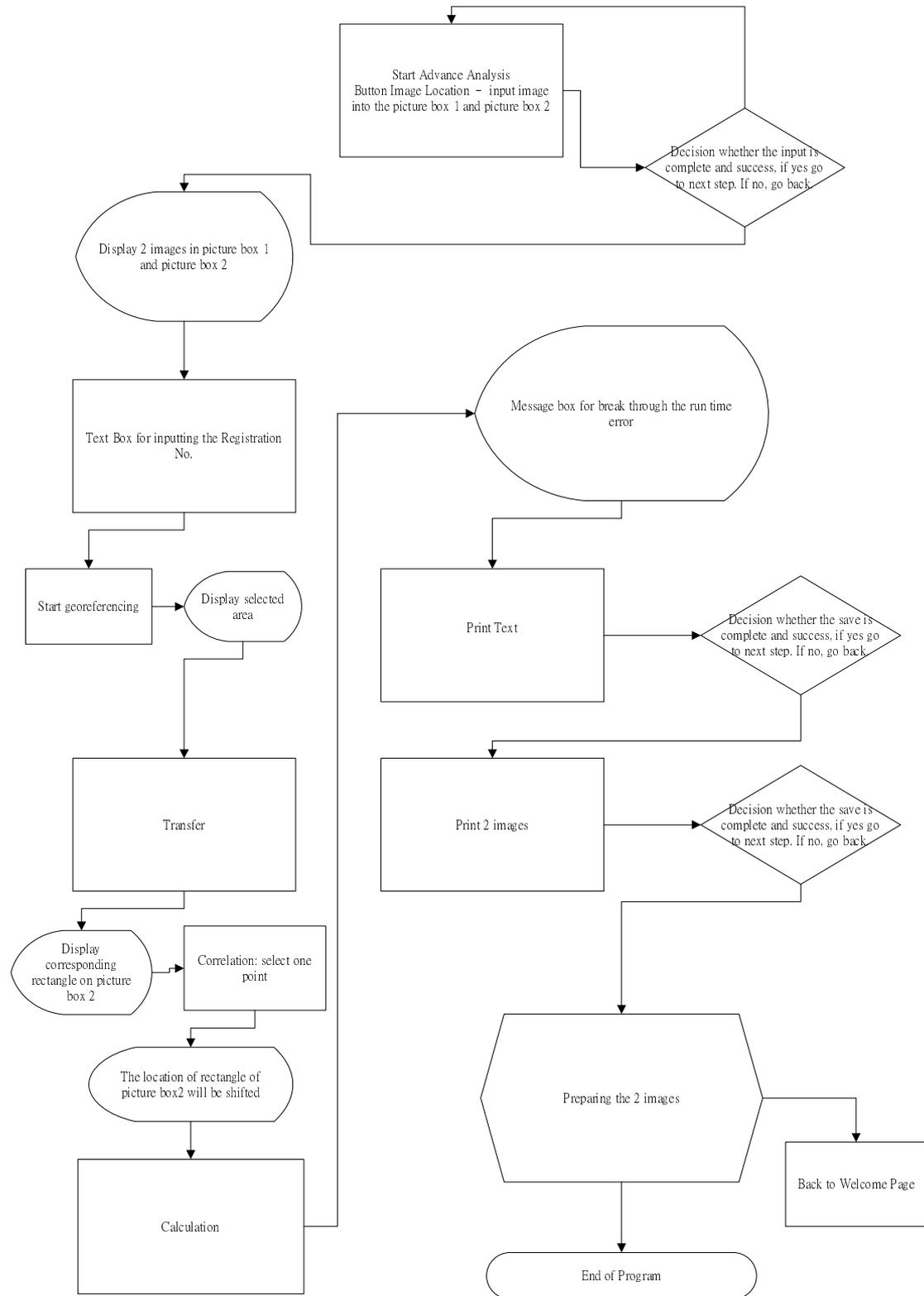


Figure 20 Algorithm Table of Advance Analysis Page

Chapter 7 Data Result & Analysis of Vegetation Health

Analysis

7.1 Data collection

Field work for testing the setting of camera and theory feasibility was held on 30th August to 10th September.

Field work for data collection was held on 31st March to 30th April in Central Western District, Yau Tsim Mong District and Eastern District. The total result is generated by 52 of trees located in Central Western District. More than 150 Photo pairs had been captured in the data collection period. And at least 130 photo pairs used in the calculation and analysis.

Every analysis was done by several small rectangles that selected in the photo which mostly contain the leaves to prevent appearance of noise. And after all the data processing, calculation and analysis: the most successful case is CW/100, CW/105, CW/111 and CW/112:

7.2 Sample of Matched Case: CW/105

In case CW/105, the tree *Ficus microcarpa* is located at Hong Kong Park, on the steep slope adjacent to the Olympic Square. The duration between last updated report and survey day is more than a year. In this case, only 3 photo pairs were taken and 9 report set in total by using small rectangles which mostly contain leaves. Each photo pair had used to generate at least 3 pairs of data. The textual descriptions of the government report are 1. Small amount of dieback twigs; 2. Moderate decay; 3. Minor crack(s); 4. Sign of pest and disease - minor. The Tree Health Score of this tree

is 10.

And the NDVI, CI and VI mode indicated in the following is the health score generated by the program and the corresponding accuracy that calculated by the accuracy formula which described in the methodology compared to the expert result.

NDVI mode	Accuracy of NDVI mode	CI mode	Accuracy of CI mode	VI mode	Accuracy of VI mode
4	7	6	5	1	10
5	6	6	5	1	10
5	6	6	5	1	10
4	7	4	7	1	10
5	6	4	7	1	10
5	6	6	5	1	10
5	6	4	7	1	10
4	7	4	7	1	10
-1	8	4	7	1	10

Table 13 Table showing the sample mode data and the calculated accuracy of CW/105

And the NDVI, CI and VI mean indicated in the following is the health score generated by the program and the corresponding accuracy that calculated by the accuracy formula which described in the methodology compared to the expert result.

NDVI mean	Accuracy of NDVI mean	CI mean	Accuracy of CI mean	VI mean	Accuracy of VI mean
1	10	5	6	3	8
2	9	5	6	3	8
2	9	5	6	3	8
1	10	5	6	3	8
2	9	5	6	3	8
2	9	5	6	3	8
2	9	5	6	4	7
2	9	5	6	3	8
2	9	5	6	4	7

Table 14 Table showing the sample mean data and the calculated accuracy of CW/105

Hence, the average performance of the program on this tree compare to the expert result is stated in the following:

Three health score	Accuracy of NDVI mode	Accuracy of NDVI mean	Accuracy of CI mode	Accuracy of CI mean	Accuracy of VI mode	Accuracy of VI mean
10	6.56	9.22	6.11	6	10	7.78

Table 15 Table showing the average performance and corresponding accuracy and score of CW/105

Furthermore, the images result could provide a better result for analysis of the health of this tree compare to the expert result:

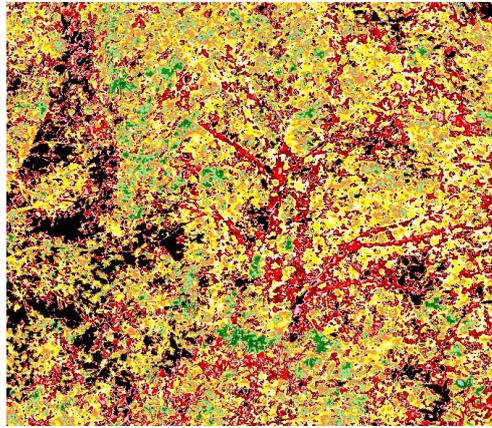


Figure 21 NDVI image of CW/105

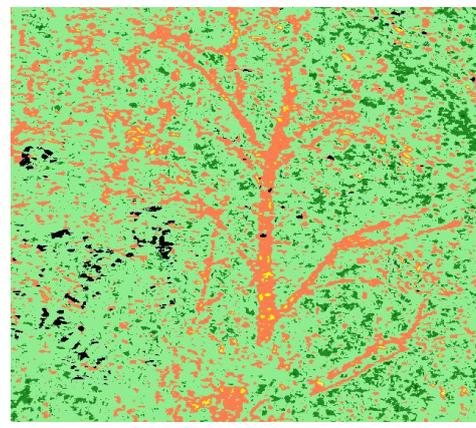


Figure 22 CI image of CW/105

These images could help explain why the mean value and mode value is different. As shown in above, this analysis contains the trucks of the tree hence the value of mean and mode will be a bit different. However, mean and mode both indicated that the tree is not a healthy tree, and in the NDVI image, the leave are all in yellow and some are even red, hence, this tree is not healthy. The expert result and the program result are matched.

7.3 Sample of Matched Case: CW/111

In case CW/111, the tree *Mangifera indica* is located at Hong Kong Park near the end of the lake. The duration between last updated report and survey day is nearly 8 months. In this case, only 3 photo pairs were taken and 8 reports set in total by using small rectangles which mostly contain leaves. Each photo par had used to generate at least 2 pairs of data. The textual descriptions of the government report are 1. With dieback twigs; 2. Minor decay; The Tree Health Score of this tree is 60.

And the NDVI, CI and VI mode indicated in the following is the health score

generated by the program and the corresponding accuracy that calculated by the accuracy formula which described in the methodology compared to the expert result.

NDVI mode	Accuracy of NDVI mode	CI mode	Accuracy of CI mode	VI mode	Accuracy of VI mode
4	8	6	10	0	4
6	10	2	6	8	8
6	10	3	7	9	7
6	10	3	7	1	5
5	9	3	7	7	9
4	8	3	7	1	5
5	9	3	7	7	9
5	9	2	6	7	9

Table 16 Table showing the sample mode data and the calculated accuracy of CW/111

And the NDVI, CI and VI mean indicated in the following is the health score generated by the program and the corresponding accuracy that calculated by the accuracy formula which described in the methodology compared to the expert result.

NDVI mean	Accuracy of NDVI mean	CI mean	Accuracy of CI mean	VI mean	Accuracy of VI mean
1	5	4	8	3	7
2	6	4	8	4	8
3	7	4	8	5	9
2	6	4	8	4	8
2	6	4	8	4	8
1	5	4	8	3	7
2	6	4	8	4	8
2	6	4	8	3	7

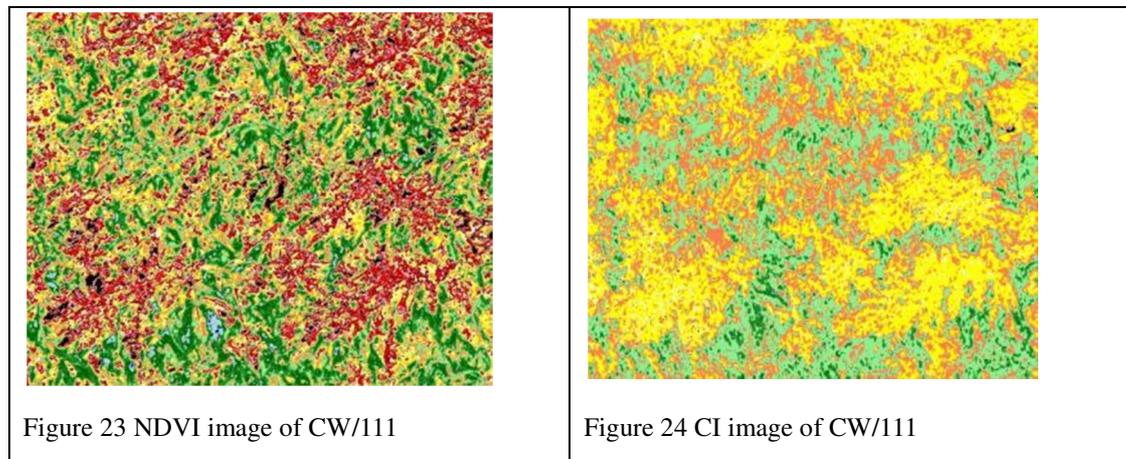
Table 17 Table showing the sample mean data and the calculated accuracy of CW/111

Hence, the average performance of the program on this tree compare to the expert result is stated in the following:

Three health score	Accuracy of NDVI mode	Accuracy of NDVI mean	Accuracy of CI mode	Accuracy of CI mean	Accuracy of VI mode	Accuracy of VI mean
60	9.13	5.88	7.13	8	7	7.75

Table 18 Table showing the average performance and corresponding accuracy and score of CW/111

Furthermore, the images result could provide a better result for analysis of the health of this tree compare to the expert result:



These images could help explain why the mean value and mode value is different. As shown in above, this analysis contains less trucks of the tree. However, the difference of mean and mode may indicate a recovery tree or a tree just have disease, and in the NDVI image, the leave are in red or in green, the difference may due to the recovery, hence, this tree is fairly healthy. The expert result and the program result are matched.

7.4 Sample of Unmatched Case: CW/91

The most unsuccessful case is CW/69, CW/91 and YTM/60:

In case CW/91, the tree *Ficus virens* var. *sublanceolata* is located at Battery Path. The duration between last updated report and survey day is nearly 8 months. In this case, only 4 photo pairs were taken and 15 reports set in total by using small rectangles which mostly contain leaves. Each photo par had used to generate at least 3 pairs of data. The textual descriptions of the government report are 1. Small amount of dieback twigs; 2. Severe cavity; 3. Moderate decay; 4. Moderate crack(s); 5. Moderate amount of fungal fruiting bodies; 6. Sign of pest and disease

observed; The Tree Health Score of this tree is -20.

And the NDVI, CI and VI mode indicated in the following is the health score generated by the program and the corresponding accuracy that calculated by the accuracy formula which described in the methodology compared to the expert result.

NDVI mode	Accuracy of NDVI mode	CI mode	Accuracy of CI mode	VI mode	Accuracy of VI mode
3	5	8	0	3	5
8	0	9	0	10	0
8	0	2	6	10	0
9	0	8	0	10	0
3	5	8	0	2	6
7	1	10	0	10	0
7	1	6	2	10	0
7	1	6	2	2	6
2	6	4	4	2	6
2	6	5	3	2	6
7	1	5	3	10	0
7	1	5	3	10	0
6	2	4	4	1	7
6	2	5	3	2	6
7	1	4	4	2	6

Table 19 Table showing the sample mode data and the calculated accuracy of CW/91

And the NDVI, CI and VI mean indicated in the following is the health score generated by the program and the corresponding accuracy that calculated by the accuracy formula which described in the methodology compared to the expert result.

NDVI mean	Accuracy of NDVI mean	CI mean	Accuracy of CI mean	VI mean	Accuracy of VI mean
6	2	6	2	10	0
4	4	6	2	7	1
4	4	5	3	7	1
6	2	6	2	10	0
6	2	6	2	10	0
4	4	6	2	6	2
3	5	5	3	5	3
4	4	5	3	5	3
6	2	6	2	10	0
5	3	6	2	8	0
4	4	6	2	5	3
4	4	6	2	6	2
3	5	6	2	5	3
3	5	6	2	5	3
4	4	6	2	6	2

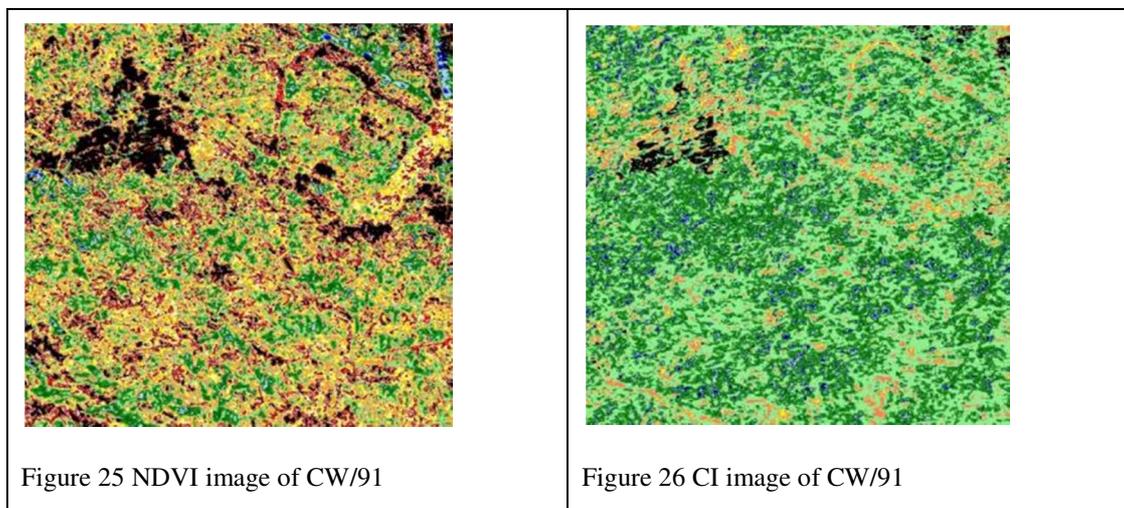
Table 20 Table showing the sample mode data and the calculated accuracy of CW/91

Hence, the average performance of the program on this tree compare to the expert result is stated in the following:

Three health score	Accuracy of NDVI mode	Accuracy of NDVI mean	Accuracy of CI mode	Accuracy of CI mean	Accuracy of VI mode	Accuracy of VI mean
-20	2.13	3.6	2.27	2.2	3.2	1.53

Table 21 Table showing the average performance and corresponding accuracy and score of CW/91

Furthermore, the images result could provide a better result for analysis of the health of this tree compare to the expert result:



In this case, the mode and value are similar to each other. The only reason of the mismatch may due to the duration between last updated record and the survey day is too far and the tree has great improvement from the previous treatment. As you can see the green leave is in big proportion of the leave of the tree shown in the NDVI and CI images.

7.5 Analysis of All Data

Through all the data processing and calculation, the result of all trees and their corresponding accuracy compare to the result from the expert result is shown as the following table:

Tree no.	Tree health score	NDVI mode	NDVI mean	CI mode	CI mean	VI mode	VI mean
CW/44	70.00	4.40	3.60	9.60	8.40	2.60	5.80
CW/46	20.00	4.33	7.58	3.67	6.42	3.33	5.83
CW/47	46.00	5.17	7.67	3.33	5.50	6.83	5.17
CW/48	90.00	5.67	4.00	6.25	5.67	4.42	6.00
CW/50	50.00	7.86	9.00	8.14	8.57	5.14	8.57
CW/51	70.00	6.75	7.00	7.67	8.00	5.17	8.83
CW/52	75.00	7.28	6.83	7.39	8.39	4.06	8.94
CW/53	95.00	0.00	0.63	5.50	5.25	0.50	4.50
CW/55	45.00	7.08	8.92	6.67	8.17	6.25	7.17
CW/56	-20.00	3.80	4.60	1.60	2.40	7.20	3.00
CW/57	-20.00	6.00	5.33	3.33	3.11	7.11	3.22
CW/58	25.00	6.17	9.50	6.17	7.50	3.50	8.50
CW/59	15.00	4.97	7.38	6.62	6.44	6.50	5.26
CW/60	-10.00	9.33	6.00	1.00	4.00	9.00	3.33
CW/62	75.00	5.19	4.12	6.50	6.96	4.81	6.12
CW/63	90.00	4.22	2.44	5.89	5.78	2.44	3.89
CW/64	-10.00	2.50	6.00	4.83	4.67	5.50	4.33
CW/65	0.00	6.00	7.33	5.33	5.00	9.33	6.00
CW/67	-10.00	5.71	4.29	1.43	3.00	4.14	1.71
CW/68	70.00	9.20	6.00	8.60	8.00	3.00	9.40
CW/69	-10.00	2.17	6.00	1.17	3.17	4.50	4.17
CW/77	70.00	9.00	7.00	9.00	9.00	5.75	8.00
CW/79	0.00	4.00	6.25	4.50	4.50	6.75	5.25
CW/90	-10.00	3.50	6.50	2.75	4.00	6.25	4.75
CW/91	-20.00	2.13	3.60	2.27	2.20	3.20	1.53
CW/98	-20.00	4.75	6.55	4.20	3.15	7.00	4.90

Table 22 Average performance of from CW/44 to CW/98

Tree no.	Tree health score	NDVI mode	NDVI mean	CI mode	CI mean	VI mode	VI mean
CW/99	60.00	8.14	6.14	9.43	9.00	5.29	7.29
CW/100	70.00	9.83	7.00	8.50	8.83	7.00	9.33
CW/101	60.00	2.00	3.43	5.86	8.29	4.00	5.86
CW/105	10.00	6.56	9.22	6.11	6.00	10.00	7.78
CW/106	60.00	2.00	3.00	5.33	8.00	4.00	7.00
CW/107	90.00	8.00	5.40	8.40	7.40	7.00	7.00
CW/108	100.00	5.25	3.50	7.38	5.63	10.00	5.25
CW/109	80.00	4.71	5.86	7.14	7.43	2.43	8.57
CW/110	-10.00	3.11	5.44	4.33	4.11	3.78	4.00
CW/111	60.00	9.13	5.88	7.13	8.00	7.00	7.75
CW/112	0.00	7.33	9.33	5.67	6.00	8.33	7.67
CW/113	5.00	5.00	9.00	7.50	6.50	3.00	7.00
CW/114	5.00	5.12	7.72	4.83	5.50	7.72	6.39
CW/121	100.00	1.78	1.56	6.44	5.44	1.78	3.33
CW/122	95.00	4.34	4.08	5.24	5.00	3.29	5.39
CW/123	0.00	7.71	9.71	4.21	5.07	9.79	7.71
E/27	100.00	5.59	4.35	7.76	5.82	4.29	6.47
YTM/49	95.00	6.05	2.95	6.13	5.45	2.87	5.24
YTM/50	100.00	2.59	2.24	2.53	5.06	0.59	5.47
YTM/60	95.00	0.00	0.43	6.79	5.79	0.50	3.50
YTM/61	95.00	1.38	0.50	9.50	6.25	0.50	3.50
YTM/84	100.00	4.78	3.78	5.78	5.22	7.00	5.89
YTM/85	100.00	3.45	5.30	9.50	6.30	9.00	9.20
YTM/86	100.00	7.50	4.83	9.17	5.67	3.33	8.83
YTM/88	95.00	2.36	0.71	7.64	5.79	0.64	2.79
YTM/89	100.00	6.58	3.58	7.17	5.17	3.33	5.17

Table 23 Average performance of from CW/99 to YTM/89

Total number of tree = 52

To calculate the percentage of matching of the program result with the expert result, the tree that with the accuracy of 5 will be counted in the percentage of matching among all the data. The following table shows the percentage of matching

by using 1. All data; 2. Data from the unhealthy tree; 3. Data from the tree without the description of no significant detect observed.

And only the data from the tree without the description of no significant detect observed will be adopted as the feasibility of the program with the program result and expert result. It is because the tree that marked with no significant detect observed is the most subjective marking of the health report and it is hard to identify whether that tree is healthy or not with this description.

7.6 Feasibility Test on VHA

Calculated only with the tree without the description of no significant detect observed (adopted):

	NDVI Mean	NDVI Mode	CI Mean	CI Mode	VI Mean	VI Mode
Total matched number:	37	39	39	43	34	43
Percentage that the program could matched (%):	71	75	75	83	65	83

Table 24 Feasibility Test Result on the tree without the description of no significant detect observed

Calculated with all data:

	NDVI Mean	NDVI Mode	CI Mean	CI Mode	VI Mean	VI Mode
Total matched number:	31	32	39	43	27	39
Percentage that the program could matched (%):	60	62	75	83	52	75

Table 25 Feasibility Test Result on all trees

Calculated only with the tree that has disease:

	NDVI	NDVI	CI	CI	VI	VI
	Mean	Mode	Mean	Mode	Mean	Mode
Total matched number:	35	38	40	43	32	40
Percentage that the program could matched (%):	67	73	77	83	62	77

Table 26 Feasibility Test Result on the tree that has disease

Chapter 8 Conclusion

In this dissertation, several things had been done.

- A. Field work on data collection and observation of the register of old and valuable tree over 8 months.

Field work for testing the setting of camera and theory accessibility was held on 30th August to 10th September.

Field work for data collection was held on 31st March to 30th April in Central Western District, Yau Tsim Mong District and Eastern District. The total result is generated by 52 of trees located in Central Western District. More than 150 Photo pairs had been captured in the data collection period. And at least 130 photo pairs used in the calculation and analysis.

- B. Develop a classification index for transferring the government textual description into a scientific number for the evaluation of the accessibility of the program

For evaluate the program's feasibility, a reasonable, scientific and comparable index must be developed convert the textual description of government report into a comparable number. Tree Health Score is designed and developed with the weighting of the disease or symptom of the tree and the level of the sickness.

- i. Amount of dieback twigs, weight = 1
- ii. Abnormal defoliation, weight = 2
- iii. Cavity, weight = 0.5
- iv. Decay, weight = 0
- v. Crack(s) , weight = 0
- vi. Amount of fungal fruiting bodies, weight = 2
- vii. Sign of pest and disease, weight = 2

Type of description of the level of symptom / disease and the corresponding score:

- i. Good overall condition, score = 0
- ii. No significant defect observed, score = 0
- iii. Discovery (only the name of the disease) , score = -10
- iv. Limited, score = -20
- v. Small, score = -30
- vi. Minor, score = -30
- vii. Severe, score = -40
- viii. Moderate, score = -50

Tree Healthy score = $100 - \text{disease weight} \times \text{score of significant level}$

- C. Conduct a testing for the CI and VI to provide a index range for the further analysis and evaluation

Since there are no scientific research to show the adopted range of CI and VI, testing aiming for providing a result with different kind of index for the user to compare and enhance the convincible power of the program is conducted.

The range of CI is from 2 to - 0.4 with the interval of 0.2

The range of VI is from 4 to - 0.8 with the interval of 0.4

- D. Design and construct a program to provide the first diagnose for user who lacking the professional knowledge of tree

Vegetation Health Analysis, a user friendly program which only need a image of true color and 1 near infra red image and a few click to provide 1 text file with 3 index and 2 images for the analysis of the health of tree.

E. Evaluate the program feasibility

To find the most reasonable and acceptable result, the result Calculated only with the tree without the description of no significant detect observed is adopted. The main reason behind is the description of “no significant detect observed” contain highest confusion. In fact, even the tree is classified with several diseases, the description will still appear in the report, it seems not to be reasonable as an illness tree can have a conclusion of “no significant detect observed”.

Furthermore, the description of “significant detect” is the most subjective one amount others description.

The feasibility of the program from the NDVI result is from 71% to 75%.

The feasibility of the program from the CI result is from 75% to 83%.

The feasibility of the program from the VI result is from 65% to 83%

Chapter 9 Recommendation

Register of Old and Valuable Trees system and Tree management section:

1. Objective description

An objective description or scientific report should be introduced to the system to provide a consistence and reliable service.

2. Increase the update rate

The update rate of the system should be increased for the detail report of the Tree management section. The update rate should be once a season for general tree and up to once in 2 months or less.

3. Increase the number of professional worker and observer

The number of professional worker and observer should be increased for monitoring or the research for the renewal of the system.

4. An accurate location map

An accurate location map should be introduced for the majority to find the tree rather than a textual description or a non-scaled map, especially when the user has no idea of the outlook of the tree.

Further Development of Vegetation Health Analysis:

1. Increase the base of the test of CI and VI range

An accurate range of CI and VI may provide a higher accuracy for the analysis result of the data.

2. More point should be added in correlation function

To reduce the noise of the manual correlation, more point should be added in the correlation function in the program

3. Multi-band camera

For reduce the noise occurring in the manual swapping and the manual correlation.

4. More sample for program analysis

Chapter 10 Reference List

(the rest of the reference will be included in the final report)

Register of Old and Valuable Trees (2005). *Register of Old and Valuable Trees*.

Retrieved May 4, 2011 from Leisure and Cultural Services Department, Agriculture,

Fisheries and Conservation Department and Housing Department, Register of Old

and Valuable Trees Web site: <http://http://ovt.lcsd.gov.hk/ovt/intro.jsp?lang=en>

"傾斜老樹 岌岌可危", (2011), *Ta Kung Pao*, Apr 14, p.A11

"九龍城危險古樹被砍", (2011), *Ta Kung Pao*, Jan 21, p.A10

"別讓老樹死於非命", (2011), *Ta Kung Pao*, Jan 5, p.A21

"政府七年「殺」30 樹王 中西區古樹明傷暗瘕政府懶提", (2011), *Apple Daily*, Feb 4, p.A06

"康文署又砍百年榕樹", (2011), *Oriental Daily News*, Jan 21, p.A28

"大樹穿窿康文署懶補救", (2010), *Oriental Daily News*, Dec 28, p.A08

"彩雲二邨南洋杉恐塌", (2010), *Oriental Daily News*, Dec 27, p.A07

"東方民調：城市老化隱患陸續浮現", (2010), *Oriental Daily News*, Dec 13, p.A08

"栢麗大道百年古樹終被斬", (2010), *Sun Daily News*, Dec 9, p.A10

"康文署斬「患癌」細葉榕 專家恐附近 3 樹感染", (2010), *am730*, Dec 9, p.M18

"栢麗老榕被移除 研原址補種樹", (2010), *Wenwei*, Dec 9, p.A20

Nichol, J. & Lee, C. M. (2005). *Urban vegetation monitoring in Hong Kong using*

high resolution multispectral images. Hong Kong: Taylor & Francis.

Nichol, J. (2009). *Remote Sensing Lecture Note*. Hong Kong: The Hong Kong Polytechnic University.

NASA (2009). *Remote Sensing Tutorial Page 3-1*. Retrieved May 3, 2011 from NASA, Web site: http://http://rst.gsfc.nasa.gov/Sect3/Sect3_1.html

Natural Resources Canada (2005). *Glossary of remote sensing terms*. Retrieved May 3, 2011 from Natural Resources Canada, Web site: http://http://www.ccrs.nrcan.gc.ca/glossary/index_e.php?id=654

NASA (2011). *Measuring Vegetation (NDVI & EVI ; Feature Articles)*. Retrieved May 3, 2011 from NASA, Earth Observatory Web site: http://http://earthobservatory.nasa.gov/Features/MeasuringVegetation/measuring_vegetation_2.php

Canon Hongkong Company Limited (2009). *Product Catalog - [Canon Hongkong Company Limited]*. Retrieved April 24, 2011 from <http://www.canon.com.hk/tc/product/catalog/productItemDetails.do?prfnbr=51217>

Sigma Corporation (2010). *Large Maximum Aperture of F1.4, specially designed for Digital SLR Cameras. 30mm F1.4 EX DC HSM - SIGMA CORPORATION*. Retrieved April 24, 2011 from http://www.sigma-photo.co.jp/english/lens/digital/30_14.htm

Hong Kong Flora and Vegetation (2011). *Vegetation Analysis Method - Hong Kong Flora and Vegetation*. Retrieved May 20, 2011 from The Chinese University of Hong Kong, Web site:
http://http://www.hkflora.com/v2/vegetation/veget_analysis_methodb.php

Measuring Vegetation Health (2011). *MVH Home Page*. Retrieved May 20, 2011 from Measuring Vegetation Health, Web site:
<http://mvh.sr.unh.edu/index.htm>

Chapter 11 Appendix

Vegetation Health Analysis -“Advance Analysis” Code

- Defining the variable for the program:

```
Public Class advanced
    Dim Nlar As Single = 0
    Dim CI_lar As Single = 0
    Dim VI_lar As Single = 0
    Dim rgbLocation, ifrLocation As String
    Dim pass As Integer = 0
    Dim cal As Integer = 0
    Dim lx1, ly1, lx2, ly2, rx1, ry1, rx2, ry2, tempRX, tempRY, shiftX, shiftY, ltempSX,
ltempSY, rtempSX, rtempSY As Integer
    Dim l_drawing, r_drawing, l_done, r_done, l_di, r_di As Boolean
    Dim r_move As Boolean
    Dim movementRX, movementRY, cnt As Integer
    Dim h, w, h2, w2, NDVI_avg, NDVI_std, NDVI_mode, NDVI_R As Double
    Dim DN_R, DN_G, DN_B, DN_IR, CI, NDVI, VI, DN_IRG, DN_IRB, NDVI_value, CI_value, VI_value
As Double(,)
    Dim CI_avg, CI_std, CI_mode, CI_R As Double
    Dim VI_avg, VI_std, VI_mode, VI_R As Double
    Dim c, r As Single
    Dim sfile_n, dir As String
    Dim scale1, scale2 As Decimal
```

- The setting after the advance analysis is opened:

```
Private Sub Form1_Load(ByVal sender As System.Object, ByVal e As System.EventArgs)
Handles MyBase.Load
    welcome.Close()
    Button5.Enabled = False
    Button6.Enabled = False
    l_drawing = False
    r_drawing = False
    l_done = False
    r_done = False
    r_move = False
```

```
SaveFileDialog1.Filter = "Text Document (*.txt)|*.txt"
```

```
SaveFileDialog2.Filter = "JPEG (*.jpg)|*.jpg"
```

```
SaveFileDialog3.Filter = "JPEG (*.jpg)|*.jpg"
```

```
End Sub
```

- **Calculation button:**

```
Private Sub Button1_Click(ByVal sender As System.Object, ByVal e As System.EventArgs)  
Handles Button1.Click
```

- **Record the scale factor of the image and the drawing image**

```
If Button5.Enabled = False Then
```

```
Dim bmp As New Drawing.Bitmap(rgbLocation)
```

```
Dim bmp2 As New Drawing.Bitmap(ifrLocation)
```

```
c = Int(lx2 / scale1 - lx1 / scale1) + 1
```

```
r = Int(ly2 / scale1 - ly1 / scale1) + 1
```

- **Recording the data**

```
Try
```

```
ReDim Preserve DN_R(c, r)
```

```
ReDim Preserve DN_G(c, r)
```

```
ReDim Preserve DN_B(c, r)
```

```
cnt = 0
```

```
MsgBox("Extract Information From Images may take a few minutes, please wait  
until Calculation Started.")
```

```
For y = 0 To r - 1
```

```
For x = 0 To c - 1
```

```
DN_R(x, y) = bmp.GetPixel(Int(lx1 / scale1) + x, Int(ly1 / scale1)  
+ y).R
```

```
DN_G(x, y) = bmp.GetPixel(Int(lx1 / scale1) + x, Int(ly1 / scale1)  
+ y).G
```

```
DN_B(x, y) = bmp.GetPixel(Int(lx1 / scale1) + x, Int(ly1 / scale1)  
+ y).B
```

```
cnt += 1
```

```
Next
```

```
cnt += 1
```

```
Next
```

```

ReDim Preserve DN_IR(c, r)
ReDim Preserve DN_IRG(c, r)
ReDim Preserve DN_IRB(c, r)
For y = 0 To r - 1
    For x = 0 To c - 1
        DN_IRG(x, y) = bmp2.GetPixel(Int(rx1 / scale2) + x, Int(ry1 / scale2)
+ y).G
        DN_IRB(x, y) = bmp2.GetPixel(Int(rx1 / scale2) + x, Int(ry1 / scale2)
+ y).B
        DN_IR(x, y) = bmp2.GetPixel(Int(rx1 / scale2) + x, Int(ry1 / scale2)
+ y).R
        cnt += 1
    Next
    cnt += 1
Next
ReDim Preserve CI(c, r)
ReDim Preserve NDVI(c, r)
ReDim Preserve VI(c, r)
cnt = 0
For y = 0 To r - 1
    For x = 0 To c - 1
        If (DN_IR(x, y) > DN_IRG(x, y) And DN_IR(x, y) > DN_IRB(x, y)) Or
(DN_G(x, y) > DN_R(x, y) And DN_G(x, y) > DN_B(x, y)) Then
            If Not DN_R(x, y) = 0 Then
                CI(x, y) = DN_G(x, y) / DN_R(x, y)
                VI(x, y) = (DN_IR(x, y) / DN_R(x, y))
            End If
            NDVI(x, y) = (DN_IR(x, y) - DN_R(x, y)) / (DN_IR(x, y) + DN_R(x,
y))
            cnt += 1
        Else
            CI(x, y) = -1
            NDVI(x, y) = 50
            VI(x, y) = -1
        End If
    Next
    cnt += 1
Next

```

```
MsgBox("Information Extracted, press 'OK' to Start the Calculation")
Calculation()
```

```
Catch ex As Exception
```

```
MsgBox("Error!!" & " " & ex.ToString)
```

```
Finally
```

```
MsgBox("Done")
```

```
bmp.Dispose()
```

```
cal = cal + 1
```

```
End Try
```

```
Else
```

```
MsgBox("Please select file location first. ")
```

```
End If
```

```
End Sub
```

- **Input Image button, RGB image will be first input.**

```
Private Sub Button2_Click(ByVal sender As System.Object, ByVal e As System.EventArgs)
```

```
Handles Button2.Click
```

```
Dim ct As Integer
```

```
Try
```

```
OpenFileDialog1.FileName = "Please input the RGB Image."
```

```
OpenFileDialog1.ShowDialog()
```

```
rgbLocation = OpenFileDialog1.FileName
```

```
Dim bmp As New Drawing.Bitmap(rgbLocation)
```

```
PictureBox1.Image = bmp
```

```
h = bmp.Height
```

```
w = bmp.Width
```

```
resizePBI(h, w)
```

```
pass = 1
```

```
OpenFileDialog2.FileName = "Please input the Infra-Red Image."
```

```
OpenFileDialog2.ShowDialog()
```

```

    ifrLocation = OpenFileDialog2.FileName
    Dim bmp2 As New Drawing.Bitmap(ifrLocation)
    PictureBox2.Image = bmp2
    h2 = bmp2.Height
    w2 = bmp2.Width
    resizePB2(h2, w2)
    pass = pass + 1

    If scale1 <> scale2 Then
        MsgBox("Two images are in different size or orientation")
    End If

Catch ex As Exception
    MsgBox("Error!!" & " " & ex.ToString)
End Try

If Not pass = 2 Then
    MsgBox("Please try again.")
End If

End Sub

```

- **Resize function for display of the RGB image**

```

Public Sub resizePB1(ByVal h, ByVal w)
    Dim TempImage As Image
    TempImage = Image.FromFile(rgbLocation)
    PictureBox1.Image = TempImage

    Dim bmp_new As New Drawing.Bitmap(PictureBox1.Image)

    Dim ref As Integer
    If bmp_new.Width > bmp_new.Height Then
        ref = bmp_new.Width
    Else
        ref = bmp_new.Height
    End If

```

```
scale1 = 400 / ref
```

```
Dim bm_dest As New Drawing.Bitmap(CInt(bmp_new.Width * scale1),  
CInt(bmp_new.Height * scale1))  
Dim gr_dest As Graphics = Graphics.FromImage(bm_dest)  
gr_dest.DrawImage(bmp_new, 0, 0, bm_dest.Width + 1, bm_dest.Height + 1)  
PictureBox1.Image = bm_dest
```

```
End Sub
```

- **Resize function for display of the RGB image**

```
Public Sub resizePB2(ByVal h2, ByVal w2)
```

```
Dim TempImage2 As Image  
TempImage2 = Image.FromFile(ifrLocation)  
PictureBox2.Image = TempImage2
```

```
Dim bmp_new2 As New Drawing.Bitmap(PictureBox2.Image)
```

```
Dim ref2 As Integer  
If bmp_new2.Width > bmp_new2.Height Then  
    ref2 = bmp_new2.Width  
Else  
    ref2 = bmp_new2.Height  
End If
```

```
scale2 = 400 / ref2
```

```
Dim bm_dest2 As New Drawing.Bitmap(CInt(bmp_new2.Width * scale2),  
CInt(bmp_new2.Height * scale2))  
Dim gr_dest2 As Graphics = Graphics.FromImage(bm_dest2)  
gr_dest2.DrawImage(bmp_new2, 0, 0, bm_dest2.Width + 1, bm_dest2.Height + 1)  
PictureBox2.Image = bm_dest2
```

```
End Sub
```

- **Start button (geo-referencing)**

```
Private Sub Button4_Click(ByVal sender As System.Object, ByVal e As System.EventArgs)  
Handles Button4.Click  
Button5.Enabled = True
```

```

    Button6.Enabled = True
    Button4.Enabled = False
End Sub

```

- **Transfer button (geo-referencing)**

```

Private Sub Button5_Click(ByVal sender As System.Object, ByVal e As System.EventArgs)
Handles Button5.Click
    If Button4.Enabled = False And Button5.Enabled = True And l_drawing = False And
l_done = True Then
        r_drawing = True
        rx1 = lx1
        ry1 = ly1
        rx2 = lx2
        ry2 = ly2
        PictureBox2.Refresh()
        PictureBox2.CreateGraphics.DrawRectangle(Pens.White, rx1, ry1, rx2 - rx1, ry2
- ry1)

        r_drawing = False
        r_done = True
    End If
End Sub

```

- **End button (geo-referencing)**

```

Private Sub Button6_Click(ByVal sender As System.Object, ByVal e As System.EventArgs)
Handles Button6.Click
    Button4.Enabled = True
    Button5.Enabled = False
    Button6.Enabled = False
End Sub

```

- **Function in recording the area**

```

Private Sub PictureBox1_MouseUp(ByVal sender As Object, ByVal e As
System.Windows.Forms.MouseEventArgs) Handles PictureBox1.MouseUp
    If Button4.Enabled = False And Button5.Enabled = True And l_drawing = False Then
        lx1 = e.X
        ly1 = e.Y
        l_drawing = True
    ElseIf Button4.Enabled = False And Button5.Enabled = True And l_drawing = True Then

```

```

PictureBox1.Refresh()
lx2 = e.X
ly2 = e.Y
If lx1 > lx2 And ly1 > ly2 Then
    Dim tempLx, tempLy As Integer
    tempLx = lx1
    tempLy = ly1
    lx1 = lx2
    ly1 = ly2
    lx2 = tempLx
    ly2 = tempLy
End If
PictureBox1.CreateGraphics.DrawRectangle(Pens.Red, lx1, ly1, lx2 - lx1, ly2 -
ly1)

l_drawing = False
l_done = True
End If

If l_di = True And r_di = True Then
    ltempSX = e.X
    ltempSY = e.Y
End If

End Sub

Private Sub PictureBox1_MouseMove(ByVal sender As Object, ByVal e As
System.Windows.Forms.MouseEventArgs) Handles PictureBox1.MouseMove
    If Button4.Enabled = False And Button5.Enabled = True And l_drawing = True Then
        PictureBox1.Refresh()
        lx2 = e.X
        ly2 = e.Y
        If lx1 < lx2 And ly1 < ly2 Then
            PictureBox1.CreateGraphics.DrawRectangle(Pens.Red, lx1, ly1, lx2 - lx1,
ly2 - ly1)
        Else
            PictureBox1.CreateGraphics.DrawRectangle(Pens.Red, lx2, ly2, lx1 - lx2,
ly1 - ly2)
        End If
    End If

```

```

End If
If l_di = True And r_di = True Then
    PictureBox1.Cursor = Cursors.Cross

Else
    PictureBox1.Cursor = Cursors.Arrow
End If
End Sub

Private Sub PictureBox2_MouseMove(ByVal sender As Object, ByVal e As
System.Windows.Forms.MouseEventArgs) Handles PictureBox2.MouseMove
    If Button4.Enabled = False And Button5.Enabled = True And l_drawing = False And
l_done = True And r_done = True Then
        PictureBox2.Cursor = Cursors.SizeAll
        If r_move = True Then
            movementRX = e.X - tempRX
            movementRY = e.Y - tempRY
            PictureBox2.Refresh()
            PictureBox2.CreateGraphics.DrawRectangle(Pens.Black, rx1 + movementRX,
ry1 + movementRY, rx2 - rx1, ry2 - ry1)
        End If
    Else
        PictureBox2.Cursor = Cursors.Arrow
    End If
    If l_di = True And r_di = True Then
        PictureBox2.Cursor = Cursors.Cross

    Else
        PictureBox2.Cursor = Cursors.Arrow
    End If

End Sub

Private Sub PictureBox2_MouseDown(ByVal sender As Object, ByVal e As
System.Windows.Forms.MouseEventArgs) Handles PictureBox2.MouseDown
    If Button4.Enabled = False And Button5.Enabled = True And l_drawing = False And
l_done = True And r_done = True And PictureBox2.Cursor = Cursors.SizeAll Then
        tempRX = e.X
        tempRY = e.Y

```

```

        r_move = True
    End If
End Sub

Private Sub PictureBox2_MouseUp(ByVal sender As Object, ByVal e As
System.Windows.Forms.MouseEventArgs) Handles PictureBox2.MouseUp
    If r_move = True Then
        r_move = False
        movementRX = e.X - tempRX
        movementRY = e.Y - tempRY
        PictureBox2.Refresh()
        rx1 += movementRX
        ry1 += movementRY
        rx2 += movementRX
        ry2 += movementRY
        PictureBox2.CreateGraphics.DrawRectangle(Pens.White, rx1, ry1, rx2 - rx1, ry2
- ry1)
    End If
    If r_di = True Then
        rtempSX = e.X
        rtempSY = e.Y
        MsgBox("L" & ltempSX & "," & ltempSY & "R" & rtempSX & "," & rtempSY)
        l_di = False
        r_di = False
        shiftX = rtempSX - ltempSX
        shiftY = rtempSY - ltempSY
        rx1 += shiftX
        ry1 += shiftY
        rx2 += shiftX
        ry2 += shiftY
        PictureBox2.Refresh()
        PictureBox2.CreateGraphics.DrawRectangle(Pens.White, rx1, ry1, rx2 - rx1, ry2
- ry1)
        MsgBox("Shift X: " & shiftX & " , Shift Y: " & shiftY)
    End If
End Sub

```

- Calculation function

```

Sub Calculation()
    Dim NDVI_sum, Nm(6), NDVI_sum2, ndvi_n, ndvi_cov, ndvi_v As Double
    Dim ci_n, CI_sum, CI_sum2, CI_m(6), CI_cov, CI_v As Double
    Dim vi_n, VI_sum, VI_sum2, VI_m(6), VI_cov, VI_v As Double
    Dim Nm1, Nm2, Nm3, Nm4, Nm5, Nm6, Nm7 As Double
    Dim CI_m1, CI_m2, CI_m3, CI_m4, CI_m5, CI_m6, CI_m7 As Double
    Dim VI_m1, VI_m2, VI_m3, VI_m4, VI_m5, VI_m6, VI_m7 As Double
    CI_m1 = CI_m2 = CI_m3 = CI_m4 = CI_m5 = CI_m6 = CI_m7 = 0
    VI_m1 = VI_m2 = VI_m3 = VI_m4 = VI_m5 = VI_m6 = VI_m7 = 0
    Nm1 = Nm2 = Nm3 = Nm4 = Nm5 = Nm6 = Nm7 = 0
    NDVI_sum = Nm(4) = NDVI_sum2 = ndvi_n = ci_n = CI_sum = CI_sum2 = CI_m(4) = CI_cov
= CI_v = ndvi_cov = ndvi_v = 0
    MsgBox("The Main Calculation is in progress.....")
    For y = 0 To r - 1
        For x = 0 To c - 1

            If Not CI(x, y) = -1 Then
                CI_sum += CI(x, y)
                ci_n += 1
            End If

            If Not VI(x, y) = -1 Then
                VI_sum += VI(x, y)
                vi_n += 1
            End If

            If Not NDVI(x, y) = 50 Then
                NDVI_sum += NDVI(x, y)
                ndvi_n += 1
            End If

        Next
    Next
    VI_avg = VI_sum / vi_n
    NDVI_avg = NDVI_sum / ndvi_n
    CI_avg = CI_sum / ci_n
    MsgBox("Auto-correlation is in progress. Please wait")
    ReDim Preserve NDVI_value(c, r)

```

```

'MsgBox("9")
ReDim Preserve CI_value(c, r)
'MsgBox("10")
ReDim Preserve VI_value(c, r)
'MsgBox("11")
For y = 0 To r - 1
    For x = 0 To c - 1
        '-----CI
        If Not CI(x, y) = -1 Then
            CI_value(x, y) = (CI(x, y) - CI_avg) ^ 2
            If x + 1 <= c And y + 1 <= r Then
                CI_cov += ((CI(x, y) - CI_avg) * (CI(x, y) - CI_avg)) / ci_n
            End If
            CI_sum2 += CI_value(x, y)
        End If
        '-----NDVI
        If Not NDVI(x, y) = 50 Then
            NDVI_value(x, y) = (NDVI(x, y) - NDVI_avg) ^ 2
            If x + 1 <= c And y + 1 <= r Then
                ndvi_cov += ((NDVI(x, y) - NDVI_avg) * (NDVI(x, y) - NDVI_avg)) /
ndvi_n
            End If
            NDVI_sum2 += NDVI_value(x, y)
        End If
        '-----VI
        If Not VI(x, y) = -1 Then
            VI_value(x, y) = (VI(x, y) - VI_avg) ^ 2
            If x + 1 <= c And y + 1 <= r Then
                VI_cov += ((VI(x, y) - VI_avg) * (VI(x, y) - VI_avg)) / vi_n
            End If
            VI_sum2 += VI_value(x, y)
        End If

    Next
Next
'MsgBox("12")
CI_v = CI_sum2 / (ci_n - 1)
CI_R = CI_cov / CI_v

```

CI_std = (CI_sum2 / ci_n) ^ 0.5

ndvi_v = NDVI_sum2 / (ndvi_n - 1)

NDVI_R = ndvi_cov / ndvi_v

NDVI_std = (NDVI_sum2 / ndvi_n) ^ 0.5

VI_v = VI_sum2 / (vi_n - 1)

VI_R = VI_cov / VI_v

VI_std = (VI_sum2 / vi_n) ^ 0.5

For y = 0 To r - 1

For x = 0 To c - 1

If Not CI(x, y) = -1 Then

If CI(x, y) < CI_avg - (3 * CI_std) Then

CI_m(0) += 1

CI_m1 += CI(x, y)

End If

If CI(x, y) < CI_avg - (2 * CI_std) And CI(x, y) >= CI_avg - (3 * CI_std)

Then

CI_m(1) += 1

CI_m2 += CI(x, y)

End If

If CI(x, y) < CI_avg - CI_std And CI(x, y) >= CI_avg - (2 * CI_std) Then

CI_m(2) += 1

CI_m3 += CI(x, y)

End If

If CI(x, y) <= CI_avg - CI_std And CI(x, y) >= CI_avg + CI_std Then

CI_m(3) += 1

CI_m4 += CI(x, y)

End If

If CI(x, y) > CI_avg + CI_std And CI(x, y) <= CI_avg + (2 * CI_std) Then

CI_m(4) += 1

CI_m5 += CI(x, y)

End If

If CI(x, y) > CI_avg + (2 * CI_std) And CI(x, y) <= CI_avg + (3 * CI_std)

Then

```

        CI_m(5) += 1
        CI_m6 += CI(x, y)
    End If
    If CI(x, y) > CI_avg + (3 * CI_std) Then
        CI_m(6) += 1
        CI_m7 += CI(x, y)
    End If
End If

If Not NDVI(x, y) = 50 Then
    If NDVI(x, y) < NDVI_avg - (3 * NDVI_std) Then
        Nm(0) += 1
        Nm1 += NDVI(x, y)
    End If
    If NDVI(x, y) < NDVI_avg - (2 * NDVI_std) And NDVI(x, y) >= NDVI_avg
- (3 * NDVI_std) Then
        Nm(1) += 1
        Nm2 += NDVI(x, y)
    End If
    If NDVI(x, y) < NDVI_avg - NDVI_std And NDVI(x, y) >= NDVI_avg - (2 *
NDVI_std) Then
        Nm(2) += 1
        Nm3 += NDVI(x, y)
    End If
    If NDVI(x, y) <= NDVI_avg - NDVI_std And NDVI(x, y) >= NDVI_avg +
NDVI_std Then
        Nm(3) += 1
        Nm4 += NDVI(x, y)
    End If
    If NDVI(x, y) > NDVI_avg + NDVI_std And NDVI(x, y) <= NDVI_avg + (2 *
NDVI_std) Then
        Nm(4) += 1
        Nm5 += NDVI(x, y)
    End If
    If NDVI(x, y) > VI_avg + (2 * NDVI_std) And NDVI(x, y) <= CI_avg + (3
* NDVI_std) Then
        Nm(5) += 1
        Nm6 += NDVI(x, y)

```

```

End If
If NDVI(x, y) > NDVI_avg + (3 * NDVI_std) Then
    Nm(6) += 1
    Nm7 += NDVI(x, y)
End If
End If

If Not VI(x, y) = -1 Then
    If VI(x, y) < 0.5 Then
        VI_m(0) += 1
        VI_m1 += VI(x, y)
    End If
    If VI(x, y) < VI_avg - (2 * VI_std) And VI(x, y) >= VI_avg - (3 * VI_std)
Then
        VI_m(1) += 1
        VI_m2 += VI(x, y)
    End If
    If VI(x, y) < VI_avg - VI_std And VI(x, y) >= VI_avg - (2 * VI_std) Then
        VI_m(2) += 1
        VI_m3 += VI(x, y)
    End If
    If VI(x, y) <= VI_avg - VI_std And VI(x, y) >= VI_avg + VI_std Then
        VI_m(3) += 1
        VI_m4 += VI(x, y)
    End If
    If VI(x, y) > VI_avg + VI_std And VI(x, y) <= VI_avg + (2 * VI_std) Then
        VI_m(4) += 1
        VI_m5 += VI(x, y)
    End If
    If VI(x, y) > VI_avg + (2 * VI_std) And VI(x, y) <= VI_avg + (3 * VI_std)
Then
        VI_m(5) += 1
        VI_m6 += VI(x, y)
    End If
    If VI(x, y) > VI_avg + (3 * VI_std) Then
        VI_m(6) += 1
        VI_m7 += VI(x, y)

```

```

        End If
    End If

Next
Next
MsgBox("Data Analysis is in progress. Please wait")
'calculation for largest mode
For i = 0 To 6

    'CI
    If CI_m(i) > CI_m(CI_lar) Then
        CI_lar = i
    End If

    'VI
    If VI_m(i) > VI_m(VI_lar) Then
        VI_lar = i
    End If

    'NDVI
    If Nm(i) > Nm(Nlar) Then
        Nlar = i
    End If
Next

'calculation for mode
'CI
If CI_lar = 0 Then
    CI_mode = CI_m1 / CI_m(0)
ElseIf CI_lar = 1 Then
    CI_mode = CI_m2 / CI_m(1)
ElseIf CI_lar = 2 Then
    CI_mode = CI_m3 / CI_m(2)
ElseIf CI_lar = 3 Then
    CI_mode = CI_m4 / CI_m(3)
ElseIf CI_lar = 4 Then
    CI_mode = CI_m5 / CI_m(4)
ElseIf CI_lar = 5 Then

```

```

    CI_mode = CI_m6 / CI_m(5)
ElseIf CI_lar = 6 Then
    CI_mode = CI_m7 / CI_m(6)
End If

```

'NDVI

```

If Nlar = 0 Then
    NDVI_mode = Nm1 / Nm(0)
ElseIf Nlar = 1 Then
    NDVI_mode = Nm2 / Nm(1)
ElseIf Nlar = 2 Then
    NDVI_mode = Nm3 / Nm(2)
ElseIf Nlar = 3 Then
    NDVI_mode = Nm4 / Nm(3)
ElseIf Nlar = 4 Then
    NDVI_mode = Nm5 / Nm(4)
ElseIf Nlar = 5 Then
    NDVI_mode = Nm6 / Nm(5)
ElseIf Nlar = 6 Then
    NDVI_mode = Nm7 / Nm(6)
End If

```

'VI

```

If VI_lar = 0 Then
    VI_mode = VI_m1 / VI_m(0)
ElseIf VI_lar = 1 Then
    VI_mode = VI_m2 / VI_m(1)
ElseIf VI_lar = 2 Then
    VI_mode = VI_m3 / VI_m(2)
ElseIf VI_lar = 3 Then
    VI_mode = VI_m4 / VI_m(3)
ElseIf VI_lar = 4 Then
    VI_mode = VI_m5 / VI_m(4)
ElseIf VI_lar = 5 Then
    VI_mode = VI_m6 / VI_m(5)
ElseIf VI_lar = 6 Then
    VI_mode = VI_m7 / VI_m(6)

```

End If

End Sub

- **Save file**

```
Private Sub Button8_Click(ByVal sender As System.Object, ByVal e As System.EventArgs)
Handles Button8.Click
    Try
        SaveFileDialog1.ShowDialog()
        sfile_n = SaveFileDialog1.FileName

        Dim sfile As New IO.FileStream(sfile_n, IO.FileMode.CreateNew,
IO.FileAccess.ReadWrite, IO.FileShare.None)
        Dim sfile_r As New IO.StreamReader(sfile)
        Dim sfile_w As New IO.StreamWriter(sfile)
        'sfile_w.WriteLine("X:      " & "Y:      " & "Chlorophyll Index:      " &
"Normalized Difference Vegetation Index:      " & "Vegetation Index:      ")

        sfile_w.WriteLine("      Thank you for using the Vegetation Health
Analysis")
        sfile_w.WriteLine("      Date:      " & Today)
        If Not TextBox1.Text = "" Then
            sfile_w.WriteLine("      Registration No.:      " & TextBox1.Text)
        End If
        '_____NDVI

sfile_w.WriteLine("-----
-----")
        sfile_w.WriteLine("      True Color Image Location and File Name:      "
& OpenFileDialog1.FileName)
        sfile_w.WriteLine("      Infra-red Image Location and File Name:      " &
OpenFileDialog2.FileName)
        sfile_w.WriteLine("      Pixel used:      " & cnt)
```

```

sfile_w.WriteLine("-----
-----")
sfile_w.WriteLine("~~~~~ Normalized Difference Vegetation Index
~~~~~")
sfile_w.WriteLine(" The NDVI average = " & NDVI_avg)
sfile_w.WriteLine(" The NDVI mode = " & NDVI_mode)
sfile_w.WriteLine(" The NDVI standard deviation = " & NDVI_std)
sfile_w.WriteLine(" The NDVI auto-correlation = " & NDVI_R)
sfile_w.WriteLine("Health Report generated by Normalized Difference Vegetation
Index")
sfile_w.WriteLine("")

```

```

sfile_w.WriteLine("-----
-----")
sfile_w.WriteLine("***** The following description is generated by the mode
value *****")
If NDVI_mode > 0.9 And NDVI_mode <= 1.0 Then
    sfile_w.WriteLine("10")
End If
If NDVI_mode > 0.8 And NDVI_mode <= 0.9 Then
    sfile_w.WriteLine("9")
End If
If NDVI_mode > 0.7 And NDVI_mode <= 0.8 Then
    sfile_w.WriteLine("8")
End If
If NDVI_mode > 0.6 And NDVI_mode <= 0.7 Then
    sfile_w.WriteLine("7")
End If
If NDVI_mode > 0.5 And NDVI_mode <= 0.6 Then
    sfile_w.WriteLine("6")
End If
If NDVI_mode > 0.4 And NDVI_mode <= 0.5 Then
    sfile_w.WriteLine("5")
End If
If NDVI_mode > 0.3 And NDVI_mode <= 0.4 Then
    sfile_w.WriteLine("4")
End If
If NDVI_mode > 0.2 And NDVI_mode <= 0.3 Then

```

```

        sfile_w.WriteLine("3")
    End If
    If NDVI_mode > 0.1 And NDVI_mode <= 0.2 Then
        sfile_w.WriteLine("2")
    End If
    If NDVI_mode > 0.0 And NDVI_mode <= 0.1 Then
        sfile_w.WriteLine("1")
    End If
    If NDVI_mode > -0.1 And NDVI_mode <= 0.0 Then
        sfile_w.WriteLine("0")
    End If
    If NDVI_mode > -0.2 And NDVI_mode <= -0.1 Then
        sfile_w.WriteLine("-1")
    End If
    If NDVI_mode > -1.0 And NDVI_mode <= -0.2 Then
        sfile_w.WriteLine("-2")
    End If

sfile_w.WriteLine("-----")
-----")
        sfile_w.WriteLine("***** The following description is generated by the mean
value *****")
    If NDVI_avg > 0.9 And NDVI_avg <= 1.0 Then
        sfile_w.WriteLine("10")
    End If
    If NDVI_avg > 0.8 And NDVI_avg <= 0.9 Then
        sfile_w.WriteLine("9")
    End If
    If NDVI_avg > 0.7 And NDVI_avg <= 0.8 Then
        sfile_w.WriteLine("8")
    End If
    If NDVI_avg > 0.6 And NDVI_avg <= 0.7 Then
        sfile_w.WriteLine("7")
    End If
    If NDVI_avg > 0.5 And NDVI_avg <= 0.6 Then
        sfile_w.WriteLine("6")
    End If
    If NDVI_avg > 0.4 And NDVI_avg <= 0.5 Then

```

```

        sfile_w.WriteLine("5")
    End If
    If NDVI_avg > 0.3 And NDVI_avg <= 0.4 Then
        sfile_w.WriteLine("4")
    End If
    If NDVI_avg > 0.2 And NDVI_avg <= 0.3 Then
        sfile_w.WriteLine("3")
    End If
    If NDVI_avg > 0.1 And NDVI_avg <= 0.2 Then
        sfile_w.WriteLine("2")
    End If
    If NDVI_avg > 0.0 And NDVI_avg <= 0.1 Then
        sfile_w.WriteLine("1")
    End If
    If NDVI_avg > -0.1 And NDVI_avg <= 0.0 Then
        sfile_w.WriteLine("0")
    End If
    If NDVI_avg > -0.2 And NDVI_avg <= -0.1 Then
        sfile_w.WriteLine("-1")
    End If
    If NDVI_avg > -1.0 And NDVI_avg <= -0.2 Then
        sfile_w.WriteLine("-2")
    End If

sfile_w.WriteLine("-----
-----")
        sfile_w.WriteLine("If the description from mode and mean is too different, the
image result should be highly considered.")

sfile_w.WriteLine("-----
-----")
        If NDVI_std >= 0.2 Then
            sfile_w.WriteLine("Since the sd is various in different area, the large
value may indicate a recovery stage of tree from disease or the tree just has inflection
with disease!!")
        End If
        If NDVI_R < 0.99 Then
            sfile_w.WriteLine("Please find another resource to determine the health

```

```

situation, the given resource is not precise enough!!")
    End If

    '-----CI

sfile_w.WriteLine("-----")
-----")
    sfile_w.WriteLine("~~~~~ Chlorophyll Vegetation Index
~~~~~")
    sfile_w.WriteLine(" The CI average = " & CI_avg)
    sfile_w.WriteLine(" The CI mode = " & CI_mode)
    sfile_w.WriteLine(" The CI standard deviation = " & CI_std)
    sfile_w.WriteLine(" The CI auto-correlation = " & CI_R)
    sfile_w.WriteLine("Health Report generated by Chlorophyll Vegetation Index")
    sfile_w.WriteLine("")

sfile_w.WriteLine("-----")
-----")
    sfile_w.WriteLine("***** The following description is generated by the mode
value *****")
    If CI_mode >= 2 Then
        sfile_w.WriteLine("10")
    End If
    If CI_mode < 2 And CI_mode >= 1.8 Then
        sfile_w.WriteLine("9")
    End If
    If CI_mode < 1.8 And CI_mode >= 1.6 Then
        sfile_w.WriteLine("8")
    End If
    If CI_mode < 1.6 And CI_mode >= 1.4 Then
        sfile_w.WriteLine("7")
    End If
    If CI_mode < 1.4 And CI_mode >= 1.2 Then
        sfile_w.WriteLine("6")
    End If
    If CI_mode < 1.2 And CI_mode >= 1.0 Then
        sfile_w.WriteLine("5")
    End If

```

```

If CI_mode < 1.0 And CI_mode >= 0.8 Then
    sfile_w.WriteLine("4")
End If
If CI_mode < 0.8 And CI_mode >= 0.6 Then
    sfile_w.WriteLine("3")
End If
If CI_mode < 0.6 And CI_mode >= 0.4 Then
    sfile_w.WriteLine("2")
End If
If CI_mode < 0.4 And CI_mode >= 0.2 Then
    sfile_w.WriteLine("1")
End If
If CI_mode < 0.2 And CI_mode >= 0.0 Then
    sfile_w.WriteLine("0")
End If
If CI_mode < 0.0 And CI_mode >= -0.2 Then
    sfile_w.WriteLine("-1")
End If
If CI_mode < -0.2 And CI_mode >= -0.4 Then
    sfile_w.WriteLine("-2")
End If

sfile_w.WriteLine("-----")
sfile_w.WriteLine("-----")
sfile_w.WriteLine("***** The following description is generated by the mean
value *****")
If CI_avg >= 2 Then
    sfile_w.WriteLine("10")
End If
If CI_avg < 2 And CI_avg >= 1.8 Then
    sfile_w.WriteLine("9")
End If
If CI_avg < 1.8 And CI_avg >= 1.6 Then
    sfile_w.WriteLine("8")
End If
If CI_avg < 1.6 And CI_avg >= 1.4 Then
    sfile_w.WriteLine("7")
End If

```

```

If CI_avg < 1.4 And CI_avg >= 1.2 Then
    sfile_w.WriteLine("6")
End If
If CI_avg < 1.2 And CI_avg >= 1.0 Then
    sfile_w.WriteLine("5")
End If
If CI_avg < 1.0 And CI_avg >= 0.8 Then
    sfile_w.WriteLine("4")
End If
If CI_avg < 0.8 And CI_avg >= 0.6 Then
    sfile_w.WriteLine("3")
End If
If CI_avg < 0.6 And CI_avg >= 0.4 Then
    sfile_w.WriteLine("2")
End If
If CI_avg < 0.4 And CI_avg >= 0.2 Then
    sfile_w.WriteLine("1")
End If
If CI_avg < 0.2 And CI_avg >= 0.0 Then
    sfile_w.WriteLine("0")
End If
If CI_avg < 0.0 And CI_avg >= -0.2 Then
    sfile_w.WriteLine("-1")
End If
If CI_avg < -0.2 And CI_avg >= -0.4 Then
    sfile_w.WriteLine("-2")
End If

```

```

sfile_w.WriteLine("-----
-----")

```

```

    sfile_w.WriteLine("If the description from mode and mean is too different, the
image result should be highly considered.")

```

```

sfile_w.WriteLine("-----
-----")

```

```

If CI_std >= 0.2 Then
    sfile_w.WriteLine("Since the sd is various in different area, the large

```

value may indicate a recovery stage of tree from disease or the tree just has inflection with disease!!")

End If

If CI_R < 0.99 Then

sfile_w.WriteLine("Please find another resource to determine the health situation, the given resource is not precise enough!!")

End If

'-----VI

sfile_w.WriteLine("-----
-----")

sfile_w.WriteLine("~~~~~ Simple Vegetation Index
~~~~~")

sfile\_w.WriteLine(" The VI average = " & VI\_avg)

sfile\_w.WriteLine(" The VI mode = " & VI\_mode)

sfile\_w.WriteLine(" The VI standard deviation = " & VI\_std)

sfile\_w.WriteLine(" The VI auto-correlation = " & VI\_R)

sfile\_w.WriteLine("Health Report generated by VI")

sfile\_w.WriteLine("")

sfile\_w.WriteLine("-----  
-----")

sfile\_w.WriteLine("\*\*\*\*\* The following description is generated by the mode value \*\*\*\*\*")

If VI\_mode >= 4.0 Then

sfile\_w.WriteLine("10")

End If

If VI\_mode < 4.0 And VI\_mode >= 3.6 Then

sfile\_w.WriteLine("9")

End If

If VI\_mode < 3.6 And VI\_mode >= 3.2 Then

sfile\_w.WriteLine("8")

End If

If VI\_mode < 3.2 And VI\_mode >= 2.8 Then

sfile\_w.WriteLine("7")

End If

If VI\_mode < 2.8 And VI\_mode >= 2.4 Then

sfile\_w.WriteLine("6")

```

End If
If VI_mode < 2.4 And VI_mode >= 2.0 Then
    sfile_w.WriteLine("5")
End If
If VI_mode < 2.0 And VI_mode >= 1.6 Then
    sfile_w.WriteLine("4")
End If
If VI_mode < 1.6 And VI_mode >= 1.2 Then
    sfile_w.WriteLine("3")
End If
If VI_mode < 1.2 And VI_mode >= 0.8 Then
    sfile_w.WriteLine("2")
End If
If VI_mode < 0.8 And VI_mode >= 0.4 Then
    sfile_w.WriteLine("1")
End If
If VI_mode < 0.4 And VI_mode >= 0 Then
    sfile_w.WriteLine("0")
End If
If VI_mode < 0.0 And VI_mode >= -0.4 Then
    sfile_w.WriteLine("-1")
End If
If VI_mode < -0.4 And VI_mode >= -0.8 Then
    sfile_w.WriteLine("-2")
End If
If VI_mode < -0.8 Then
    sfile_w.WriteLine("-3")
End If

sfile_w.WriteLine("-----")
sfile_w.WriteLine("-----")
sfile_w.WriteLine("***** The following description is generated by the mean
value *****")
If VI_avg >= 4.0 Then
    sfile_w.WriteLine("10")
End If
If VI_avg < 4.0 And VI_avg >= 3.6 Then
    sfile_w.WriteLine("9")

```

```

End If
If VI_avg < 3.6 And VI_avg >= 3.2 Then
    sfile_w.WriteLine("8")
End If
If VI_avg < 3.2 And VI_avg >= 2.8 Then
    sfile_w.WriteLine("7")
End If
If VI_avg < 2.8 And VI_avg >= 2.4 Then
    sfile_w.WriteLine("6")
End If
If VI_avg < 2.4 And VI_avg >= 2.0 Then
    sfile_w.WriteLine("5")
End If
If VI_avg < 2.0 And VI_avg >= 1.6 Then
    sfile_w.WriteLine("4")
End If
If VI_avg < 1.6 And VI_avg >= 1.2 Then
    sfile_w.WriteLine("3")
End If
If VI_avg < 1.2 And VI_avg >= 0.8 Then
    sfile_w.WriteLine("2")
End If
If VI_avg < 0.8 And VI_avg >= 0.4 Then
    sfile_w.WriteLine("1")
End If
If VI_avg < 0.4 And VI_avg >= 0 Then
    sfile_w.WriteLine("0")
End If
If VI_avg < 0.0 And VI_avg >= -0.4 Then
    sfile_w.WriteLine("-1")
End If
If VI_avg < -0.4 And VI_avg >= -0.8 Then
    sfile_w.WriteLine("-2")
End If
If VI_avg < -0.8 Then
    sfile_w.WriteLine("-3")
End If

```

```

sfile_w.WriteLine("-----
-----")
        sfile_w.WriteLine("If the description from mode and mean is too different, the
image result should be highly considered.")

sfile_w.WriteLine("-----
-----")
        If VI_std >= 0.4 Then
            sfile_w.WriteLine("Since the sd is various in different area, the large
value may indicate a recovery stage of tree from disease or the tree just has inflection
with disease!!")
        End If
        If VI_R < 0.99 Then
            sfile_w.WriteLine("Please find another resource to determine the health
situation, the given resource is not precise enough!!")
        End If

        sfile_w.Close()
        sfile_r.Close()
        sfile.Close()
        MsgBox("Text File is Saved")

    Catch ex As Exception
        MsgBox("Error!!" & " " & ex.ToString)
    End Try
End Sub

Private Sub Button7_Click(ByVal sender As System.Object, ByVal e As System.EventArgs)
Handles Button7.Click
    welcome.Show()
    Me.Close()

End Sub

Private Sub Button3_Click(ByVal sender As System.Object, ByVal e As System.EventArgs)
Handles Button3.Click
    Try

```

```

MsgBox("Graphical Result is in Progress.... Please Wait")
Dim abmp As New Drawing.Bitmap(CInt(c), CInt(r))
Dim cibmp As New Drawing.Bitmap(CInt(c), CInt(r))
For y = 0 To r - 1
    For x = 0 To c - 1
        If Not NDVI(x, y) = 50 Then
            If NDVI(x, y) >= 0.9 And NDVI(x, y) <= 1 Then
                abmp.SetPixel(x, y, Color.DarkBlue)
            ElseIf NDVI(x, y) >= 0.8 And NDVI(x, y) < 0.9 Then
                abmp.SetPixel(x, y, Color.Blue)
            ElseIf NDVI(x, y) >= 0.7 And NDVI(x, y) < 0.8 Then
                abmp.SetPixel(x, y, Color.LightBlue)
            ElseIf NDVI(x, y) >= 0.6 And NDVI(x, y) < 0.7 Then
                abmp.SetPixel(x, y, Color.DarkGreen)
            ElseIf NDVI(x, y) >= 0.5 And NDVI(x, y) < 0.6 Then
                abmp.SetPixel(x, y, Color.ForestGreen)
            ElseIf NDVI(x, y) >= 0.4 And NDVI(x, y) < 0.5 Then
                abmp.SetPixel(x, y, Color.LightGreen)
            ElseIf NDVI(x, y) >= 0.3 And NDVI(x, y) < 0.4 Then
                abmp.SetPixel(x, y, Color.Coral)
            ElseIf NDVI(x, y) >= 0.2 And NDVI(x, y) < 0.3 Then
                abmp.SetPixel(x, y, Color.Yellow)
            ElseIf NDVI(x, y) >= 0.1 And NDVI(x, y) < 0.2 Then
                abmp.SetPixel(x, y, Color.Cornsilk)
            ElseIf NDVI(x, y) >= 0.0 And NDVI(x, y) < 0.1 Then
                abmp.SetPixel(x, y, Color.DarkRed)
            ElseIf NDVI(x, y) >= -0.1 And NDVI(x, y) < 0.0 Then
                abmp.SetPixel(x, y, Color.Red)
            ElseIf NDVI(x, y) >= -0.2 And NDVI(x, y) < -0.1 Then
                abmp.SetPixel(x, y, Color.Pink)
            ElseIf NDVI(x, y) >= -0.3 And NDVI(x, y) <= -1 Then
                abmp.SetPixel(x, y, Color.Black)
            End If
        End If
    End If

    If Not CI(x, y) = -1 Then
        If CI(x, y) >= 2 Then
            cibmp.SetPixel(x, y, Color.DarkBlue)
        End If
    End If
End For
End For

```

```

ElseIf CI(x, y) >= 1.8 And CI(x, y) < 2 Then
    cibmp.SetPixel(x, y, Color.Blue)
ElseIf CI(x, y) >= 1.6 And CI(x, y) < 1.8 Then
    cibmp.SetPixel(x, y, Color.LightBlue)
ElseIf CI(x, y) >= 1.4 And CI(x, y) < 1.6 Then
    cibmp.SetPixel(x, y, Color.DarkGreen)
ElseIf CI(x, y) >= 1.2 And CI(x, y) < 1.4 Then
    cibmp.SetPixel(x, y, Color.ForestGreen)
ElseIf CI(x, y) >= 1.0 And CI(x, y) < 1.2 Then
    cibmp.SetPixel(x, y, Color.LightGreen)
ElseIf CI(x, y) >= 0.8 And CI(x, y) < 1.0 Then
    cibmp.SetPixel(x, y, Color.Coral)
ElseIf CI(x, y) >= 0.6 And CI(x, y) < 0.8 Then
    cibmp.SetPixel(x, y, Color.Yellow)
ElseIf CI(x, y) >= 0.4 And CI(x, y) < 0.6 Then
    cibmp.SetPixel(x, y, Color.Cornsilk)
ElseIf CI(x, y) >= 0.2 And CI(x, y) < 0.4 Then
    cibmp.SetPixel(x, y, Color.DarkRed)
ElseIf CI(x, y) >= 0.0 And CI(x, y) < 0.2 Then
    cibmp.SetPixel(x, y, Color.Red)
ElseIf CI(x, y) >= -0.2 And CI(x, y) < 0.0 Then
    cibmp.SetPixel(x, y, Color.Pink)
ElseIf CI(x, y) >= -0.4 And CI(x, y) <= -0.2 Then
    cibmp.SetPixel(x, y, Color.Black)
End If
End If

```

Next

Next

MsgBox("Save the NDVI result")

If SaveFileDialog2.ShowDialog() = DialogResult.OK Then

Dim extension As String = SaveFileDialog2.FileName

extension = \_

extension.Substring(extension.LastIndexOf(".") + 1).ToLower

Select Case extension

Case "jpg", "jpeg"

```

        abmp.Save(SaveFileDialog2.FileName,
Drawing.Imaging.ImageFormat.Jpeg)
        Case Else
            MsgBox("Wrong image format, fail to save image, Please try again.
")

            End Select
        End If
        MsgBox("Save te CI result")
        If SaveFileDialog3.ShowDialog() = DialogResult.OK Then
            Dim extension2 As String = SaveFileDialog3.FileName
            extension2 = _
            extension2.Substring(extension2.LastIndexOf(".") + 1).ToLower()

            Select Case extension2
                Case "jpg", "jpeg"
                    cibmp.Save(SaveFileDialog3.FileName,
Drawing.Imaging.ImageFormat.Jpeg)
                    MsgBox("JPEG is saved")
                Case Else
                    MsgBox("Wrong image format, fail to save image, Please try again.
")

                    End Select
            End If

            Catch ex As Exception
                MsgBox("Error!!" & " " & ex.ToString)

            End Try
        End Sub

        Private Sub Button9_Click(ByVal sender As System.Object, ByVal e As System.EventArgs)
Handles Button9.Click
            Button4.Enabled = True
            Button5.Enabled = False
            Button6.Enabled = True
            MsgBox("Select a comment point for correlation on the Left Image and Right Image.
")

```

```
l_di = True  
r_di = True  
End Sub
```

```
End Class
```

## Vegetation Health Analysis -“Basic Analysis” Code Analysis

Public Class basic

```
Dim rgbLocation As String
Dim pass As Integer = 0
Dim cal As Integer = 0
Dim lx1, ly1, lx2, ly2, rx1, ry1, rx2, ry2, tempRX, tempRY As Integer
Dim l_drawing, r_drawing, l_done, r_done As Boolean
Dim r_move As Boolean
Dim movementRX, movementRY, cnt As Integer
Dim h, w As Double
Dim c, r As Single
Dim DN_R, DN_G, DN_B, CI, CI_value As Double(,)
Dim CI_avg, CI_std, CI_mode, CI_R As Double
Dim sfile_n, dir As String
Dim scale1 As Decimal
Dim CI_lar As Single = 0
```

```
Private Sub basic_Load(ByVal sender As System.Object, ByVal e As System.EventArgs)
```

Handles MyBase.Load

```
welcome.Close()
Button6.Enabled = False
l_drawing = False
r_drawing = False
l_done = False
r_done = False
r_move = False
SaveFileDialog1.Filter = "Text Document (*.txt)|*.txt"
SaveFileDialog2.Filter = "JPEG (*.jpg)|*.jpg"
```

End Sub

```
Private Sub Button2_Click(ByVal sender As System.Object, ByVal e As System.EventArgs)
```

Handles Button2.Click

```
pass = 0
Dim ct As Integer
Try
    OpenFileDialog1.FileName = "Please input the RGB Image."
```

```

OpenFileDialog1.ShowDialog()
rgbLocation = OpenFileDialog1.FileName
Dim bmp As New Drawing.Bitmap(rgbLocation)
PictureBox1.Image = bmp
h = bmp.Height
w = bmp.Width
resizePBI(h, w)

```

```

Catch ex As Exception

```

```

    MsgBox("Error!!" & " " & ex.ToString)

```

```

    MsgBox("Please try again!")

```

```

End Try

```

```

End Sub

```

```

Private Sub Button1_Click(ByVal sender As System.Object, ByVal e As System.EventArgs)

```

```

Handles Button1.Click

```

```

Dim bmp As New Drawing.Bitmap(rgbLocation)

```

```

c = Int(lx2 / scale1 - lx1 / scale1) + 1

```

```

r = Int(ly2 / scale1 - ly1 / scale1) + 1

```

```

Try

```

```

    MsgBox("Extract Information From Images may take a few minutes, please wait
until Calculation Started.")

```

```

ReDim Preserve DN_R(c, r)

```

```

ReDim Preserve DN_G(c, r)

```

```

ReDim Preserve DN_B(c, r)

```

```

cnt = 0

```

```

For y = 0 To r - 1

```

```

    For x = 0 To c - 1

```

```

        DN_R(x, y) = bmp.GetPixel(Int(lx1 / scale1) + x, Int(ly1 / scale1) +
y).R

```

```

        DN_G(x, y) = bmp.GetPixel(Int(lx1 / scale1) + x, Int(ly1 / scale1) +
y).G

```

```

        DN_B(x, y) = bmp.GetPixel(Int(lx1 / scale1) + x, Int(ly1 / scale1) +
y).B

```

```

        cnt += 1

```

```

    Next

```

```

    cnt += 1

```

```

Next
ReDim Preserve CI(c, r)
cnt = 0
For y = 0 To r - 1
    For x = 0 To c - 1
        If DN_G(x, y) > DN_B(x, y) Then
            If Not DN_R(x, y) = 0 Then
                CI(x, y) = DN_G(x, y) / DN_R(x, y)
                cnt += 1
            Else
                CI(x, y) = -1
            End If
        End If
    Next
    cnt += 1
Next
MsgBox("Information Extracted, press 'OK' to Start the Calculation")
calculation()
Catch ex As Exception
    MsgBox("Error!!" & " " & ex.ToString)
    MsgBox("Please select file location first. ")
Finally
    MsgBox("Done")
    bmp.Dispose()
    cal = cal + 1
End Try

End Sub

Public Sub resizePBI(ByVal h, ByVal w)
    Dim TempImage As Image
    TempImage = Image.FromFile(rgbLocation)
    PictureBox1.Image = TempImage

    Dim bmp_new As New Drawing.Bitmap(PictureBox1.Image)

    Dim ref As Integer
    If bmp_new.Width > bmp_new.Height Then
        ref = bmp_new.Width

```

```

Else
    ref = bmp_new.Height
End If

scale1 = 400 / ref

Dim bm_dest As New Drawing.Bitmap(CInt(bmp_new.Width * scale1),
CInt(bmp_new.Height * scale1))
Dim gr_dest As Graphics = Graphics.FromImage(bm_dest)
gr_dest.DrawImage(bmp_new, 0, 0, bm_dest.Width + 1, bm_dest.Height + 1)
PictureBox1.Image = bm_dest

End Sub

Sub calculation()

Dim ci_n, CI_sum, CI_sum2, CI_m(6), CI_cov, CI_v As Double
Dim CI_m1, CI_m2, CI_m3, CI_m4, CI_m5, CI_m6, CI_m7 As Double
CI_m1 = CI_m2 = CI_m3 = CI_m4 = CI_m5 = CI_m6 = CI_m7 = 0
ci_n = CI_sum = CI_sum2 = CI_m(4) = CI_cov = CI_v = 0

For y = 0 To r - 1
    For x = 0 To c - 1
        If Not CI(x, y) = -1 Then
            CI_sum += CI(x, y)
            ci_n += 1
        End If
    Next
Next

CI_avg = CI_sum / ci_n
ReDim Preserve CI_value(c, r)

For y = 0 To r - 1
    For x = 0 To c - 1
        '_____CI
        If Not CI(x, y) = -1 Then
            CI_value(x, y) = (CI(x, y) - CI_avg) ^ 2
            If x + 1 <= c And y + 1 <= r Then

```

```

        CI_cov += ((CI(x, y) - CI_avg) * (CI(x, y) - CI_avg)) / ci_n
    End If
    CI_sum2 += CI_value(x, y)
End If

Next

Next

CI_v = CI_sum2 / (ci_n - 1)
CI_R = CI_cov / CI_v
CI_std = (CI_sum2 / ci_n) ^ 0.5

For y = 0 To r - 1
    For x = 0 To c - 1

        If Not CI(x, y) = -1 Then
            If CI(x, y) < CI_avg - (3 * CI_std) Then
                CI_m(0) += 1
                CI_m1 += CI(x, y)
            End If
            If CI(x, y) < CI_avg - (2 * CI_std) And CI(x, y) >= CI_avg - (3 * CI_std)
Then
                CI_m(1) += 1
                CI_m2 += CI(x, y)
            End If
            If CI(x, y) < CI_avg - CI_std And CI(x, y) >= CI_avg - (2 * CI_std) Then
                CI_m(2) += 1
                CI_m3 += CI(x, y)
            End If
            If CI(x, y) <= CI_avg - CI_std And CI(x, y) >= CI_avg + CI_std Then
                CI_m(3) += 1
                CI_m4 += CI(x, y)
            End If
            If CI(x, y) > CI_avg + CI_std And CI(x, y) <= CI_avg + (2 * CI_std) Then
                CI_m(4) += 1
                CI_m5 += CI(x, y)
            End If
            If CI(x, y) > CI_avg + (2 * CI_std) And CI(x, y) <= CI_avg + (3 * CI_std)

```

Then

CI\_m(5) += 1

CI\_m6 += CI(x, y)

End If

If CI(x, y) > CI\_avg + (3 \* CI\_std) Then

CI\_m(6) += 1

CI\_m7 += CI(x, y)

End If

End If

Next

Next

'calculation for largest mode

For i = 0 To 6

'CI

If CI\_m(i) > CI\_m(CI\_lar) Then

CI\_lar = i

End If

Next

'calculation for mode

'CI

If CI\_lar = 0 Then

CI\_mode = CI\_m1 / CI\_m(0)

ElseIf CI\_lar = 1 Then

CI\_mode = CI\_m2 / CI\_m(1)

ElseIf CI\_lar = 2 Then

CI\_mode = CI\_m3 / CI\_m(2)

ElseIf CI\_lar = 3 Then

CI\_mode = CI\_m4 / CI\_m(3)

ElseIf CI\_lar = 4 Then

CI\_mode = CI\_m5 / CI\_m(4)

ElseIf CI\_lar = 5 Then

CI\_mode = CI\_m6 / CI\_m(5)

ElseIf CI\_lar = 6 Then

```

        CI_mode = CI_m7 / CI_m(6)
    End If
End Sub

Private Sub PictureBox1_MouseUp(ByVal sender As Object, ByVal e As
System.Windows.Forms.MouseEventArgs) Handles PictureBox1.MouseUp
    If Button4.Enabled = False And l_drawing = False Then
        lx1 = e.X
        ly1 = e.Y
        l_drawing = True
    ElseIf Button4.Enabled = False And l_drawing = True Then
        PictureBox1.Refresh()
        lx2 = e.X
        ly2 = e.Y
        If lx1 > lx2 And ly1 > ly2 Then
            Dim templx, temply As Integer
            templx = lx1
            temply = ly1
            lx1 = lx2
            ly1 = ly2
            lx2 = templx
            ly2 = temply
        End If
        PictureBox1.CreateGraphics.DrawRectangle(Pens.Red, lx1, ly1, lx2 - lx1, ly2 -
ly1)

        l_drawing = False
        l_done = True
    End If

End Sub

Private Sub PictureBox1_MouseMove(ByVal sender As Object, ByVal e As
System.Windows.Forms.MouseEventArgs) Handles PictureBox1.MouseMove
    If Button4.Enabled = False And l_drawing = True Then
        PictureBox1.Refresh()
        lx2 = e.X
        ly2 = e.Y
        If lx1 < lx2 And ly1 < ly2 Then

```

```

        PictureBox1.CreateGraphics.DrawRectangle(Pens.Red, lx1, ly1, lx2 - lx1,
ly2 - ly1)
    Else
        PictureBox1.CreateGraphics.DrawRectangle(Pens.Red, lx2, ly2, lx1 - lx2,
ly1 - ly2)
    End If
End If

End Sub

```

```

Private Sub Button4_Click(ByVal sender As System.Object, ByVal e As System.EventArgs)
Handles Button4.Click
    Button4.Enabled = False
    Button6.Enabled = True
End Sub

```

```

Private Sub Button6_Click(ByVal sender As System.Object, ByVal e As System.EventArgs)
Handles Button6.Click
    Button4.Enabled = True
    Button6.Enabled = False
End Sub

```

```

Private Sub Button8_Click(ByVal sender As System.Object, ByVal e As System.EventArgs)
Handles Button8.Click
    Try
        SaveFileDialog1.ShowDialog()
        sfile_n = SaveFileDialog1.FileName

        Dim sfile As New IO.FileStream(sfile_n, IO.FileMode.CreateNew,
IO.FileAccess.ReadWrite, IO.FileShare.None)
        Dim sfile_r As New IO.StreamReader(sfile)
        Dim sfile_w As New IO.StreamWriter(sfile)
        sfile_w.WriteLine("                Thank you for using the Vegetation Health
Analysis")
        sfile_w.WriteLine("                Date:                " & Today)
        If Not TextBox1.Text = "" Then
            sfile_w.WriteLine("                Registration No.:                " & TextBox1.Text)

```

```

End If
sfile_w.WriteLine("~~~~~ Chlorophyll Vegetation Index
~~~~~")
sfile_w.WriteLine(" The CI average = " & CI_avg)
sfile_w.WriteLine(" The CI mode = " & CI_mode)
sfile_w.WriteLine(" The CI standard deviation = " & CI_std)
sfile_w.WriteLine(" The CI auto-correlation = " & CI_R)
sfile_w.WriteLine("Health Report generated by Chlorophyll Vegetation Index")
sfile_w.WriteLine("")

sfile_w.WriteLine("-----
-----")
sfile_w.WriteLine("***** The following description is generated by the mode
value *****")
If CI_mode >= 2 Then
 sfile_w.WriteLine("10")
End If
If CI_mode < 2 And CI_mode >= 1.8 Then
 sfile_w.WriteLine("9")
End If
If CI_mode < 1.8 And CI_mode >= 1.6 Then
 sfile_w.WriteLine("8")
End If
If CI_mode < 1.6 And CI_mode >= 1.4 Then
 sfile_w.WriteLine("7")
End If
If CI_mode < 1.4 And CI_mode >= 1.2 Then
 sfile_w.WriteLine("6")
End If
If CI_mode < 1.2 And CI_mode >= 1.0 Then
 sfile_w.WriteLine("5")
End If
If CI_mode < 1.0 And CI_mode >= 0.8 Then
 sfile_w.WriteLine("4")
End If
If CI_mode < 0.8 And CI_mode >= 0.6 Then
 sfile_w.WriteLine("3")
End If

```

```

If CI_mode < 0.6 And CI_mode >= 0.4 Then
 sfile_w.WriteLine("2")
End If
If CI_mode < 0.4 And CI_mode >= 0.2 Then
 sfile_w.WriteLine("1")
End If
If CI_mode < 0.2 And CI_mode >= 0.0 Then
 sfile_w.WriteLine("0")
End If
If CI_mode < 0.0 And CI_mode >= -0.2 Then
 sfile_w.WriteLine("-1")
End If
If CI_mode < -0.2 And CI_mode >= -0.4 Then
 sfile_w.WriteLine("-2")
End If

sfile_w.WriteLine("-----")
sfile_w.WriteLine("-----")
sfile_w.WriteLine("***** The following description is generated by the mean
value *****")
If CI_avg >= 2 Then
 sfile_w.WriteLine("10")
End If
If CI_avg < 2 And CI_avg >= 1.8 Then
 sfile_w.WriteLine("9")
End If
If CI_avg < 1.8 And CI_avg >= 1.6 Then
 sfile_w.WriteLine("8")
End If
If CI_avg < 1.6 And CI_avg >= 1.4 Then
 sfile_w.WriteLine("7")
End If
If CI_avg < 1.4 And CI_avg >= 1.2 Then
 sfile_w.WriteLine("6")
End If
If CI_avg < 1.2 And CI_avg >= 1.0 Then
 sfile_w.WriteLine("5")
End If

```

```

If CI_avg < 1.0 And CI_avg >= 0.8 Then
 sfile_w.WriteLine("4")
End If
If CI_avg < 0.8 And CI_avg >= 0.6 Then
 sfile_w.WriteLine("3")
End If
If CI_avg < 0.6 And CI_avg >= 0.4 Then
 sfile_w.WriteLine("2")
End If
If CI_avg < 0.4 And CI_avg >= 0.2 Then
 sfile_w.WriteLine("1")
End If
If CI_avg < 0.2 And CI_avg >= 0.0 Then
 sfile_w.WriteLine("0")
End If
If CI_avg < 0.0 And CI_avg >= -0.2 Then
 sfile_w.WriteLine("-1")
End If
If CI_avg < -0.2 And CI_avg >= -0.4 Then
 sfile_w.WriteLine("-2")
End If

sfile_w.WriteLine("-----")
sfile_w.WriteLine("-----")
sfile_w.WriteLine("If the description from mode and mean is too different, the
image result should be highly considered.")

sfile_w.WriteLine("-----")
sfile_w.WriteLine("-----")

If CI_std >= 0.2 Then
 sfile_w.WriteLine("Since the sd is various in different area, the large
value may indicate a recovery stage of tree from disease or the tree just has inflection
with disease!!")
End If
If CI_R < 0.99 Then
 sfile_w.WriteLine("Please find another resource to determine the health
situation, the given resource is not precise enough!!")

```

End If

```
sfile_w.Close()
sfile_r.Close()
sfile.Close()
MsgBox("Text File is saved")
```

```
Dim abmp As New Drawing.Bitmap(CInt(c), CInt(r))
cnt = 0
For y = 0 To r - 1
 For x = 0 To c - 1
 If Not CI(x, y) = -1 Then
 If CI(x, y) >= 2 Then
 abmp.SetPixel(x, y, Color.DarkBlue)
 ElseIf CI(x, y) >= 1.8 And CI(x, y) < 2 Then
 abmp.SetPixel(x, y, Color.Blue)
 ElseIf CI(x, y) >= 1.6 And CI(x, y) < 1.8 Then
 abmp.SetPixel(x, y, Color.LightBlue)
 ElseIf CI(x, y) >= 1.4 And CI(x, y) < 1.6 Then
 abmp.SetPixel(x, y, Color.DarkGreen)
 ElseIf CI(x, y) >= 1.2 And CI(x, y) < 1.4 Then
 abmp.SetPixel(x, y, Color.ForestGreen)
 ElseIf CI(x, y) >= 1.0 And CI(x, y) < 1.2 Then
 abmp.SetPixel(x, y, Color.LightGreen)
 ElseIf CI(x, y) >= 0.8 And CI(x, y) < 1.0 Then
 abmp.SetPixel(x, y, Color.Coral)
 ElseIf CI(x, y) >= 0.6 And CI(x, y) < 0.8 Then
 abmp.SetPixel(x, y, Color.Yellow)
 ElseIf CI(x, y) >= 0.4 And CI(x, y) < 0.6 Then
 abmp.SetPixel(x, y, Color.Cornsilk)
 ElseIf CI(x, y) >= 0.2 And CI(x, y) < 0.4 Then
 abmp.SetPixel(x, y, Color.DarkRed)
 ElseIf CI(x, y) >= 0.0 And CI(x, y) < 0.2 Then
 abmp.SetPixel(x, y, Color.Red)
 ElseIf CI(x, y) >= -0.2 And CI(x, y) < 0.0 Then
 abmp.SetPixel(x, y, Color.Pink)
 ElseIf CI(x, y) >= -0.4 And CI(x, y) <= -0.2 Then
 abmp.SetPixel(x, y, Color.Black)
```

```

 End If
 End If
 cnt += 1
Next
cnt += 1
Next

If SaveFileDialog2.ShowDialog() = DialogResult.OK Then
 Dim extension As String = SaveFileDialog2.FileName
 extension = _
 extension.Substring(extension.LastIndexOf(".") + 1).ToLower
 Select Case extension
 Case "jpg", "jpeg"
 abmp.Save(SaveFileDialog2.FileName,
Drawing.Imaging.ImageFormat.Jpeg)
 MsgBox("JPEG is saved")
 Case Else
 MsgBox("Wrong image format, fail to save image, Please try again.
")
 End Select

End If

Catch ex As Exception
 MsgBox("Error!!" & " " & ex.ToString)
End Try
End Sub

Private Sub Button7_Click(ByVal sender As System.Object, ByVal e As System.EventArgs)
Handles Button7.Click
 welcome.Show()
Me.Close()
'PictureBox1.Image.Dispose()
'Array.Clear(DN_R, c, r)
'Array.Clear(DN_G, c, r)
'Array.Clear(DN_B, c, r)

```

```
'Array.Clear(CI, c, r)
'Array.Clear(CI, c, r)
'rgbLocation = ""
'pass = 0
'cal = 0
'lx1 = ly1 = lx2 = ly2 = rx1 = ry1 = rx2 = ry2 = tempRX = tempRY = 0
'l_drawing = r_drawing = l_done = r_done = 0
'r_move = 0
'movementRX = movementRY = cnt = 0
'h = w = 0
'c = r = 0
'CI_avg= CI_std= CI_mode= CI_R =0
'scale1 = 0
'CI_lar = 0
```

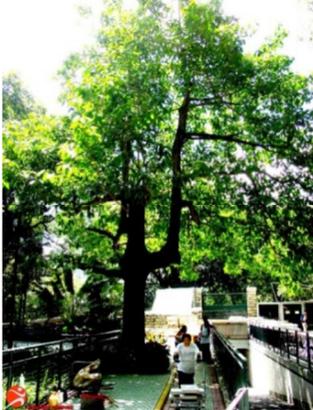
End Sub

End Class

## Trees Sample:

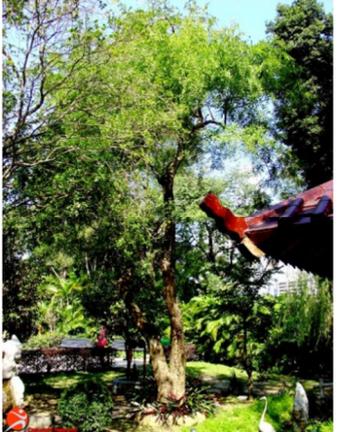
### Trees Folder:

| Background information of the tree:                                                                                                                                                                                                | Textual description of the government report and the number of data obtained and processed                                                                                                                                               | Picture of the tree                                                                  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <p>Case: LCSD CW/44</p> <p>Botanical Name: Bunya-bunya</p> <p>Location: Hong Kong Zoological and Botanical Gardens, on the slope facing Glenealy</p> <p>Last updated: 30/04/10</p> <p>Survey dated: 18/04/11</p>                   | <p>No. Photo pairs: 2</p> <p>Report Set: 5</p> <p>Textual description of the government report: Small amount of dieback twigs</p> <p>No significant defect observed</p>                                                                  |    |
| <p>Case: LCSD CW/46</p> <p>Botanical Name: Hydnocarpus anthelmintica</p> <p>Location: Hong Kong Zoological and Botanical Gardens, near the edge of the Albany Road</p> <p>Last updated: 28/04/10</p> <p>Survey dated: 18/04/11</p> | <p>No. Photo pairs: 4</p> <p>Report Set: 12</p> <p>Textual description of the government report: Small amount of dieback twigs</p> <p>Limited cavity</p> <p>Fungal fruiting bodies observed</p> <p>Sign of pest and disease observed</p> |   |
| <p>Case: LCSD CW/47</p> <p>Botanical Name: Wrightia laevis</p> <p>Location: Hong Kong Zoological and Botanical Gardens, near the edge of the Albany Road</p> <p>Last updated: 27/04/10</p> <p>Survey dated: 18/04/11</p>           | <p>No. Photo pairs: 2</p> <p>Report Set: 6</p> <p>Textual description of the government report: Small amount of dieback twigs</p> <p>Moderate cavity and decay</p> <p>Minor crack(s)</p>                                                 |  |

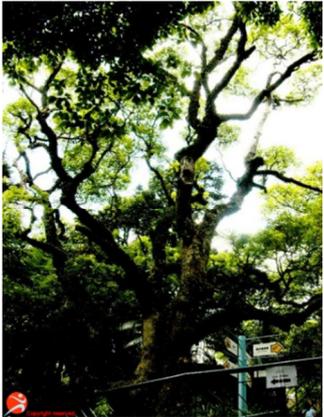
|                                                                                                                                                                                                                                       |                                                                                                                                                                                            |                                                                                      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <p>Case: LCSD CW/48<br/> Botanical Name: <i>Nauclea orientalis</i><br/> Location: Hong Kong Zoological and Botanical Gardens, near the tunnel to the Old Garden<br/> Last updated: 16/03/10<br/> Survey dated: 18/04/11</p>           | <p>No. Photo pairs: 4<br/> Report Set: 12<br/> Textual description of the government report:<br/> Limited cavity<br/> Minor decay</p>                                                      |    |
| <p>Case: LCSD CW/50<br/> Botanical Name: <i>Taxodium distichum</i><br/> Location: Hong Kong Zoological and Botanical Gardens, near the Menageries<br/> Last updated: 24/03/10<br/> Survey dated: 18/04/11</p>                         | <p>No. Photo pairs: 2<br/> Report Set: 7<br/> Textual description of the government report:<br/> Small amount of dieback twigs<br/> Severe cavity<br/> Minor decay<br/> Minor crack(s)</p> |   |
| <p>Case: LCSD CW/51<br/> Botanical Name: <i>Araucaria cunninghamii</i><br/> Location: Hong Kong Zoological and Botanical Gardens, near Upper Albert Road<br/> Last updated: 27/04/10<br/> Survey dated: 18/04/11</p>                  | <p>No. Photo pairs: 3<br/> Report Set: 12<br/> Textual description of the government report:<br/> Small amount of dieback twigs<br/> No significant defect observed</p>                    |  |
| <p>Case: LCSD CW/52<br/> Botanical Name: <i>Elaeodendron orientale</i><br/> Location: Hong Kong Zoological and Botanical Gardens, at the east border of the Fountain area<br/> Last updated: 27/04/10<br/> Survey dated: 18/04/11</p> | <p>No. Photo pairs: 2<br/> Report Set: 9<br/> Textual description of the government report:<br/> Moderate cavity<br/> Minor crack(s)</p>                                                   |  |

|                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                         |                                                                                      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <p>Case: LCSD CW/53<br/> Botanical Name: <i>Toona sinensis</i><br/> Location: Hong Kong Zoological and Botanical Gardens, near the edge of the Albany Road<br/> Last updated: 27/04/10<br/> Survey dated: 18/04/11</p>       | <p>No. Photo pairs: 1<br/> Report Set: 1<br/> Textual description of the government report:<br/> Cavity</p>                                                                                                                                                                                                             |    |
| <p>Case: LCSD CW/55<br/> Botanical Name: <i>Dillenia alata</i><br/> Location: Hong Kong Zoological and Botanical Gardens, at the edge of a path near Albany Road<br/> Last updated: 13/03/10<br/> Survey dated: 18/04/11</p> | <p>No. Photo pairs: 4<br/> Report Set: 12<br/> Textual description of the government report:<br/> Small amount of dieback twigs<br/> Moderate cavity<br/> Minor decay<br/> Minor crack(s)</p>                                                                                                                           |    |
| <p>Case: LCSD CW/56<br/> Botanical Name: <i>Cassia javanica</i><br/> Location: Hong Kong Zoological and Botanical Gardens, close to Garden Road<br/> Last updated: 24/03/10<br/> Survey dated: 18/04/11</p>                  | <p>No. Photo pairs: 2<br/> Report Set: 5<br/> Textual description of the government report:<br/> Moderate amount of dieback twigs<br/> Minor abnormal defoliation<br/> Moderate cavity<br/> Severe decay<br/> Severe crack(s)<br/> Moderate amount of fungal fruiting bodies<br/> Sign of pest and disease moderate</p> |  |

|                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                          |                                                                                      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <p>Case: LCSD CW/57</p> <p>Botanical Name: Pterocarpus indicus</p> <p>Location: Hong Kong Zoological and Botanical Gardens, inside the Aviary</p> <p>Last updated: 13/03/10</p> <p>Survey dated: 18/04/11</p>                     | <p>No. Photo pairs: 3</p> <p>Report Set: 9</p> <p>Textual description of the government report:</p> <p>Abnormal foliage colour</p> <p>Moderate amount of dieback twigs</p> <p>Moderate abnormal defoliation</p> <p>Severe cavity</p> <p>Moderate decay</p> <p>Severe crack(s)</p> <p>Small amount of fungal fruiting bodies</p> <p>Sign of pest and disease moderate</p> |    |
| <p>Case: LCSD CW/58</p> <p>Botanical Name: Lysidice rhodostegia</p> <p>Location: Hong Kong Zoological and Botanical Gardens, near Garden Road in the pump station</p> <p>Last updated: 11/03/10</p> <p>Survey dated: 18/04/11</p> | <p>No. Photo pairs: 1</p> <p>Report Set: 3</p> <p>Textual description of the government report:</p> <p>Small amount of dieback twigs</p> <p>Moderate cavity</p> <p>Minor decay</p> <p>Fungal fruiting bodies observed</p>                                                                                                                                                |  |
| <p>Case: LCSD CW/59</p> <p>Botanical Name: Ficus rumphii</p> <p>Location: Hong Kong Zoological and Botanical Gardens, at the Garden Road border of the garden</p> <p>Last updated: 11/03/10</p> <p>Survey dated: 18/04/11</p>     | <p>No. Photo pairs: 5</p> <p>Report Set: 17</p> <p>Textual description of the government report:</p> <p>Moderate amount of dieback twigs</p> <p>Moderate cavity</p> <p>Moderate decay</p> <p>Moderate crack(s)</p> <p>Fungal fruiting bodies</p>                                                                                                                         |  |

|                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                            |                                                                                      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                                             | observed                                                                                                                                                                                                                                                   |                                                                                      |
| <p>Case: LCSD CW/60</p> <p>Botanical Name: <i>Parkia javanica</i></p> <p>Location: Hong Kong Zoological and Botanical Gardens, on the edge of a path near Garden Road</p> <p>Last updated: 11/03/10</p> <p>Survey dated: 18/04/11</p>       | <p>No. Photo pairs: 1</p> <p>Report Set: 3</p> <p>Textual description of the government report:</p> <p>Small amount of dieback twigs</p> <p>Minor abnormal defoliation</p> <p>Limited cavity</p> <p>Minor decay</p> <p>Fungal fruiting bodies observed</p> |    |
| <p>Case: LCSD CW/62</p> <p>Botanical Name: <i>Sophora japonica</i></p> <p>Location: Hong Kong Zoological and Botanical Gardens, at the east border of the Fountain area</p> <p>Last updated: 19/03/10</p> <p>Survey dated: 18/04/11</p>     | <p>No. Photo pairs: 3</p> <p>Report Set: 13</p> <p>Textual description of the government report:</p> <p>Moderate cavity</p> <p>Minor crack(s)</p>                                                                                                          |   |
| <p>Case: LCSD CW/63</p> <p>Botanical Name: <i>Cinnamomum burmannii</i></p> <p>Location: Hong Kong Zoological and Botanical Gardens, at the east border of the Fountain area</p> <p>Last updated: 19/03/10</p> <p>Survey dated: 18/04/11</p> | <p>No. Photo pairs: 3</p> <p>Report Set: 9</p> <p>Textual description of the government report:</p> <p>Limited cavity</p> <p>Minor decay</p> <p>No significant defect observed</p>                                                                         |  |

|                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                          |                                                                                      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <p>Case: LCSD CW/64</p> <p>Botanical Name: <i>Ziziphus mauritiana</i></p> <p>Location: Hong Kong Zoological and Botanical Gardens, at the east border of the Fountain area</p> <p>Last updated: 14/05/10</p> <p>Survey dated: 18/04/11</p> | <p>No. Photo pairs: 2</p> <p>Report Set: 6</p> <p>Textual description of the government report: Moderate amount of dieback twigs</p> <p>Minor abnormal defoliation</p> <p>Severe cavity</p> <p>Moderate decay</p> <p>Severe crack(s)</p> |    |
| <p>Case: LCSD CW/65</p> <p>Botanical Name: <i>Araucaria heterophylla</i></p> <p>Location: Hong Kong Zoological and Botanical Gardens, facing Upper Albert Road</p> <p>Last updated: 14/05/10</p> <p>Survey dated: 18/04/11</p>             | <p>No. Photo pairs: 1</p> <p>Report Set: 3</p> <p>Textual description of the government report: Sign of pest and disease moderate</p>                                                                                                    |   |
| <p>Case: LCSD CW/67</p> <p>Botanical Name: <i>Drypetes roxburghii</i></p> <p>Location: Hong Kong Zoological and Botanical Gardens, near the octagonal pavilion</p> <p>Last updated: 16/03/10</p> <p>Survey dated: 18/04/11</p>             | <p>No. Photo pairs: 2</p> <p>Report Set: 7</p> <p>Textual description of the government report: Severe cavity</p> <p>Minor decay</p> <p>Severe crack(s)</p> <p>Moderate amount of fungal fruiting bodies</p>                             |  |

|                                                                                                                                                                                                                                   |                                                                                                                                                                                                                     |                                                                                      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <p>Case: LCSD CW/68</p> <p>Botanical Name: <i>Cinnamomum camphora</i></p> <p>Location: Hong Kong Zoological and Botanical Gardens, near the octagonal pavilion</p> <p>Last updated: 16/03/10</p> <p>Survey dated: 18/04/11</p>    | <p>No. Photo pairs: 2</p> <p>Report Set: 5</p> <p>Textual description of the government report: Small amount of dieback twigs</p>                                                                                   |    |
| <p>Case: LCSD CW/69</p> <p>Botanical Name: <i>Podocarpus neriifolius</i></p> <p>Location: Hong Kong Zoological and Botanical Gardens, near the octagonal pavilion</p> <p>Last updated: 16/03/10</p> <p>Survey dated: 18/04/11</p> | <p>No. Photo pairs: 2</p> <p>Report Set: 6</p> <p>Textual description of the government report: Small amount of dieback twigs</p> <p>Limited cavity</p> <p>Minor decay</p> <p>Sign of pest and disease moderate</p> |   |
| <p>Case: LCSD CW/77</p> <p>Botanical Name: <i>Ficus microcarpa</i></p> <p>Location: Garden Road at junction with Upper Albert Road</p> <p>Last updated: 01/04/10</p> <p>Survey dated: 18/04/11</p>                                | <p>No. Photo pairs: 1</p> <p>Report Set: 4</p> <p>Textual description of the government report: Small amount of dieback twigs</p> <p>No significant defect observed</p>                                             |  |
| <p>Case: LCSD CW/79</p> <p>Botanical Name: <i>Ficus microcarpa</i></p> <p>Location: Garden Road next to St. John's Building</p> <p>Last updated: 30/03/10</p> <p>Survey dated: 18/04/11</p>                                       | <p>No. Photo pairs: 1</p> <p>Report Set: 4</p> <p>Textual description of the government report: Small amount of dieback twigs</p> <p>Limited cavity</p> <p>Moderate decay</p>                                       |  |

|                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                         |                                                                                      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
|                                                                                                                                                                                 | <p>Minor crack(s)<br/> Small amount of fungal fruiting bodies</p>                                                                                                                                                                                                                       |                                                                                      |
| <p>Case: LCSD CW/90<br/> Botanical Name: <i>Ficus microcarpa</i><br/> Location: Central Government Offices Compound<br/> Last updated: 29/04/10<br/> Survey dated: 01/04/11</p> | <p>No. Photo pairs: 1<br/> Report Set: 4<br/> Textual description of the government report:<br/> Moderate amount of dieback twigs<br/> Limited cavity<br/> Moderate decay<br/> Moderate crack(s)<br/> Small amount of fungal fruiting bodies<br/> Sign of pest and disease observed</p> | N/A                                                                                  |
| <p>Case: LCSD CW/91<br/> Botanical Name: <i>Ficus virens</i> var. <i>sublanceolata</i><br/> Location: Battery Path<br/> Last updated: 20/06/10<br/> Survey dated: 01/04/11</p>  | <p>No. Photo pairs: 4<br/> Report Set: 15<br/> Textual description of the government report:<br/> Small amount of dieback twigs<br/> Severe cavity<br/> Moderate decay<br/> Moderate crack(s)<br/> Moderate amount of fungal fruiting bodies<br/> Sign of pest and disease observed</p> |  |
| <p>Case: LCSD CW/98<br/> Botanical Name: <i>Cassia javanica</i> var. <i>indochinensis</i><br/> Location: In the carpark of Murray Building<br/> Last updated: 15/02/10</p>      | <p>No. Photo pairs: 9<br/> Report Set: 20<br/> Textual description of the government report:<br/> Small amount of dieback twigs</p>                                                                                                                                                     |  |

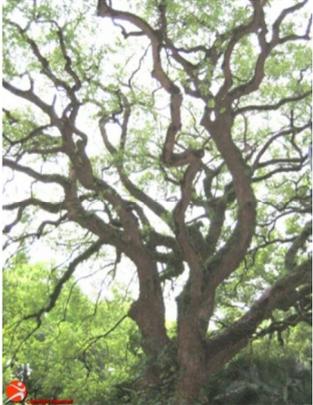
|                                                                                                                                                                                                                    |                                                                                                                                                                                       |                                                                                      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <p>Survey dated: 01/04/11</p>                                                                                                                                                                                      | <p>Severe cavity<br/>Moderate decay<br/>Moderate crack(s)<br/>Moderate amount of fungal fruiting bodies<br/>Sign of pest and disease observed</p>                                     |    |
| <p>Case: LCSD CW/99<br/>Botanical Name: <i>Tectona grandis</i><br/>Location: Central Fire Station<br/>Last updated: 17/06/10<br/>Survey dated: 01/04/11</p>                                                        | <p>No. Photo pairs: 2<br/>Report Set: 7<br/>Textual description of the government report:<br/>Small amount of dieback twigs<br/>Limited cavity<br/>No significant defect observed</p> |   |
| <p>Case: LCSD CW/100<br/>Botanical Name: <i>Ficus microcarpa</i><br/>Location: Hong Kong Park near the Hong Kong Squash Centre<br/>Last updated: 07/04/10<br/>Survey dated: 01/04/11</p>                           | <p>No. Photo pairs: 2<br/>Report Set: 6<br/>Textual description of the government report:<br/>Small amount of dieback twigs<br/>No significant defect observed</p>                    |  |
| <p>Case: LCSD CW/101<br/>Botanical Name: <i>Bombax ceiba</i><br/>Location: Hong Kong Park, on the slope at the eastern border of Hong Kong Squash Centre<br/>Last updated: 31/05/10<br/>Survey dated: 01/04/11</p> | <p>No. Photo pairs: 2<br/>Report Set: 6<br/>Textual description of the government report:<br/>Small amount of dieback twigs<br/>Limited cavity</p>                                    |  |

|                                                                                                                                                                                                                                          |                                                                                                                                                                                                                  |                                                                                      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <p>Case: LCSD CW/105<br/> Botanical Name: <i>Ficus microcarpa</i><br/> Location: Hong Kong Park, on the steep slope adjacent to the Olympic Square<br/> Last updated: 07/04/10<br/> Survey dated: 01/04/11</p>                           | <p>No. Photo pairs: 2<br/> Report Set: 7<br/> Textual description of the government report:<br/> Small amount of dieback twigs<br/> Moderate decay<br/> Minor crack(s)<br/> Sign of pest and disease - minor</p> |    |
| <p>Case: LCSD CW/106<br/> Botanical Name: <i>Bombax ceiba</i><br/> Location: Hong Kong Park, on the slope in front of the Aviary Support Centre<br/> Last updated: 07/04/10<br/> Survey dated: 01/04/11</p>                              | <p>No. Photo pairs: 3<br/> Report Set: 9<br/> Textual description of the government report:<br/> Small amount of dieback twigs<br/> Limited cavity<br/> Minor decay<br/> Moderate crack(s)</p>                   |   |
| <p>Case: LCSD CW/107<br/> Botanical Name: <i>Ficus microcarpa</i><br/> Location: Hong Kong Park near the Olympic Square<br/> Last updated: 07/04/10<br/> Survey dated: 01/04/11</p>                                                      | <p>No. Photo pairs: 1<br/> Report Set: 3<br/> Textual description of the government report:<br/> With dieback twigs</p>                                                                                          |  |
| <p>Case: LCSD CW/108<br/> Botanical Name: <i>Ficus virens</i> var. <i>sublanceolata</i><br/> Location: Hong Kong Park, near the Forsgate Conservatory and the Olympic Square<br/> Last updated: 07/04/10<br/> Survey dated: 01/04/11</p> | <p>No. Photo pairs: 3<br/> Report Set: 5<br/> Textual description of the government report:<br/> Good overall condition</p>                                                                                      |  |

|                                                                                                                                                                                                |                                                                                                                                                                                                                                             |                                                                                      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <p>Case: LCSD CW/109<br/> Botanical Name: Ficus elastica<br/> Location: Hong Kong Park near the Stand of Olympic Square<br/> Last updated: 07/04/10<br/> Survey dated: 01/04/11</p>            | <p>No. Photo pairs: 3<br/> Report Set: 8<br/> Textual description of the government report:<br/> With dieback twigs<br/> Limited cavity</p>                                                                                                 |    |
| <p>Case: LCSD CW/110<br/> Botanical Name: Ficus microcarpa<br/> Location: Hong Kong Park, at south corner of Forsgate Conservatory<br/> Last updated: 07/04/10<br/> Survey dated: 01/04/11</p> | <p>No. Photo pairs: 3<br/> Report Set: 7<br/> Textual description of the government report:<br/> With dieback twigs<br/> Moderate decay<br/> Minor crack(s)<br/> Fungal fruiting bodies observed<br/> Sign of pest and disease moderate</p> |   |
| <p>Case: LCSD CW/111<br/> Botanical Name: Mangifera indica<br/> Location: Hong Kong Park near the end of the lake<br/> Last updated: 17/06/10<br/> Survey dated: 01/04/11</p>                  | <p>No. Photo pairs: 3<br/> Report Set: 9<br/> Textual description of the government report:<br/> With dieback twigs<br/> Minor decay</p>                                                                                                    |  |

|                                                                                                                                                                                  |                                                                                                                                                                                                                        |                                                                                      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <p>Case: LCSD CW/112<br/> Botanical Name: Ziziphus jujuba<br/> Location: Hong Kong Park near the restaurant<br/> Last updated: 28/05/10<br/> Survey dated: 01/04/11</p>          | <p>No. Photo pairs: 3<br/> Report Set: 8<br/> Textual description of the government report:<br/> Moderate amount of dieback twigs<br/> Abnormal defoliation<br/> Moderate decay<br/> Moderate cavity<br/> Crack(s)</p> |    |
| <p>Case: LCSD CW/113<br/> Botanical Name: Ziziphus jujuba<br/> Location: Hong Kong Park near the restaurant<br/> Last updated: 28/05/10<br/> Survey dated: 01/04/11</p>          | <p>No. Photo pairs: 1<br/> Report Set: 3<br/> Textual description of the government report:<br/> Moderate amount of dieback twigs<br/> Abnormal defoliation<br/> Moderate decay<br/> Moderate cavity<br/> Crack(s)</p> |   |
| <p>Case: LCSD CW/114<br/> Botanical Name: Ficus microcarpa<br/> Location: Hong Kong Park near the Museum of Tea Ware<br/> Last updated: 28/05/10<br/> Survey dated: 01/04/11</p> | <p>No. Photo pairs: 2<br/> Report Set: 9<br/> Textual description of the government report:<br/> Moderate amount of dieback twigs<br/> Abnormal defoliation<br/> Moderate cavity<br/> Moderate decay<br/> Crack(s)</p> |  |
| <p>Case: LCSD CW/121<br/> Botanical Name: Ginkgo biloba<br/> Location: Chater Garden<br/> Last updated: 18/06/10</p>                                                             | <p>No. Photo pairs: 2<br/> Report Set: 9<br/> Textual description of the government report:<br/> Good overall condition</p>                                                                                            |  |

|                                                                                                                                                                            |                                                                                                                                                                                                                                                           |                                                                                      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <p>Survey dated: 18/04/11</p>                                                                                                                                              |                                                                                                                                                                                                                                                           |                                                                                      |
| <p>Case: LCSD CW/122<br/> Botanical Name: Artocarpus altilis<br/> Location: Chater Garden<br/> Last updated: 18/06/10<br/> Survey dated: 18/04/11</p>                      | <p>No. Photo pairs: 2<br/> Report Set: 19<br/> Textual description of the government report:<br/> Cavity<br/> No significant defect observed</p>                                                                                                          |    |
| <p>Case: LCSD CW/123<br/> Botanical Name: Ficus benjamina<br/> Location: Chater Garden<br/> Last updated: 15/12/09<br/> Survey dated: 18/04/11</p>                         | <p>No. Photo pairs: 2<br/> Report Set: 14<br/> Textual description of the government report:<br/> Small amount of dieback twigs<br/> Moderate decay<br/> Moderate crack(s)<br/> Fungal fruiting bodies observed<br/> Sign of pest and disease - minor</p> |   |
| <p>Case: LCSD E/27<br/> Botanical Name: Mimusops elengi<br/> Location: Victoria Park, near North Changing Room<br/> Last updated: 18/06/10<br/> Survey dated: 18/04/11</p> | <p>No. Photo pairs: 16<br/> Report Set: 17<br/> Textual description of the government report:<br/> Good overall condition</p>                                                                                                                             |  |

|                                                                                                                                                                                                       |                                                                                                                                                  |                                                                                      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <p>Case: LCSD YTM/49<br/> Botanical Name: Cinnamomum camphora<br/> Location: Kowloon Park, on the slope opposite to No. 38, Haiphong Road<br/> Last updated: 30/03/10<br/> Survey dated: 20/03/11</p> | <p>No. Photo pairs: 2<br/> Report Set: 19<br/> Textual description of the government report:<br/> Cavity<br/> No significant defect observed</p> |    |
| <p>Case: LCSD YTM/50<br/> Botanical Name: Cinnamomum camphora<br/> Location: Kowloon Park, on the slope opposite to No. 35, Haiphong Road<br/> Last updated: 30/11/09<br/> Survey dated: 18/04/11</p> | <p>No. Photo pairs: 2<br/> Report Set: 17<br/> Textual description of the government report:<br/> Good overall condition</p>                     |   |
| <p>Case: LCSD YTM/60<br/> Botanical Name: Albizia lebbek<br/> Location: Kowloon Park, at the North-eastern edge of the Colour Garden<br/> Last updated: 16/11/09<br/> Survey dated: 18/04/11</p>      | <p>No. Photo pairs: 1<br/> Report Set: 7<br/> Textual description of the government report:<br/> Cavity<br/> No significant defect observed</p>  |  |
| <p>Case: LCSD YTM/61<br/> Botanical Name: Albizia lebbek<br/> Location: Kowloon Park, on the edge of footpath outside the Colour Garden<br/> Last updated: 16/11/09<br/> Survey dated: 18/04/11</p>   | <p>No. Photo pairs: 1<br/> Report Set: 4<br/> Textual description of the government report:<br/> Cavity<br/> No significant defect observed</p>  |  |

|                                                                                                                                                                                                      |                                                                                                                                                 |                                                                                      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <p>Case: LCSD YTM/84<br/> Botanical Name: <i>Ficus microcarpa</i><br/> Location: Kowloon Park, outside Chinese Garden<br/> Last updated: 30/11/09<br/> Survey dated: 18/04/11</p>                    | <p>No. Photo pairs: 2<br/> Report Set: 9<br/> Textual description of the government report:<br/> Good overall condition</p>                     |    |
| <p>Case: LCSD YTM/85<br/> Botanical Name: <i>Ficus microcarpa</i><br/> Location: Kowloon Park, outside Chinese Garden<br/> Last updated: 30/11/09<br/> Survey dated: 18/04/11</p>                    | <p>No. Photo pairs: 2<br/> Report Set: 20<br/> Textual description of the government report:<br/> Good overall condition</p>                    |   |
| <p>Case: LCSD YTM/86<br/> Botanical Name: <i>Ficus microcarpa</i><br/> Location: Kowloon Park, inside Chinese Garden<br/> Last updated: 09/12/09<br/> Survey dated: 18/04/11</p>                     | <p>No. Photo pairs: 1<br/> Report Set: 6<br/> Textual description of the government report:<br/> Good overall condition</p>                     |  |
| <p>Case: LCSD YTM/88<br/> Botanical Name: <i>Plumeria rubra</i> cv. <i>Acutifolia</i><br/> Location: Kowloon Park, inside Chinese Garden<br/> Last updated: 16/11/09<br/> Survey dated: 18/04/11</p> | <p>No. Photo pairs: 2<br/> Report Set: 7<br/> Textual description of the government report:<br/> Cavity<br/> No significant defect observed</p> |  |

|                                                                                                                                                                               |                                                                                                                               |                                                                                    |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| <p>Case: LCSD YTM/89<br/>Botanical Name: Ficus<br/>microcarpa<br/>Location: Kowloon Park,<br/>inside Chinese Garden<br/>Last updated: 16/11/09<br/>Survey dated: 18/04/11</p> | <p>No. Photo pairs: 3<br/>Report Set: 12<br/>Textual description of<br/>the government report:<br/>Good overall condition</p> |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|