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Oil Palm Health Estimation Using Low Altitude Remote Sensing

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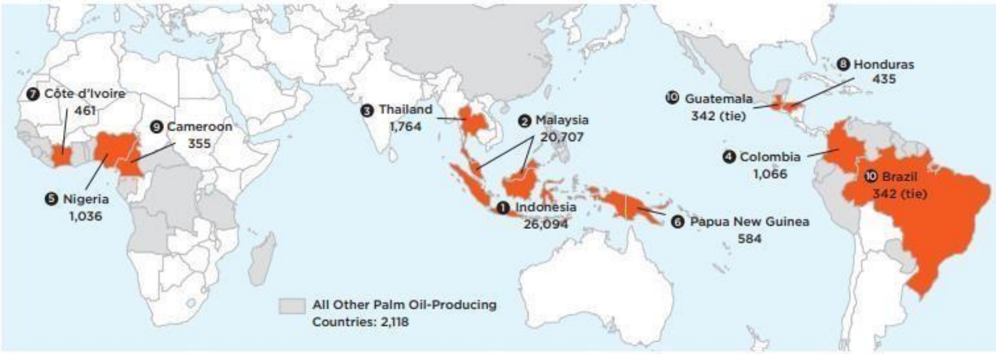
Abstract. Unmanned Aerial Vehicle (UAV), Unmanned Aerial System (UAS), or drones are small autonomous airplane that does not need a pilot on board (CAR, 2016). UAS is increasingly becoming widely known for its capability to bring many innovations to the world. UAVs are also utilized as geospatial technology tools, providing benefits to environmental monitoring. Therefore, this study aims to estimate oil palm health using UAV payload remote sensing compact sensors. Two remote sensing compact sensors were used in this study which is visible (RGB) and Near Infra-red (NIR) to get the reflectance curve of the oil palm. Analysing oil palm condition from reflectance curve by using a spectroradiometer are the first objective while analysing extraction oil palm condition by using sensors is the second objective. Some policy and regulation were involved to follow the guideline that has been implemented by the agency. Instead of using a UAV, the spectroradiometer was used to visualize the spectral response curve of an oil palm. As a result, the oil palm condition at study area is in healthy condition where the reflectance curve for multispectral compact sensors (0.84) and spectrometer (0.82) which are above healthy indicator (0.5) whereby favourable to determine the growth stability of oil palm trees. As a summary, these techniques are potential to support the development of modernization technology in environmental monitoring for oil palm plantations and give an alternative way to give good result on oil palm health condition.

Keywords: Unmanned Aerial Vehicle (UAV), Oil Palm Health, Regulation, Climate Change

1. Introduction

The oil palm or in scientific name as *Elais Guineensis* is a common plant that grows in this country for industrial production such as oil, food, and others. To generate adequate production and maintain long-term health, oil palms need enough nutrients in the proper amounts. While the soil does contain certain nutrients that the oil palm needs to thrive and be resourceful, these nutrients are frequently inadequate.

Nevertheless, as evidenced by sample field testing and growth in plant production in the oil palm industry, fertilisers are crucial for economic productivity. [1]. Considering Malaysia is one of the world's top two producers of oil palm, it is widely used to cook fast food, fuel vehicles, and trucks, and make hundreds of common household items, from beauty products to baked products.



Palm oil is an ingredient in thousands of products on the market today, from instant noodles to cookies to soaps. While Indonesia and Malaysia lead the world in palm oil production, other countries hope to increase their market share. Thus forests and other tropical ecosystems elsewhere in Asia, as well as in Africa and Latin America, are at risk for development.

Figure 1. Top 10 Palm Oil-Producing Countries, 2017 (Thousands of Tons of Oil Produced)

Unfortunately, existing techniques of producing palm oil frequently result in the eradication of carbon-rich tropical forests and peatlands, making it a significant contribution to global warming. [2,3,4]. The palm oil business needs to reform, according to experts in agriculture, biology, and even technology, if we are to safeguard biodiversity, preserve our natural resources, and lessen the danger of climate change. [5,6]. Leaf analysis data are often compared to predefined critical levels to evaluate whether an oil plant has a nutritional shortage. [7].

With the fast advancement of UAV technology and its applications in agriculture, many researchers may now own a low-cost UAV and do data collecting with a low budget, fewer employees, less time, and more accurate results in Malaysia [8,9]. Furthermore, UAVs have the capability of flying at a very low altitude and capturing a very high-resolution image as compared to typical digital aerial images captured from the air.

Furthermore, Remote Sensing (RS), often known as earth observation, is the process of gathering information about items or places on the Earth's surface without coming into physical touch with the object or area. Humans do this activity using their eyes, sense of smell, or hearing.; so, remote sensing is a day-to-day business for people. It is a great approach for monitoring the state and progress of oil palm development, as well as assisting in decision-making for effective plantation management. [10]. Besides, this method was used in various applications of oil palm plantation tracking, including land cover mapping, automated tree counting, shift identification, age estimate, above-ground biomass (AGB) estimation, pollution estimation, pest and disease detection, and yield estimation [11,12].

As the usage of drones in agriculture has risen in recent years, we need to ensure that the drone rule and regulations are being implemented in our research. In Malaysia, there is several governments who oversees the aircraft, permit, and license, license product. CAAM, or the Civil Aviation Authority of Malaysia, is tasked with contributing to the growth of Malaysia's civil aviation technical sector while also adhering to ICAO standards to ensure aviation is safe, secure, and efficient. Furthermore, CAAM has also issued Civil Aviation Directive 6011 Part (V) Special UAS Project, Agricultural UAS Operations (AGR), and other publications. CAAM would like to underline that any Unmanned Aircraft System (UAS) or more familiarly known as Drone flying operations is now regulated by Civil Aviation Regulation 2016 (MCAR) Regulation 140-144. Other governments involved in UAV regulation include Malaysia's Surveying and Mapping Department (JUPEM), Malaysia's Communications and Multimedia Commission (MCMC), Malaysia's Office of the Chief Government Security Officer (CGS0), and others.

Hence, the aim of this research project is to estimate the oil palm health using UAV payload remote sensing compact sensors at Bukit Kledek Estate, Melaka. In order to accomplish the project, there are objectives that need to be done which are to extract oil palm condition by using sensors and UAV platform and to assess oil palm condition from reflectance curve by using a spectroradiometer. This project will employ geomatics techniques such as photogrammetry and remote sensing to evaluate and monitor palm oil tree health utilizing a multispectral camera payload on a UAV and a spectroradiometer.

2. Methods and Aspects

2.1 Study Area

The chosen study area is Bukit Kledek Estate, Gemencheh Negeri Sembilan (see Figure 1). It is one of the plantations from Tradewinds Plantation Berhad with an area of 865.80 ha with approximately 100 workers.

2.2 Data Acquirement

Data acquirement has involved 3 types of tools which are multispectral camera, GPS tool, and spectroradiometer. Before flying the UAV, ground control point (GCP) needs to be established first. About 20 samples of the oil palm leaves were obtained for the oil palm reflectance curve. Topcon GR-5 model was used during GNSS measurement in real-time kinematic for approximately one hour. 12 ground control points were established during the measurement

Figure 2. Establishment of GCP and point marking

Two sensors were used during the measurements which are RGB and NIR band sensors. Following mounting the multispectral band to the UAV, it will be flown to obtain images of the oil palm plants. The drone utilised in the measurement was a DJI Phantom 4 Advanced Model, which employed a multi-rotor system. The flight plan was done by using DJI GO software where the overlapping between the images is about 70 percent front lap and 65 percent for the side lap. The height of the drone during the flight is approximately 150 meters.

20 Samples are being collected from the 17th frond of oil palm leaves. Frond 17 was chosen because good pruning is necessary for the most efficient use of fertilisers and to create an easily accessible plantation. Therefore, the palms should retain the maximum number of leaves. More fronds are preferable for productivity when trimming (palms can capture more sunlight and easy to cut).

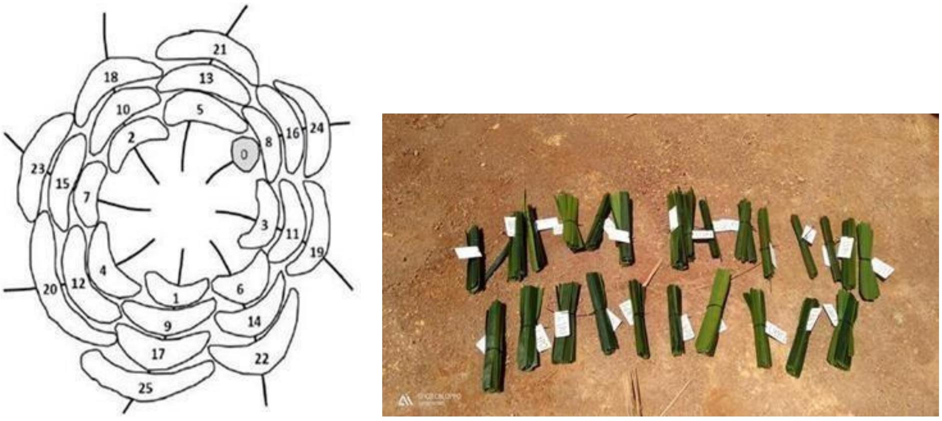


Figure 3. Picture of frond 17 and 20 samples of oil palm leaves collected

2.3 Methodology

2.3.1 Figure 4 show the methodology for this research project. Three sections are being prepared

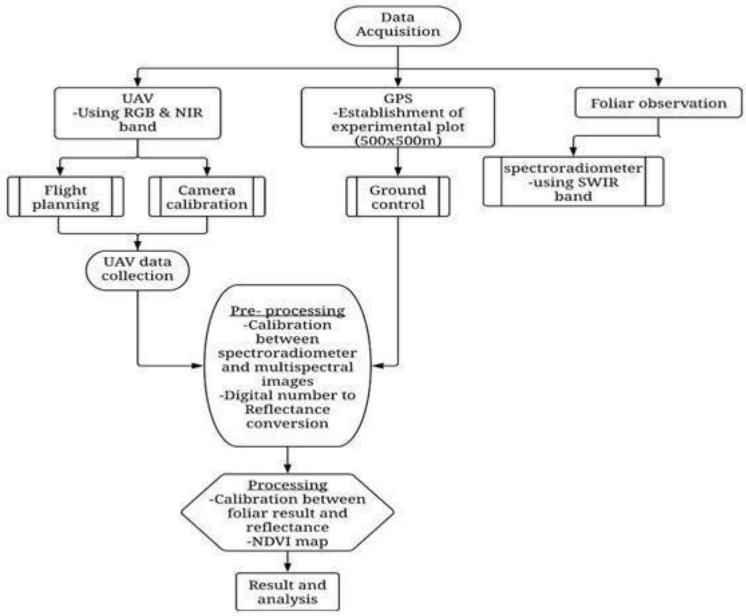


Figure 4. Flowchart of methodology

2.4 Data Pre-processing and processing

UAV images data for RGB and NIR band were processed using PIX4D software to generate orthophoto for the RGB band and NIR band. Layer stacking were done after process of orthophoto generation with the radiometric correction. Reflectance graph of oil palm leaves sample were processed automatically using spectroradiometer by per sample. After that, all the reflectance graph were compiled using Microsoft Excel to produce the graph. Besides that, Vegetation Indices Map (NDVI) were processed using ENVI software.

3. Result and Discussions

3.1 Multispectral Images and Spectroradiometer Spectral Reflectance Graph

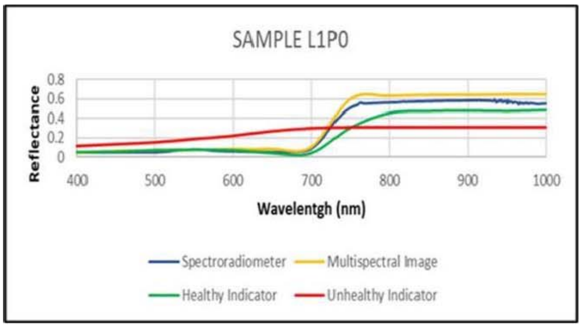


Figure 5 Reflectance graph for sample L1P0

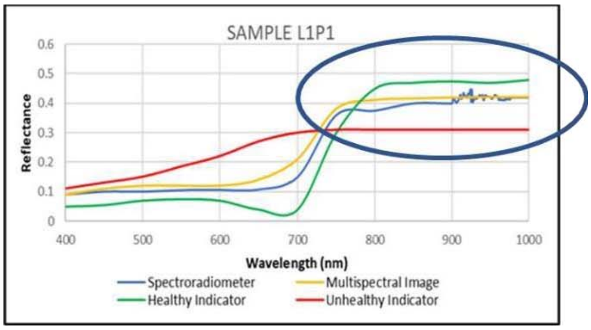


Figure 6 Reflectance graph for sample L1P1

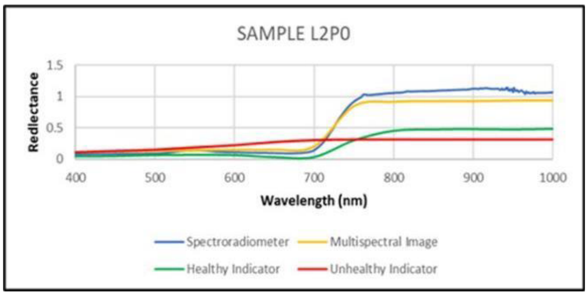


Figure 7 Reflectance graph for sample L2P0

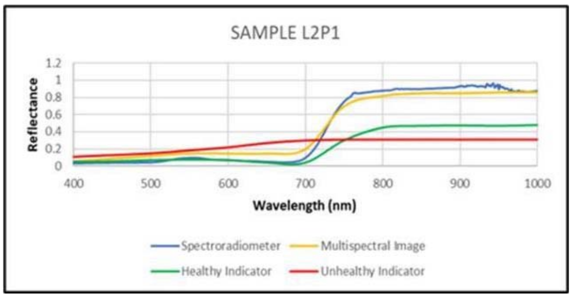


Figure 8 Reflectance graph for sample L2P1

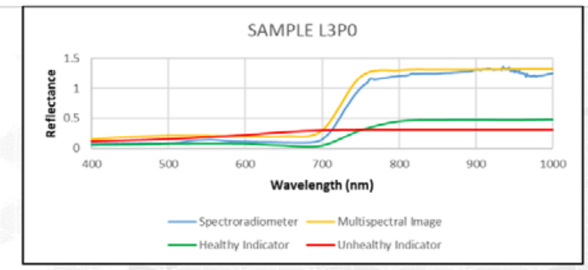


Figure 9 Reflectance graph for sample L3P0

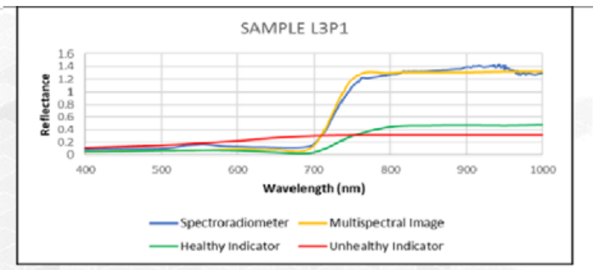


Figure 10 Reflectance graph for sample L3P1

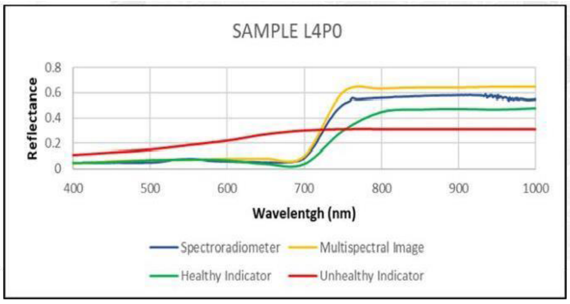


Figure 11 Reflectance graph for sample L4P0

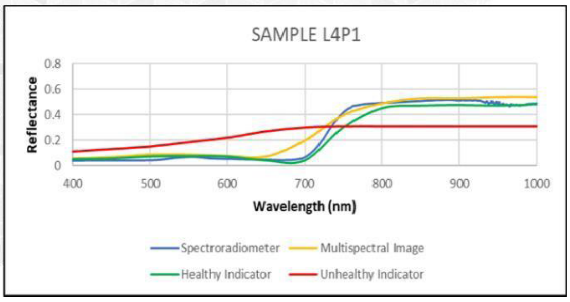


Figure 12 Reflectance graph for sample L4P1

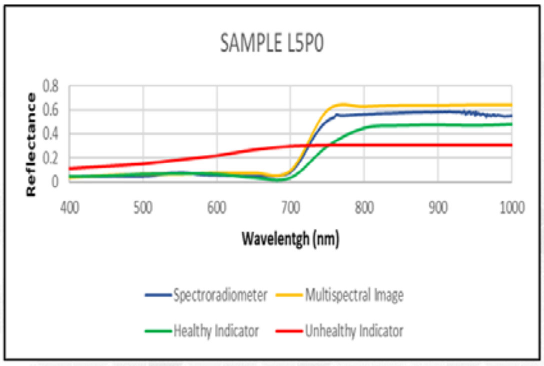


Figure 13 Reflectance graph for sample L5P0

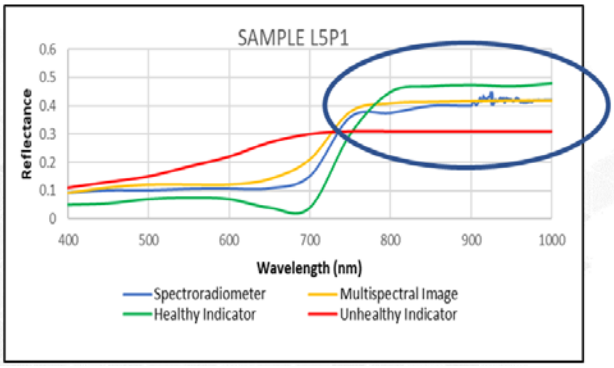


Figure 14 Reflectance graph for sample L5P1

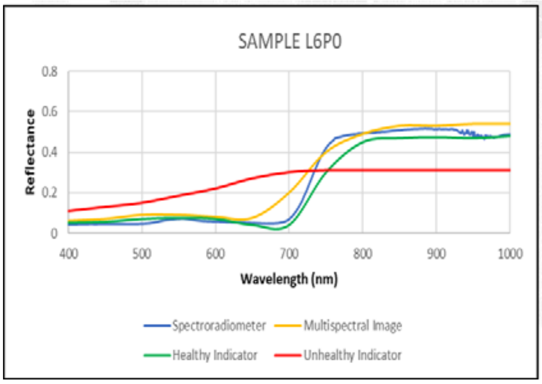


Figure 15 Reflectance graph for sample L6P0

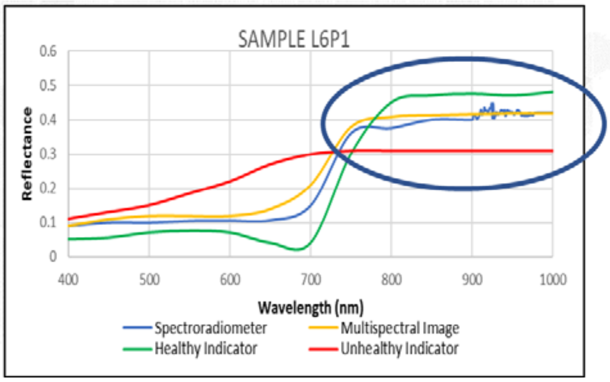
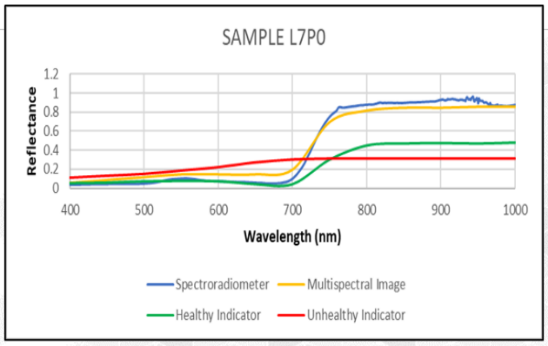


Figure 16 Reflectance graph for sample L6P1



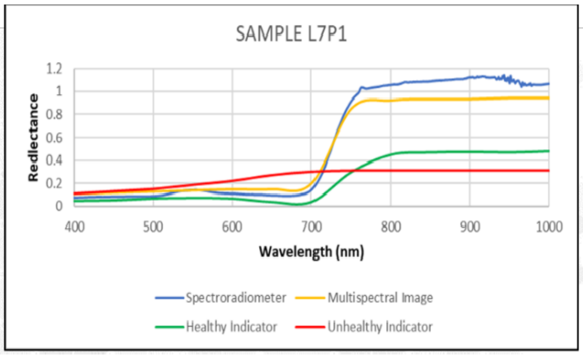
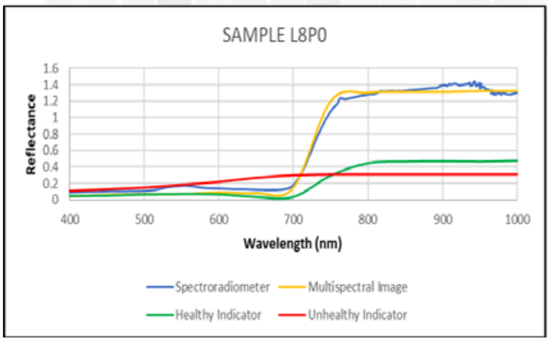


Figure 17 Reflectance graph for sample L7P0 **Figure 18** Reflectance graph for the sample L7P1



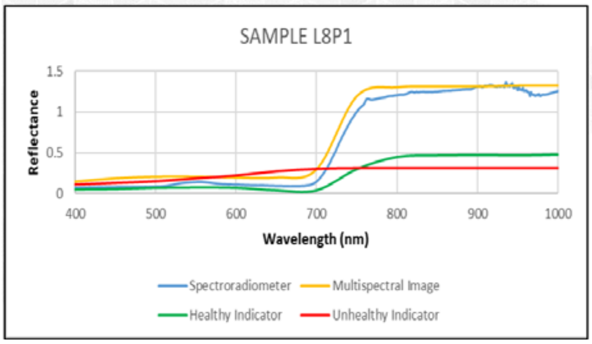
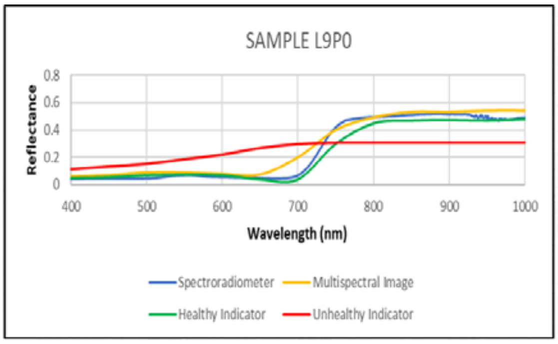


Figure 19 Reflectance graph for sample L8P0 **Figure 20** Reflectance graph for sample L8P1



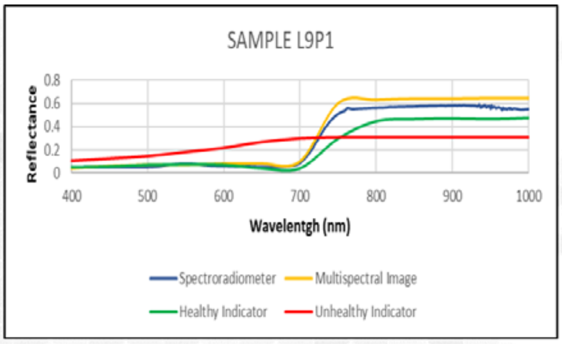


Figure 21 Reflectance graph for sample L9P0 **Figure 22** Reflectance graph for sample L9P1

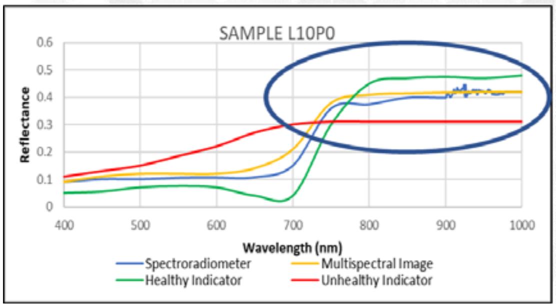


Figure 23 Reflectance graph for sample L10P0

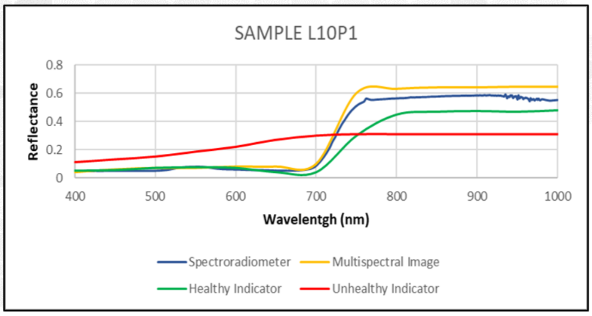


Figure 24 Reflectance graph for sample L10P1

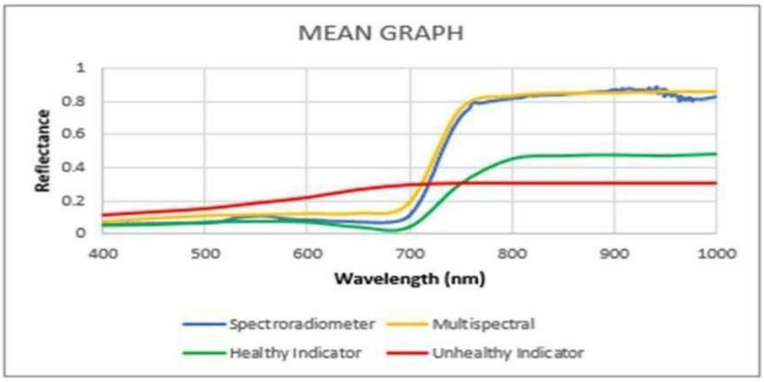


Figure 25 Mean reflectance graph for the samples

From all these graphs, the reflectance value for the two types of data acquisition is similarly same between 0.05 to 0.2 for the green band. For NIR band is from 700-1000nm where these two data show the same valuation trend which indicates the condition of the oil palm tree. From all the figures, it can be said that the sample for L1P1, L5P1, L6P1, and L10P0 shows slightly below the healthy indicator whereas others are above healthy condition where the reflectance value is above 0.5.

Moreover, based on the graph in figure 25 above, it can be concluded there is a slight difference in reflectance between the spectroradiometer and the UAV. It shows that UAV data can be used for the detection of the reflectance of healthy and non-healthy leaves. The condition of plants may be measured using the NIR band at wavelengths ranging from 750nm to 1000nm. Usually, healthy plants absorb most of the visible light while reflecting a large amount of the near-infrared light. Unhealthy plants do the opposite. Value for reflectance is by percentage or from value 0 to 1 which defines the condition of the vegetation.

Based on Figure 25, we can state that the mean graph for all the samples is above the healthy indicator which indicates the trees are in good condition. In general, it can be said that the trend reflectance graph between the multispectral images and spectroradiometer observation indicates the same pattern where the NIR light reflects more at the wavelength 750nm to 1000nm. Overall, the condition of the palm oil tree at Bukit Kledek Estate, Melaka is in good and healthy condition.

3.2 Normalized Difference Vegetation Index (NDVI)

Besides, from the NDVI map shown in figure 11, it can be seen that the majority of oil palm tree shows greener color which indicates the high reflectance of NIR-light which shows the oil palm tree in the area is in healthy condition. A healthy plant will reflect few in red light and reflect more in NIR light to produce a large NDVI value while an unhealthy will reflect more in red light and reflect less in NIR light to produce a small NDVI value.

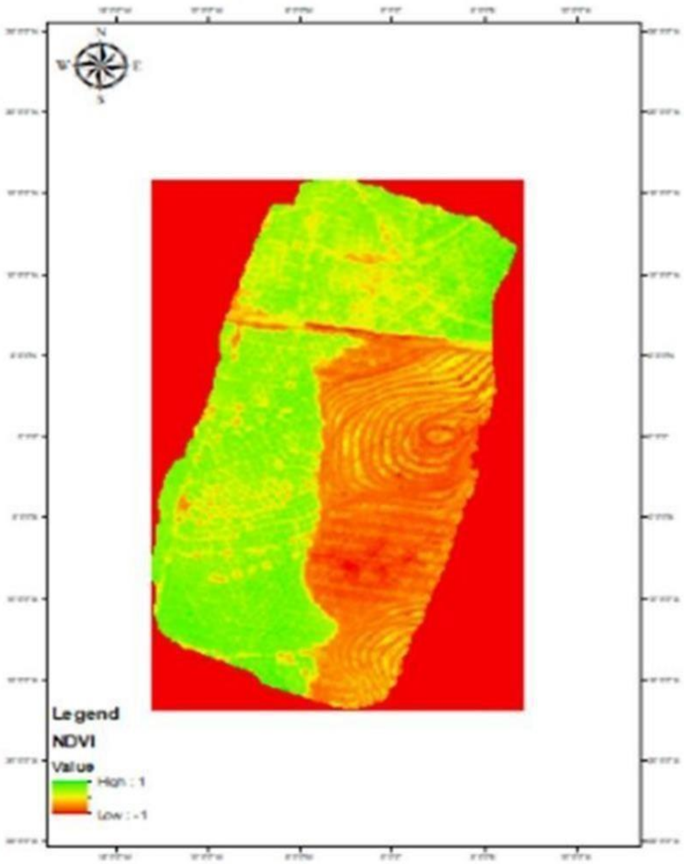


Figure 26 NDVI at Bukit Kledek Estate

4. Conclusion

It is possible to infer that the study's aim and objective have been accomplished. When the reflectance of multispectral images displays the same trend as the reflectance of a spectroradiometer, the usage of a spectroradiometer to validate the spectral reflectance from multispectral images is acceptable. When compared to manned airplanes and satellite imaging, UAVs' capacity to take higher quality aerial photographs at a substantially cheaper cost can supply oil palm growers with more accurate data. Hence, it shows that UAV data can be used for the detection of the reflectance of healthy and non-healthy leaves. Therefore, the use of multispectral camera payload on the UAV in identifying the condition of the palm oil tree can be accepted.

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