Use of Unmanned Aerial Vehicles (UAVs) in Oil Palm Plantations

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We are the second largest producer of palm oil in the world after Indonesia. There are 4.49 million hectares of land in Malaysia under oil palm cultivation. Malaysia produces 17.73 million tonnes of palm oil and 2.13 tonnes of palm kernel oil. The palm oil industry also provides employment for over half a million people.

Precision Farming (PF) is about managing variations in the field accurately to produce an optimum yield. It involves data collection, data processing, and data analysis to produce field variability maps, a support system for decisions and proper management practice. Short revisit times are also necessary to allow a prompt response to field conditions. But it is time consuming to acquire larger data-sets to assess field variability, especially in larger farms such as in an oil palm estate.

Satellite images and aerial photos are widely used for crop monitoring and yield prediction. However, the use of satellite images is limited as images are not always available when needed and sometimes, the resolution of available images is too low to be of use. In addition, a manned airborne platform has disadvantages on operational complexity, high costs and lengthy product delivery.

Recently, Unmanned Aerial Vehicles (UAVs) are being used as an alternative platform for this purpose. UAVs carry many types of sensors, such as multispectral, hyperspectral, Near Infrared (NIR), thermal, microwave and laser scanners. It is an ideal platform for PF operation since it can provide high spatial resolution for up to centimetres, as well as having low operational costs and real-time data acquisition.

There are two broad platforms for UAVs, namely rotary wing and fixed wing. Rotary wing UAVs have the advantage of being able to take off and land vertically. However, they have a short flight range due to mechanical complexity and shortened battery power. Fixed wing UAVs have the advantage of being able to fly at high speeds for long durations with simpler aerodynamic features. Some do not require a runway or launcher for take-off and landing; they have a flight duration of 1-2 hours, which allows an area of 50-300 hectares to be photographed per flight.

Currently, besides the availability of sensors for data acquisition, data analysis methods and algorithm development are improving rapidly. The most common indices used are the Green - Red Ratio Vegetation Index (GRVI), Normalised Green - Red Difference Index (NGRDI), Leaf Area Index (LAI), Normalised Difference Vegetation Index (NDVI), and Visible Vegetation Index (VVI). However, the capability of these indices, which are developed using multispectral images, is limited when compared to hyperspectral images since, normally, it only has five bands.

Hyperspectral images contain many continuous spectral bands to record spectral responses of materials

Figure 1: Turnigy 9XR octocopter UAV used for ganoderma detection, available at Department of Biological and Agricultural Engineering, Faculty of Engineering, Universiti Putra Malaysia

and so allow more information to be extracted, which provide for various applications, such as vegetation cover condition, plant cell structure condition and plant structural water content as well as some other valuable information. Generally, healthy vegetation covers signify high reflectance in near infrared and low reflectance in the visible region of the electromagnetic spectrum.

The most common applications of UAV in oil palm plantation can be categorised into four major activities: Surveillance, mapping, monitoring and spraying.

Before the opening of new areas for oil palm plantations, operators can first make a survey and map fields from the air, showing terrain and drainage. This is to facilitate decisions on the provision and financing of projects to be implemented. The same process is also applied during replanting programmes. Furthermore, monitoring land work progress during planting is more practical using UAVs instead of conventional methods which are more laborious.

Digital maps derived from UAV images can be used to create an inventory of assets in a plantation, such as roads, number of trees, culvert, ramp, office, etc. They are useful tools for planning, as well as for cost projections such as for fertiliser and pesticide budgeting, profits projection, road maintenance, plantation management, environmental management and many other applications.

Furthermore, variable rate application maps can be generated using spectral data to understand the nutrient uptake in a field. Therefore, by applying the appropriate amount of fertiliser, it reduces costs and increases yields.

UAVs can also be used to monitor the health status of oil palms and keep tabs on disease, water stress and nutrient deficiency. This inspection work can be done by utilising various sensors and vegetative indices. Recently, many investigations were carried out to demonstrate the hyperspectral capability in early detection of plant diseases as well as ganoderma disease detection in oil palm plantation. This approach makes crop inspection much easier and saves time. In the areas of labour shortages and improper infrastructure systems, especially steep slopes, UAVs can be employed to spray fertiliser and pesticide. Urea foliar spraying can raise the percentage of nitrogen in leaves and even the quantity used is smaller than that used by sows. The spraying of pesticides can overcome the problem of insects, especially if the spread of insects cannot be controlled manually.

While the ability of data analysis methods and algorithm development keep growing, the use of UAV in oil palm plantations is still not without challenges. Most UAVs face restrictions in terms of weather vagaries, such as wind and rain. Furthermore, the capability of the UAV sensors is limited in that it cannot fly into canopies, so information below canopies, such as soil properties cannot be retrieved directly.

The application of UAVs should be expanded to many other activities in the future, for example, replacing the normal pollination process when there is a reduction in number of insects (due to disease outbreaks) which help to pollinate oil palms.

Hopefully, UAVs can also help overcome labour shortage by being used for major daily tasks done by plantation workers, such as front pruning, counting the number of Fresh Fruit Bunches (FFBs), identifying mature

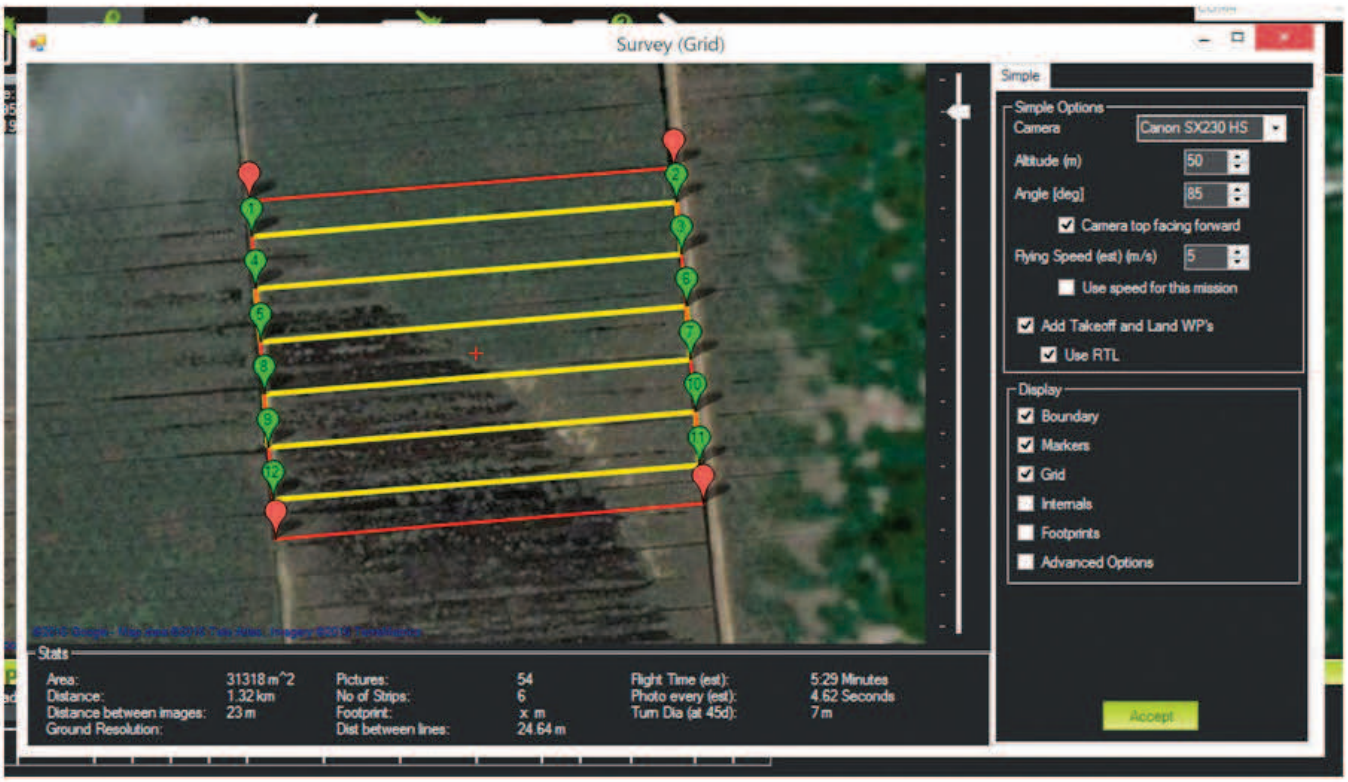

Figure 2: Waypoints created in a mission planner software before flying a UAV

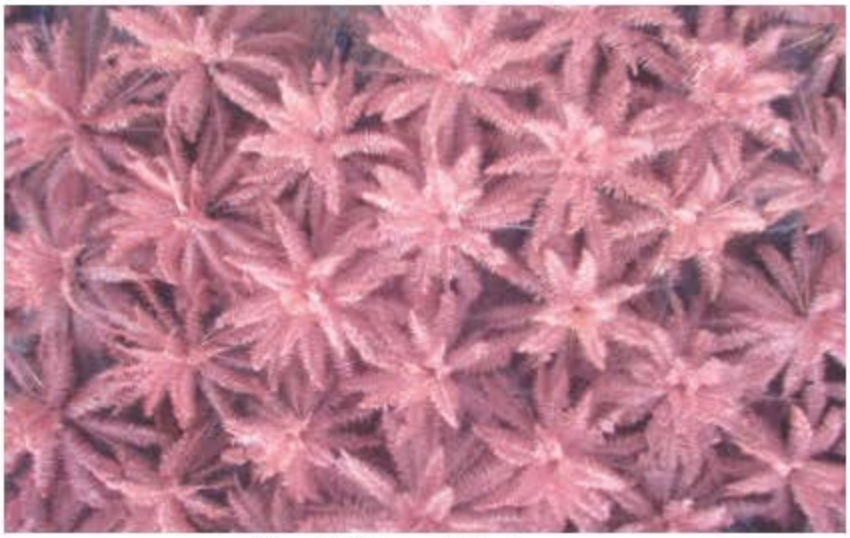

Figure 3: NIR image of oil palm canopy

FFBs, harvesting and collecting the FFBs. Despite current limitations and challenges, technology UAVs offer a brighter future for the oil palm industry and help increase yield production as well as provide better plantation management. ■

Author's Biodata

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IEM DIARY OF EVENTS

Title: 2nd Mentors Workshop 2017: "Log Book Training Scheme – Guidelines for Mentors" - POSTPONED FROM 9 SEPTEMBER 2017

21 October 2017
Organised by: Standing Committee on Admission and Practical Training
Time : 8.30 a.m. - 12.30 p.m.
CPD/PDP : 3.5

Title: 32nd Annual General Meeting of the Mechanical Engineering Technical Division, IEM

21 October 2017
Organised by: Mechanical Engineering Technical Division
Time : 11.00 a.m. - 1.00 p.m.
CPD/PDP : 2

Title: Technical Visit to MMU Cyberjaya

24 October 2017
Organised by: Bectrical Engineering Technical Division
Time : 8.00 a.m. - 12.30 p.m.
CPD/PDP : 3.5

Title: Technical Visit to SKF Bearing Industries (M) Sdn. Bhd.

24 October 2017
Organised by: Mechanical Engineering Technical Division
Time : 2.00 p.m. - 4.30 p.m.
CPD/PDP : 3

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