Pre- and Post-Pruning Assessment of Lychee Tree Crop Structure Using Multi-Spectral RPAS Imagery

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Abstract:
Lychee production in Australia is worth >$20 million annually. Pruning of trees encourages new growth, has a positive effect on fruiting of lychee, makes fruit-picking easier, and may increase yield, as it increases light interception and tree crown surface area. It is therefore important to assess tree pruning efforts. The objective of this research was to assess changes in tree structure, i.e. tree height, crown area, circumference and width, and fractional canopy cover using multi-spectral RPAS imagery collected before and after pruning of a lychee plantation. A secondary objective was to assess any variations in the results as a function of various flying heights (30 m/4.1 cm pixels, 50 m/6.5 cm pixels and 70 m/8.8 cm pixels).

RPAS multi-spectral (green, red, red edge and NIR bands) imagery was collected for a lychee farm at Shailer Park, Queensland, on 11 February 2017 (pre-pruning) and 4 March 2017 (post-pruning) (Figure 1), coincidently with field based measurements of tree height, crown width, crown circumference, and four representative photos per tree taken underneath the canopy looking straight up. These photos were analysed to determine the fractional cover of leaves and branches in relation to sky. The data were processed in Pix4D Mapper to produce an orthomosaic, a DSM and a DTM. A canopy height model (CHM) was produced by subtracting the DTM from the DSM. Ten AeroPoint ground control points were used for geometric correction of the imagery. Eight near-lambertian radiometric calibration targets (Figure 1) with known reflectance values were used to convert the multi-spectral imagery to at-surface reflectance using an empirical line correction (Wang et al., 2015).

An object-based image analysis approach was used to automatically delineate the individual tree crowns based on the CHM and the multi-spectral orthomosaic. The CHM was used to identify areas of the tree crowns >1 m in height and areas with high vegetation index values. The areas were then grown outwards based on lower height thresholds. The tree crown edges were adjusted based on spectral information. Once the tree crown extent had been mapped (Figure 1), various segmentation and tree crown adjustment steps were used to delineate individual tree crowns. Variables were produced to automatically count tree crowns and measure their area, circumference and width.
The results showed that individual tree crowns could be automatically delineated and counted and that their area, circumference and width could be accurately measured. The best-fit equation based on a scatterplot between field-measured fractional canopy cover and vegetation indices produced r^2 values up to 0.77. Pre- and post-pruning results showed

significant differences in all measured tree structural variables. With increasing flying height, tree crown height was underestimated. The different flying heights produced similar measurements of tree crown area and width. Tree crown circumference measurements decreased slightly with increasing flying height due to the larger pixel size, producing a smoother crown edge. At the tree crown level, no significant differences in mapped fractional canopy cover were observed for the imagery collected at different heights.

These results show that multi-spectral RPAS imagery can provide a suitable means of assessing pruning efforts based on changes in tree structure of lychee plantations and that it is important to collect imagery in a consistent manner, as varying flying heights may cause changes to tree structural measurements.

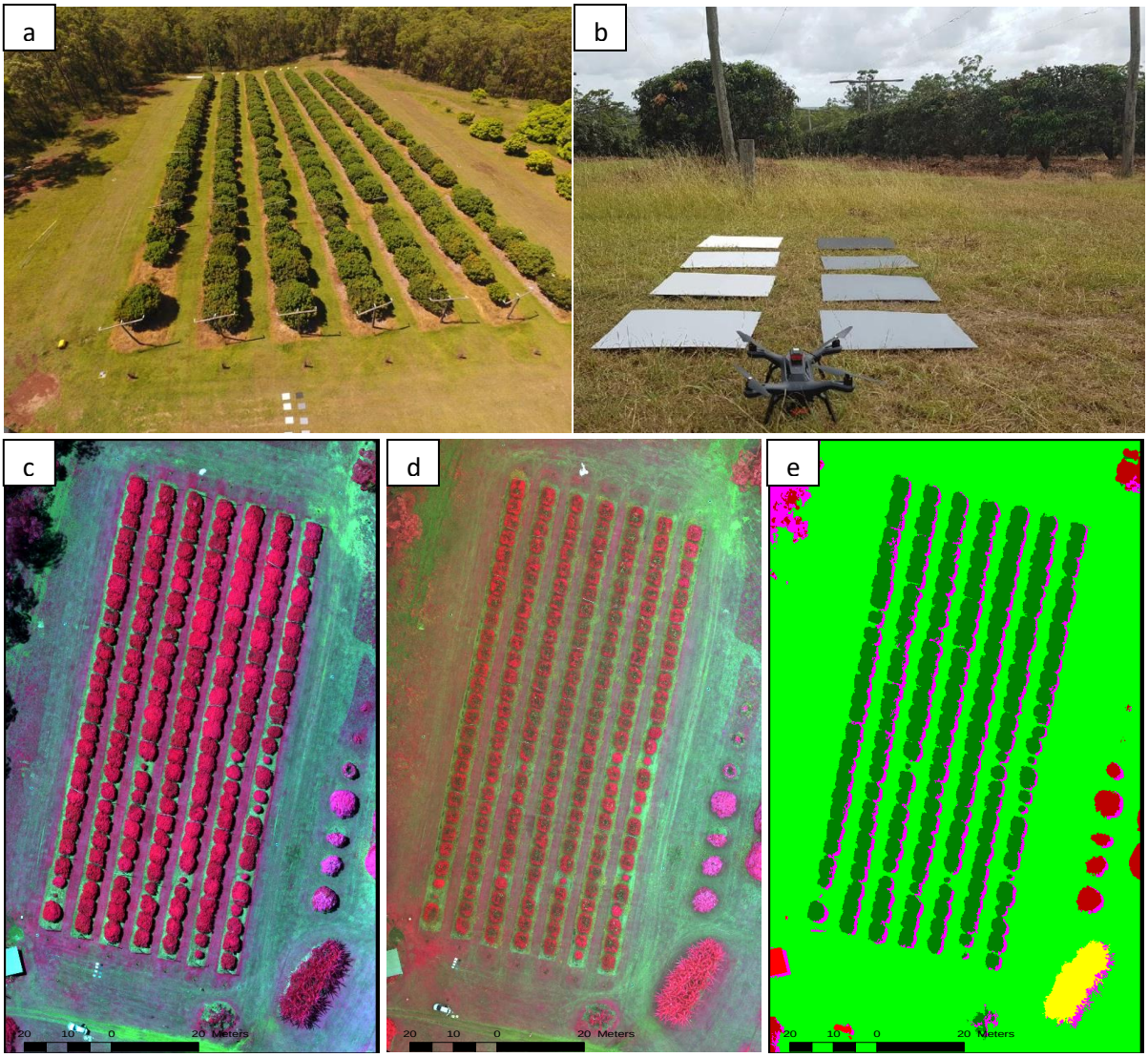

Figure 1. (a) Overview of lychee farm, (b) 3DR Solo with Parrot Sequoia multi-spectral camera and radiometric calibration targets, (c) pre-pruning orthomosaic (11 Feb 2017) (d); post-pruning orthomosaic (4 Mar 2017); and (e) example land-cover map, showing the extent of lychee trees in dark green.

References:

Wang, C. and Myint, S.W. (2015). A simplified empirical line method of radiometric calibration for small unmanned aircraft systems-based remote sensing. IEEE Journal of Selected Topics in Applied Earth Observation and Remote Sensing, 8(5), 1-10.