Connecting the dots: airborne laser scanning from an Unmanned Aircraft System (UAS)

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Keywords: UAS, LiDAR, forest structure, SfM, 3D point clouds

Abstract:
The *TerraLuma* research project in the School of Land and Food at the University of Tasmania, Australia has developed novel tools and algorithms for environmental remote sensing applications and aerial surveys using unmanned aircraft systems (UAS). Up-to-date and accurate spatial data are of crucial importance for sustainable management of our eco- and agro-systems. During the last five years, we have been working on UAS and the integration of specialised earth observation sensors, such as multispectral and hyperspectral sensors, thermal cameras, and laser scanners, to map and monitor different aspects of the environment at ultra-high resolutions on-demand.

The primary advantage of UAS-based remote sensing is the ability to bridge the scale gap between field-based observations and full-scale airborne or satellite observations. The key advantages of UAS for environmental remote sensing are their capacity to: 1) collect ultra-high spatial resolution imagery (1 – 20 cm), 2) acquire data on-demand at critical times, and 3) carry multiple sensors that can collect imagery outside of the human visible range.

This presentation will cover recent developments in small LiDAR sensors on UAS. In 2010, the *TerraLuma* group was the first to integrate a laser scanner on-board a multi-rotor UAS to capture detailed 3D structure of eucalyptus trees in forestry plantations. We demonstrated that we can identify individual trees and extract forest inventory metrics in an accurate and repeatable manner. Recently, we have improved on our early UAS LiDAR prototype by designing a new heavy-lift multi-rotor with the new Velodyne VLP-16 'Puck' laser scanner, an accurate GPS/IMU unit with a dual GPS antenna, and a machine vision camera fully stabilised on a gimbal. In this presentation, we will present the initial results from a laser scan over a pine forest. In addition, we will present a comparison of a LiDAR point cloud and structure-from-motion (SfM) point cloud to show the difference between the two techniques for quantifying vegetation structure. Finally, we will discuss the advantages and disadvantages of UAS LiDAR and SfM for characterisation of forest canopy structure.

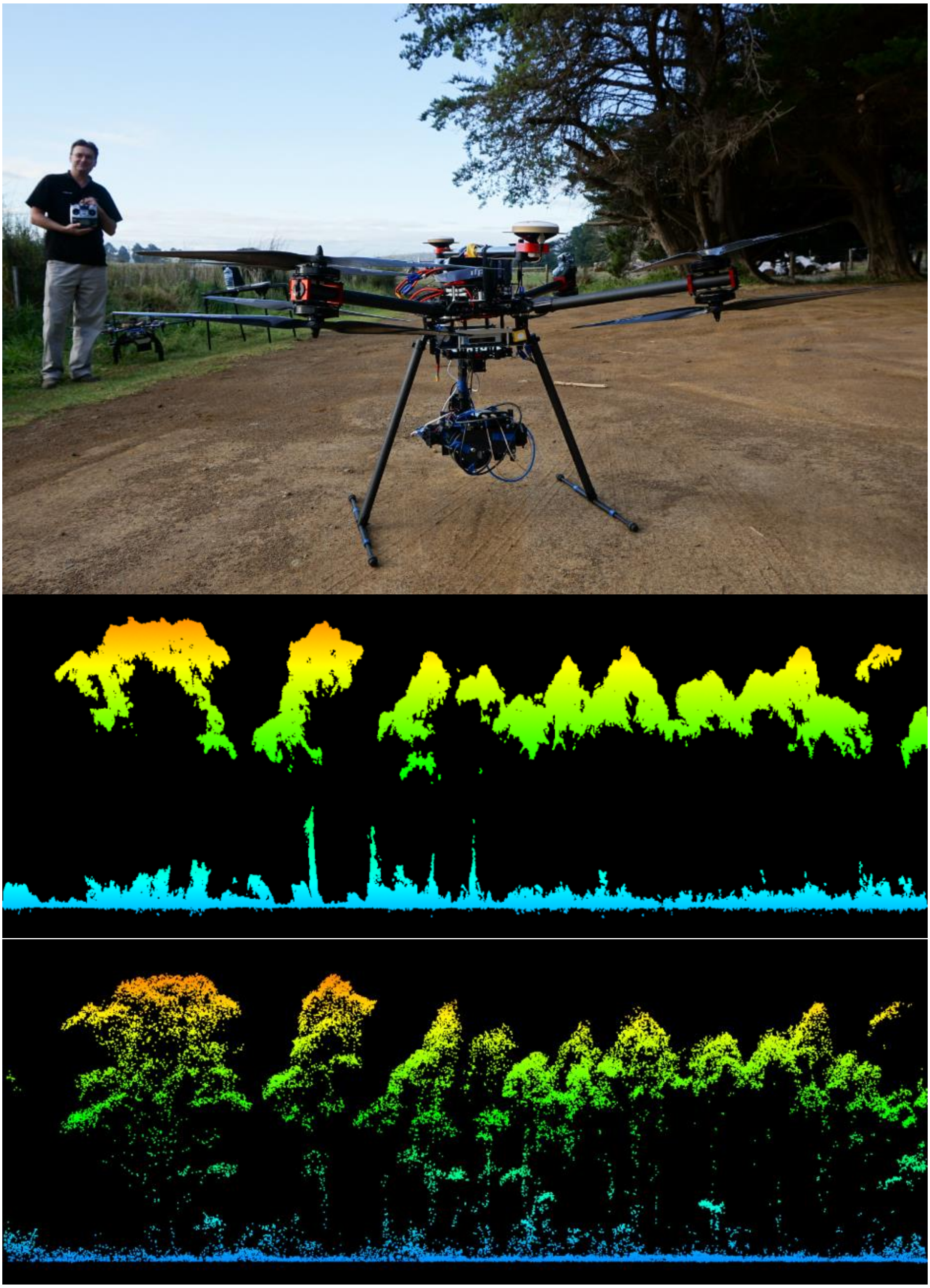

Figure 1. Prototype UAS LiDAR system based on the Velodyne 'Puck', and a comparison of UAS SfM (top) vs LiDAR (bottom) point clouds of an open sclerophyll Eucalyptus forest.

References:

1. Wallace, L., Lucieer, A., and Watson, C. (2014). Evaluating tree detection and segmentation routines on very high resolution UAV LiDAR data. *IEEE Transactions on Geoscience and Remote Sensing*, 52(12): 7619-7628. doi:10.1109/TGRS.2014.2315649

2. Wallace, L., Musk, R., and Lucieer, A. (2014). An assessment of the repeatability of automatic forest inventory metrics derived from UAV-borne laser scanning data. *IEEE Transaction on Geoscience and Remote Sensing,* 52 (11), 7160-7169. doi:10.1109/TGRS.2014.2308208.

3. Wallace, L., Lucieer, A., and Watson, C. (2014). Detecting pruning of individual stems using Airborne Laser Scanning data captured from an Unmanned Aerial Vehicle. *International Journal of Applied Earth Observation and Geoinformation*, 30 (1), 76-85, 2014. doi:10.1016/j.jag.2014.01.010

4. Wallace, L., Lucieer, A., Watson, C., & Turner, D. (2012). Development of a UAV-LiDAR System with Application to Forest Inventory. *Remote Sensing (UAV special issue)*, 4(6), 1519-1543. doi:10.3390/rs4061519

5. Wallace, L., Lucieer, A., Turner, D. and Watson C. (2011) Error assessment and mitigation for hyper-temporal UAV-borne LiDAR surveys of forest inventory, SilviLaser 2011, Hobart, Tasmania, 16 – 20 October.