DIGITISING THE VINEYARD: DEVELOPING NEW TECHNOLOGIES FOR VITICULTURE IN AUSTRALIA

Authors: Everard J. EDWARDS[1*], Mark R. THOMAS[1], Stephen GENSEMER[2], Peyman MOGHADAM[3], Thomas LOWE[3], Dadong WANG[4], Ryan LAGERSTROM[4], Chad HARGRAVE[5], Jonathon RALSTON[5]

[1]*CSIRO Agriculture & Food, Locked Bag 2, Glen Osmond, SA 5064, Australia*
[2]*CSIRO Manufacturing, Locked Bag 2, Glen Osmond, SA 5064, Australia*
[3]*CSIRO Data61, PO BOX 883, Kenmore, QLD 4069, Australia*
[4]*CSIRO Data61, PO BOX 76, Epping, NSW 1710, Australia*
[5]*CSIRO Energy, PO BOX 883, Kenmore, QLD 4069, Australia*

*Corresponding author: everard.edwards@csiro.au

Abstract:

Context and purpose of the study - New and developing technologies, that provide sensors and the software systems for using and interpreting them, are becoming pervasive through our lives and society. From smart phones to cars to farm machinery, all contain a range of sensors that are monitored automatically with intelligent software, providing us with the information we need, when we need it. This technological revolution has the potential to monitor all aspects of vineyard activity, assisting growers to make the management choices they need to achieve the outcomes they want. For example, a future vineyard may possess automated imaging that generates a three dimensional model of the vine canopy, highlighting differences from the desired structure and how to use canopy management to improve fruit composition, or generates maps with yield estimates and measurements of berry composition throughout the growing season. That same imaging may also provide whole of vineyard data on vine nutrition or early warning of disease, allowing proactive management on a rapid timescale. We are working with a range of technologies to develop such capabilities for Australian viticulture.

Material and methods – A variety of technologies are being deployed at the whole block scale to address a number of management questions. Early indicators of yield variation are being assessed shortly after budburst, using video imaging with consumer video cameras and machine learning, to determine inflorescence numbers. Canopy growth and structure are being monitored using (i) photogrammetry with drones imagery, (ii) video imaging from vehicles and (iii) a spinning LiDAR system using Simultaneous Localisation and Mapping (SLAM) to register the data. The latter is also being used to develop novel indices of canopy structure. Hyperspectral imaging is being used to segment vine images into their constituent parts and analyse them for fruit and canopy composition and presence of disease. Finally, yield estimation from veraison onwards is being developed using (i) video imaging in daylight, (ii) digital imaging with depth perception and (iii) foliage penetrating (FOPEN) technology. These technologies are being trialed at commercial vineyards in multiple winegrape growing regions of South Australia, concentrating on vines grown with the locally common 'Australian sprawl' trellis type, where the fruit are typically highly occluded by leaves, compared to vertical shoot position trellis types.

Results – The technologies described are at various stages of development, from the lab to field application at vineyard scale, but all have produced results with potential commercial application. Initial imaging work with inflorescence counts produced 94% accuracy; a preliminary pipeline to analyse drone imagery with depth data from photogrammetry for estimating vine cover irrespective of cover crop has been developed; a preliminary pipeline to analyse video imagery from the ground and map canopy gap fraction and leaf area index has been developed; the ability to accurately register 3D LiDAR data using SLAM and only basic GPS data has been demonstrated and use the results to develop models of seasonal light interception and indices of canopy light penetration; further, the ability of the FOPEN to determine the presence of fruit within a 'sprawl' canopy has been demonstrated.

We are continuing to develop these technologies and apply them at the whole block scale in order to produce accurate yield estimates that do not rely on point measurements and spatial maps to allow fine-grained vineyard management decisions.

Keywords: digital technologies, FOPEN, LiDAR, photogrammetry, proximal sensing, RGB imaging, viticulture.