Abstract

Digital Twin for the Future of Orchard Production Systems †

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Abstract: The evolution of orchard production systems towards higher density layouts, makes monitoring of canopy and disease increasingly important. Technological advances over the last few years have greatly increased our ability to collect, collate and analyse our data on a per-tree basis at large orchard scales. We call this the Digital-Twin Orchard. A digital-twin is a virtual model of every tree and surroundings. The pairing of the virtual and physical worlds allows analysis of data and continuous monitoring of orchards production systems to predict stress, disease and crop losses, and to develop new opportunities for end-to-end learning. Monitoring of orchards is not a new concept but the digital-twin is a continuously learning system that could be queried automatically to analyse specific outcomes under varying simulated environmental and orchard management parameters. Digital-twin enables improvement of production and dynamic prediction of disease, stress and yield gaps using an end-to-end AI platform. In this paper, we present AgScan3D+: our automated dynamic canopy monitoring system to generate a digital-twin of every tree on a large orchard scale. AgScan3D+ consists of a spinning 3D LiDAR plus cameras that can be retrofitted to a farm vehicle and provides real time on-farm decision support by monitoring the condition of every plant in 3D such as their health, structure, stress, fruit quality, and more. The proposed system has been trialled in mango, macadamia, avocado and grapevines orchards and generated a digital-twin of 15,000 trees. The results were used to model canopy structural characteristics such as foliage density and light penetration distribution.

Keywords: digital twin; 3D LiDAR; SLAM; artificial intelligent; machine learning; horticulture