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| **PINT – A Program for Performing Survival Counts** |
| **Introduction/Aim:**  Seedlings represent an acutely vulnerable stage of a tree’s development cycle. Field surveys have historically been used to assess survival: a practice that is costly and not without hazard. It is also challenging to tackle the problem operationally or at scale using remote sensing due to a combination of the diminutive size of young trees, absence of distinctive morphological structure, and quantity of data involved. Moreover, monitoring needs can be site-specific and influenced by factors such as plant maturity, local vegetation, substrate, and geomorphology. Successful techniques for conifer seedling detection based on supervised and deep learning have been reported; and while these methods claim precision rates in excess of 80% and accuracy in excess of 90%, such approaches rely on convolution neural networks (CNN), which require extensive training data sets.  In this paper we discuss an approach based on morphological and spatial filtering that automatically detects healthy young pinus radiata and eucalyptus seedlings in plantations. The likely locations of individual unhealthy or deceased (“missing”) trees are also computed based on the non-uniform distributions of identified healthy trees.  **Methods:**  The strategy adopted is as follows. Standard flight patterns are flown by an unmanned aerial vehicle and a 3D point cloud created from the 2D image stack using standard photogrammetric software. The 3D point cloud is normalised to the topography of the local terrain and a series of morphological operations used to provide additional properties for points identified as connected identities. Unwanted points are discarded, and the residual data morphologically and spatially filtered using seedling colour, structure, and distribution. Maps of the resulting entities are computed and used to represent the locations of healthy seedlings. Based on the estimated probability distributions of the identified trees, locations of missing trees are then inferred, which allows tree density and replenishment diagrams to be created as a function of site geography. Weeds are also detected and classified by type.  **Results:**  Diagnostic tests conducted on over 2,000 Ha of radiata pine and eucalyptus plantation show that the proposed approach allows healthy trees to be detected and located both reliably and accurately, and that the likelihood of falsely identifying unhealthy trees is low (< 5%). The healthy seedling classification algorithm demonstrated precision and specificity in the region of 90 – 95%, and recall approaching 99%, with about 85% of missing/unhealthy seedlings shown to have been located within 1 m of their correct position. Weed detection and classification was similarly successful.  **Conclusion:**  This approach will allow practitioners to estimate reforestation costs more efficiently and inexpensively. It offers forestry practitioners a monitoring solution that is fine-resolution, rapid and scalable and supports precision mapping. The method could potentially accelerate the recovery of forest ecosystems with respect to their health, integrity, and sustainability. |