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Using 3D Satellite Imagery to Generate a High Precision Canopy Height Model

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Abstract : Good knowledge of the physical environment is essential for an integrated forest planning. This information enables better forecasting of operating costs, determination of cutting volumes, and preservation of ecologically sensitive areas. The use of satellite images in stereoscopic pairs gives the capacity to generate high precision 3D models, which are scale-adapted for harvesting operations. These models could represent an alternative to 3D LiDAR data, thanks to their advantageous cost of acquisition. The objective of the study was to assess the quality of stereo-derived canopy height models (CHM) in comparison to a traditional LiDAR CHM and ground tree-height samples. Two study sites harboring two different forest stand types (broadleaf and conifer) were analyzed using stereo pairs and tri-stereo images from the WorldView-3 satellite to calculate CHM. Acquisition of multispectral images from an Unmanned Aerial Vehicle (UAV) was also realized on a smaller part of the broadleaf study site. Different algorithms using two softwares (PCI Geomatica and Correlator3D) with various spatial resolutions and band selections were tested to select the 3D modeling technique, which offered the best performance when compared with LiDAR. In the conifer study site, the CHM produced with Corelator3D using only the 50-cm resolution panchromatic band was the one with the smallest Root-mean-square deviation (RMSE: 1.31 m). In the broadleaf study site, the tri-stereo model provided slightly better performance, with an RMSE of 1.2 m. The tri-stereo model was also compared to the UAV, which resulted in an RMSE of 1.3 m. At individual tree level, when ground samples were compared to satellite, lidar, and UAV CHM, RMSE were 2.8, 2.0, and 2.0 m, respectively. Advanced analysis was done for all of these cases, and it has been noted that RMSE is reduced when the canopy cover is higher when shadow and slopes are lower and when clouds are distant from the analyzed site.

Keywords : very high spatial resolution, satellite imagery, WorlView-3, canopy height models, CHM, LiDAR, unmanned aerial vehicle, UAV
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