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Detection of model-based Individual Conifer Tree Crown and Estimation of Tree Height Using LiDAR Point Clouds

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Abstract

Individual tree crown parameters and tree height are desirable in forest inventory and ecological studies to estimate forest carbon stocks and volume acculately. In this study, a new method to detect model-based individual conifer tree crown and estimate tree height using small footprint Light Detecting And Ranging (LiDAR) raw data is developed. The model-based conifer tree crown has solid geometry form, and can be expressed by a geometric equation which is a function of crown radius, crown height, crown curvature and 3-dimensional tree top position. To estimate crown parameters, LiDAR point clouds which represent tree crown are extracted. Then, tree crown parameters are estimated by hill-climbing method using extracted LiDAR point clouds. Hill-climbing method searches the best fit parameters by changing tree crown parameters iteratively. From the estimated crown parameters, crown region and tree height are estimated. The developed method is applied to a Japanese cedar (Cryptomeria japonica D. Don) plantation. Detected tree crown parameters are reconstructed on 3-dimensional scene. Detected trees are validated with field measurements which are number of detected trees, tree height, position and projected crown area. In total, 83 percent of the field measured trees are correctly detected. However, 17 percent are not detected due to the suppression or proximity. Tree height derived by LiDAR is estimated with root mean square error (RMSE) of 1.37m. Underestimation of tree height is approximately decreased by 1m, because the hill-climbing

method estimates 3-dimensional tree top position higher than “nearest” tree top pulse. Projected crown area derived by LiDAR corresponds with field measurement. However, the underestimation can be seen and RMSE is 7.12m^2. These results show that the developed method is appropriate for detecting tree crown and estimating tree height.

Keywords: Airborne LiDAR, Forestry, Tree height, Model-based conifer tree crown, Individual tree crown detection

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