Geophysical Research Abstracts
Vol. 21, EGU2019-5465-1, 2019
EGU General Assembly 2019

Optimization of Terrestrial LiDAR Sampling Pattern in Plot-scale Forest Measurement

Linyuan Li (1,2), Xihan Mu (1), Wuming Zhang (1), Peng Wan (1), and Guangjian Yan (1)

(1) Faculty of Geographical Science, Beijing Normal University, Beijing, China (muxihan@bnu.edu.cn), (2) EMMAH, Institut National de la Recherche Agronomique, Avignon, France

Terrestrial LiDAR (TLS) instruments have great capability to describe canopy structure with unprecedented levels of detail in plot-scale forest measurement. However, in most cases, only parts of the trees within the sample plot are scanned due to occlusion effects from the other trees in the direction of the laser beam. These obstructions cause incomplete observation and missing features, resulting in the underestimation of tree attributes. Typical data acquisition with multi-scan mode seeks to mitigate occlusion effect and then provide almost full coverage of plot. The density of scan stations is determined by plot size, the density of plants and the metrics to be measured. Currently, the determination of density and locations of multiple scans depends on surveyor's experience and is lack of scientific protocols, generally, causing data redundancy and low efficiency of measurement, e.g. time cost in moving devices and scan registration. In fact, the occlusion effect primarily comes from the unknown complex spatial pattern of trees in natural forest conditions. UAVs are able to map the spatial locations of trees and are expected to provide basic knowledge for the optimization of TLS sampling pattern in forest conditions.

The focus of this study is on strategies to derive multi-scan locations over forest plots. A novel chain-mode optimization of TLS sampling pattern was designed to maximize visibility of trees with minimum scans, hence improving the data quality and the efficiency of measurement. We proposed three basic optimization rules: (1) scan candidates prefer to locate on those positions undergoing low occlusion effect; (2) cumulative angular sampling (CAS) of each tree scanned from several directions satisfies the requirement user defined; (3) scan locations are uniformly distributed. In the implementation, 2D visibility analysis is firstly conducted for all the trees, simplified as circles in a plot, based on tree location map derived from UAV images. This step aims to find locally optimal scan locations following the first rule. Secondly, the CAS of each tree is geometrically computed. This step is devoted to select those trees requiring more scans to meet user level following the second rule. Thirdly, the former two steps are consecutively repeated in consideration of the third rule, only for those selected trees, until the CAS of each tree meets the user's requirements. Through two simulated forest plots where trees respectively distributed follow a spatial random pattern and a row-spaced pattern, the proposed chain-mode scans yielded comparable data quality with regular scans whereas the efficiency is improved by up to 30%. It is expected that this chain-mode optimization method can be applied in more forest experiments, especially in long-term TLS measurements.