

EVALUATING THE POTENTIAL OF STRUCTURE FROM MOTION TECHNOLOGY FOR FOREST INVENTORY DATA COLLECTION

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Abstract—Since the inception of its annual plot design, the Forest Inventory and Analysis (FIA) Program of the USDA Forest Service has integrated into its data collection operations elements of digital technology, including data loggers, laser distance recorders and clinometers, and GPS devices. Data collected with the assistance of this technology during a typical plot visit comprise measurements of object dimensionality and location, as well as ocular assessments of inventory parameters of interest, all organized in a tabular form. Unlike the wealth of tabular data collected every year on FIA plots, digital images have been acquired only in the course of special projects (e.g. fire plots). Although small in number and acquired usually only along the cardinal directions, these images are nevertheless regarded as snapshots of plot conditions in time, and well-suited to retrospective resolution of an occasional ambiguity present in the tabular data. Owing to recent advancements in digital imagery technology and the field of computer vision, sets of numerous images acquired on an FIA plot with large spatial overlap among successive frames can be used to initially generate three-dimensional representations of structural plot elements in the form of a point cloud. Further processing of the cloud with algorithms originally developed for terrestrial LiDAR data leads to the identification of individual objects and quantification of their dimensionality. Variants of this process, usually known as vision structure from motion, have been used for digital reconstructions of man-made objects in urban settings. The adaptation of the process to on-plot settings and ground-based, under canopy imagery, presented with substantial challenges due to the intense variability in solar illumination conditions within a plot and the absence of planar surfaces separated by distinct edges. Algorithmic customizations have resolved many of these limitations. The modified process has been tested with inexpensive, off-the-shelf, all-weather, pinhole motion cameras weighing less than 150 grams, secured on the helmet of a field crew member. Initial results underline the method's potential for automated tree stem mapping, derivation of ground surfaces, comprehensive assessment of coarse woody debris volume and distribution, tree-specific measurements of crown base and ladder fuels, as well as for counting and assessing the height of seedlings in microplots.

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