The Accuracy of Drones in Forest Structure Analysis: Determining Height and DBH of Canopy Trees

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In forest conservation and management, the extent and inaccessibility of forested ecosystems pose significant challenges for routine monitoring. Traditional monitoring approaches like field plot surveys obtain highly accurate measurements, but these data tend to be constrained to small sites (<0.25 acres) and require time-intensive skilled labor. Drones may offer an effective solution to data collection as they can more efficiently gather data with a variety of sensor payloads, can observe larger areas and access sites that are difficult or dangerous to reach, and are more cost effective. In this study, we flew a DJI Phantom quadcopter over Mason Farm Biological Reserve, an urban forest in Chapel Hill, NC. We collected aerial imagery and processed it with Pix4D structure-from-motion software to generate an orthomosaic map and 3D point cloud of a forested site. We paired data with field plot surveys to determine the actual height and diameter at breast height (DBH) of trees within the site. We then used regression models to evaluate the accuracy of drone-collected imagery to estimate tree height and DBH. We found a statistically significant relationship between known and estimated tree height with a very high correlation ($R^2 = 0.95$), and a less strongly correlated relationship between known and estimated DBH ($R^2 = 0.49$) as drone-based DBH measurements were estimated for all species using a particular species' DBH-height relationship model. By estimating DBH from drone data using a species-specific DBH-height relationship model in future studies, drones offer a promising potential in forest structure analysis.