Estimating the height of conifer seedlings in recovering linear disturbances with UAV photogrammetry

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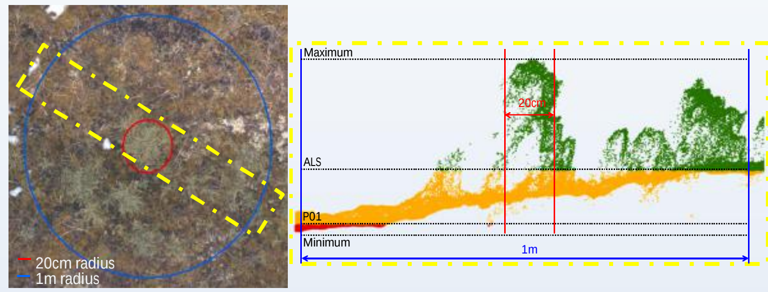
Boreal Ecosystem Recovery & Assessment

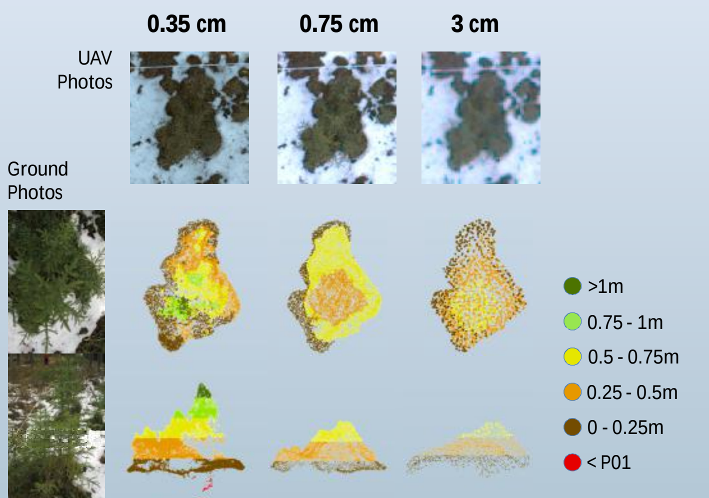
BACKGROUND

Recent advances in computer science have given a renewed impetus to Digital Aerial Photogrammetry (DAP) applications in forestry. With an inexpensive UAV (a.k.a. drone), it is possible to capture geolocated, above-canopy digital photographs that can be automatically aligned using a Structure from Motion workflow to create a 3D model (point cloud) that has orders of magnitude more points than typical airborne laser scanning (ALS) data. Our research is part of BERA's efforts to develop cost-effective methods to monitor seismic line forest recovery.



METHODS

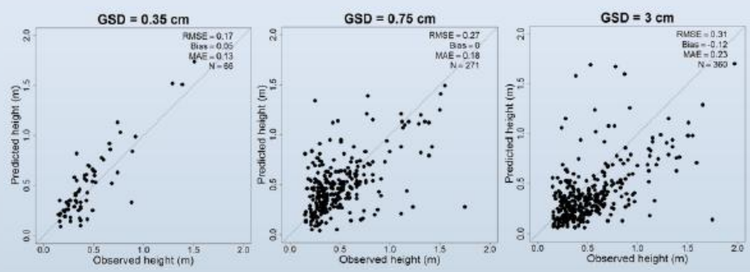
Sites were established along selected seismic lines near CNRL Kirby-South SAGD plant in Alberta. All conifer seedlings touching a measuring tape deployed along the 150m transect centerline were geolocated and measured, as well as the largest seedling inside each of the ten 10 m^2 subplots within the two belt plots at each end of the transect. Nine ground control points (GCP) were placed within a given site and their precise coordinates collected. UAV DAP data was acquired at 8 sites in August and 5 sites in October 2017, at flying altitudes of 5 m, 30 m and 120 m, yielding a ground sampling distance (GSD) of 0.35 cm, 0.75 cm and 3 cm respectively.



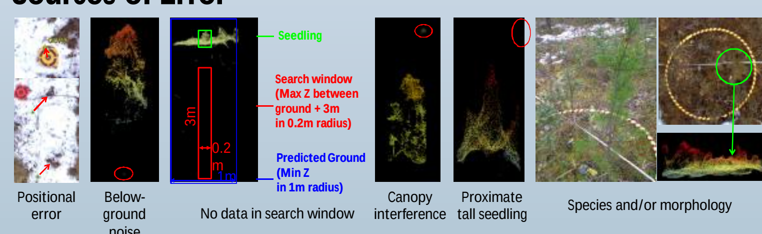
Each UAV DAP dataset was processed in Agisoft Photoscan using the GCPs to optimize alignment and georeference the 3D model. When a UAV acquisition did not cover all GCPs at a site, pseudo-GCP's were created using salient ground features in the processed datasets. Multiple methods of seedling height estimation were tested, and the best method was selected for analysis. Ground elevation at the base of each seedling was estimated as the elevation of the lowest point within a 1 m radius of the seedling. Top elevation was estimated as the elevation of the tallest point within a 20 cm radius, 3 m tall cylinder centred at the seeding location. Individual seedling height was estimated from the resulting point cloud subsets as top elevation minus ground elevation. Bias, mean absolute error (MAE) and RMSE of ground-measured vs DAP-estimated height for all seedlings at each flying altitude were derived.

RESULTS

There were 407 conifer seedlings available for analysis within the DAP point clouds. These point clouds had varying mean densities, from 336 points/m^2 for the 3cm GSD imagery to 31,000 points/m^2 for the 0.35 cm GSD imagery. The denser point cloud yields a reasonable RMSE (35%); however the RMSE of the other two is too large to reliably estimate individual seedling height (> 60%). Multiple sources of error are suspected to contribute to the large RMSE.



Sources of Error



CONCLUSIONS

UAV DAP can be used to estimate seedling height under ideal conditions including: accurate ground control and seedling locations, high resolution and overlap of UAV photographs, and point cloud noise removal. Because of UAV DAPs limited capabilities for detecting small seedlings when flying above the forest canopy, an operational employment of UAV DAP for survival surveys would be challenging, less so for establishment surveys. Further research is required to refine these preliminary results and to define specifications for the UAV DAP workflow from acquisition to estimation.

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