NATIONAL CONSORTIUM FOR REMOTE SENSING EDUCATION, RESEARCH, AND APPLICATIONS

IndianaView

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Using UAVs to Complete Large Area Tree Mapping.

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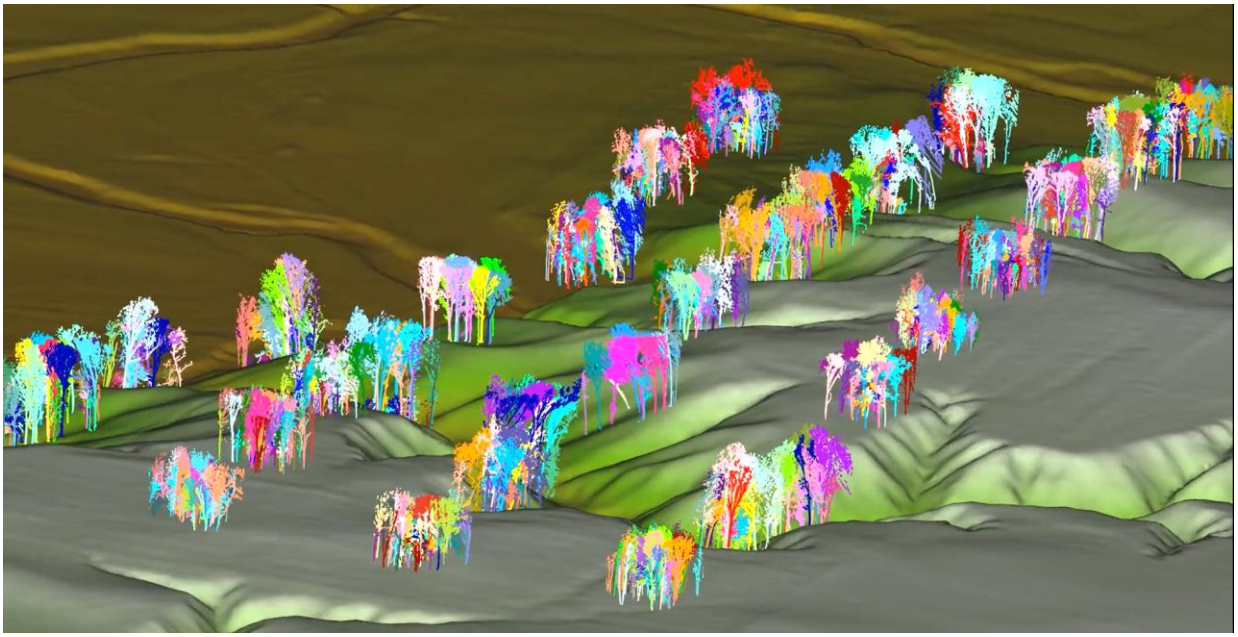

Figure 1. A Digital Terrain Model of a portion of Purdue's Martell Forest populated by the individual trees extracted from terrestrial laser scans of each inventory plot. This these digital plots allow algorithms to be developed for automatic feature extraction from point cloud data. The results of which can then be checked against the on-the-ground measurements collected by this project at each plot.

Introduction: Trees are big business. In the United States, over 800 million acres of land are covered by managed forests. This number includes plantations grown for lumber, natural forests preserved by private or governmental agencies, and agricultural forests grown for a small portion of the tree. Taken together, the forest industry represents 200 billion dollars of economic activity, 10 billion of which happens locally in Indiana [1][2]. Trees are also necessary for cooling urban centers, managing erosion in flood-prone areas, absorbing carbon and producing oxygen, and providing habitat for wildlife.

Despite the value of trees, automatic methods for monitoring forest health are several decades developmentally behind those used in agriculture. The goal of this project is to develop methods for mapping and monitoring large areas of forest automatically.

Methodology: The first step in this task was to build a dataset of known tree features covering a large area of forest. We collected the following data over Martell Forest, a 500-acre research forest near Purdue University:

- Unmanned Aerial Vehicle (UAV) imagery once per season.
- A terrestrial laser scan at each of the 109 inventory plots scattered throughout the forest
- Manual tree location, measurement, and species identification at each inventory plot.

Results: We implemented a tree segmentation algorithm [3] to separate individual trees from the terrestrial laser-scanned point clouds to digitally recreate the inventory plots (Figure 1). Each digital plot was also matched up with the corresponding imagery for each of the 4 seasons. All the remotely sensed data was then paired with the manual plot measurements to form a validation dataset for future research.

FOR FURTHER READING:

[1] Forestry, "Indiana Forest Industry Overview," *Forestry*, 05-Aug-2022. [Online]. Available: https://www.in.gov/dnr/forestry/forest-industry-overview. [Accessed: 05-Sep-2022].

[2] "The state of the Forest," *USDA*, 29-Jul-2021. [Online]. Available: https://www.usda.gov/media/blog/2019/04/22/state-forest. [Accessed: 05-Sep-2022].

[3] J. Carpenter, J. Jung, S. Oh, B. Hardiman, and S. Fei, "An unsupervised canopy-to-root pathing (UCRP) tree segmentation algorithm for automatic forest mapping," Remote Sensing, vol. 14, no. 17, p. 4274, 2022.