# Extracting Tree Trunks from Backpack LiDAR Point Cloud Data by Combining Geometric Features and Deep Learning

***Jinyuan Shao***, Purdue University West Lafayette (E-Mail: jyshao@purdue.edu); Songlin Fei, Purdue University West Lafayette

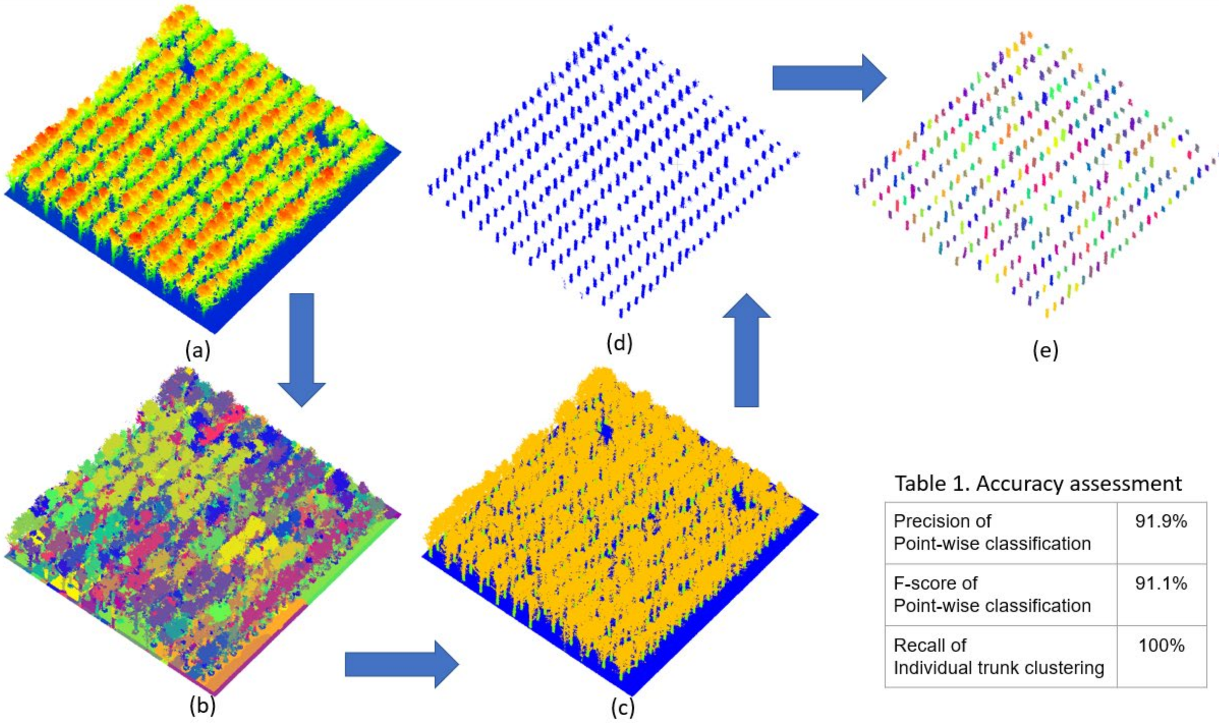


Table 1. Accuracy assessment

| | |
|---|---|
| Precision of Point-wise classification | 91.9% |
| F-score of Point-wise classification | 91.1% |
| Recall of Individual trunk clustering | 100% |

Figure 1. (a) Input point clouds colored by height; (b) Random colored geometric portioned results; (c) Trunk segmentation results. Trunks, ground, and canopy are colored in green, blue, and yellow; (d) Separating trunks points from segmentation results; (e) Single tree trunk clustering results.

**Background**: LiDAR point cloud is the most commonly used geospatial data for various geospatial research fields. Especially in forestry, the complex structure of forests makes it impossible to accurately quantify forest attributes with 2D geospatial data, such as imagery of satellites and UAVs, so 3D point clouds from LiDAR are an essential data source for foresty research. With the development of laser scanning technology, larger area, and more dense point clouds emerge, which pose a challenge for data processing in LiDAR forestry.

**Introduction**: Extracting tree trunks from forests is a key task for quantifying forests, providing the most basic information for tree counting, tree localization, and diameter measurement. However, it is not easy to obtain trunk features from plot-level, high-density point clouds. Geometric feature-based methods require recursive calculation for each point, while more emerging deep learning methods often do not support large-scale point cloud inputs. In this project, we will combine geometric feature extraction and deep learning to extract tree trunks from large-scale point clouds to achieve the balance between accuracy and large scale.

**Methodology**: Point clouds data was captured by a Backpack LiDAR system in Purdue Martell Forest plot 5a with 10 years of red oaks (*Quercus rubra*) will be used in this project. Geometric features, such as linearity, planarity, and scattering by neighborhood search on plot-level point clouds. Then geometric partitions were implemented with similar geometric features by the Potts energy model. A deep learning model with a Pointnet features extraction module was next used to learn semantic information from geometric partitioned point clouds. As the semantic information is extracted, the trunk points will be separated from the plot-level point cloud. Finally, connected-component analysis was used to cluster individual tree trunks.

**Results:**

- Combining geometric feature extraction and deep learning could achieve large-scale point cloud tree trunk extraction.
- The algorithm was able to achieve a precision of 91.9% accuracy for point-wise classification and recall of 100% for individual trunks clustering on the test dataset.