

Tree Extraction from Photogrammetrically Derived Point Clouds

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BACKGROUND

To monitor large forest stands, foresters use a system of small plots to sample the properties of the trees within the stand. These forest inventory methods provide trusted data but are restricted in coverage.

- Inventories require many hours of skilled labor to complete
- Inventories cannot cover the entire population

Unmanned Aerial Vehicles (UAVs) provide new possibilities.

- UAV's can access hundreds of acres of forest in hours
- UAV-mounted sensors collect point clouds of entire stands

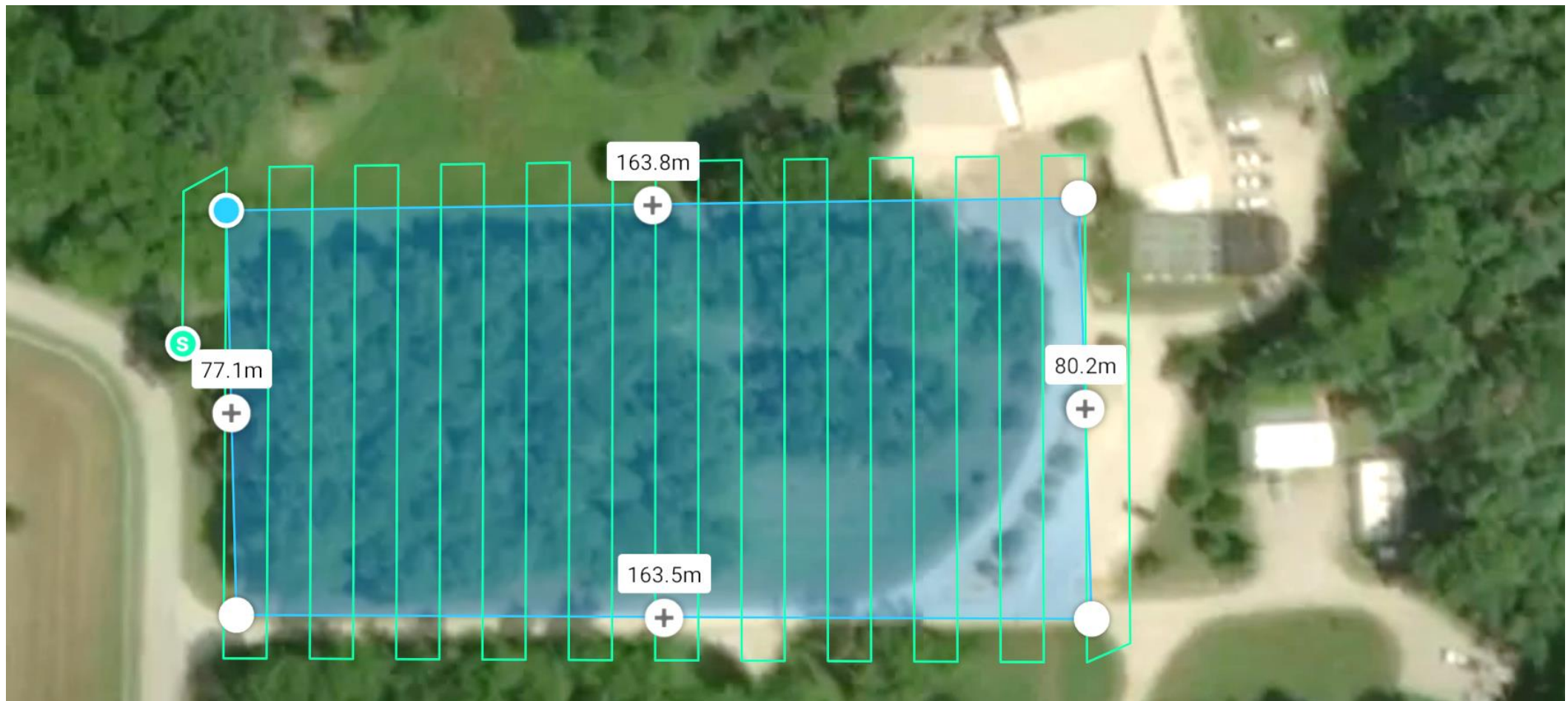
However, it is difficult to automatically extract useful metrics about each tree from point clouds. Reliable feature extraction methods are needed to achieve population-wide inventories.

OBJECTIVE: Segment individual trees from point cloud data and extract inventory features

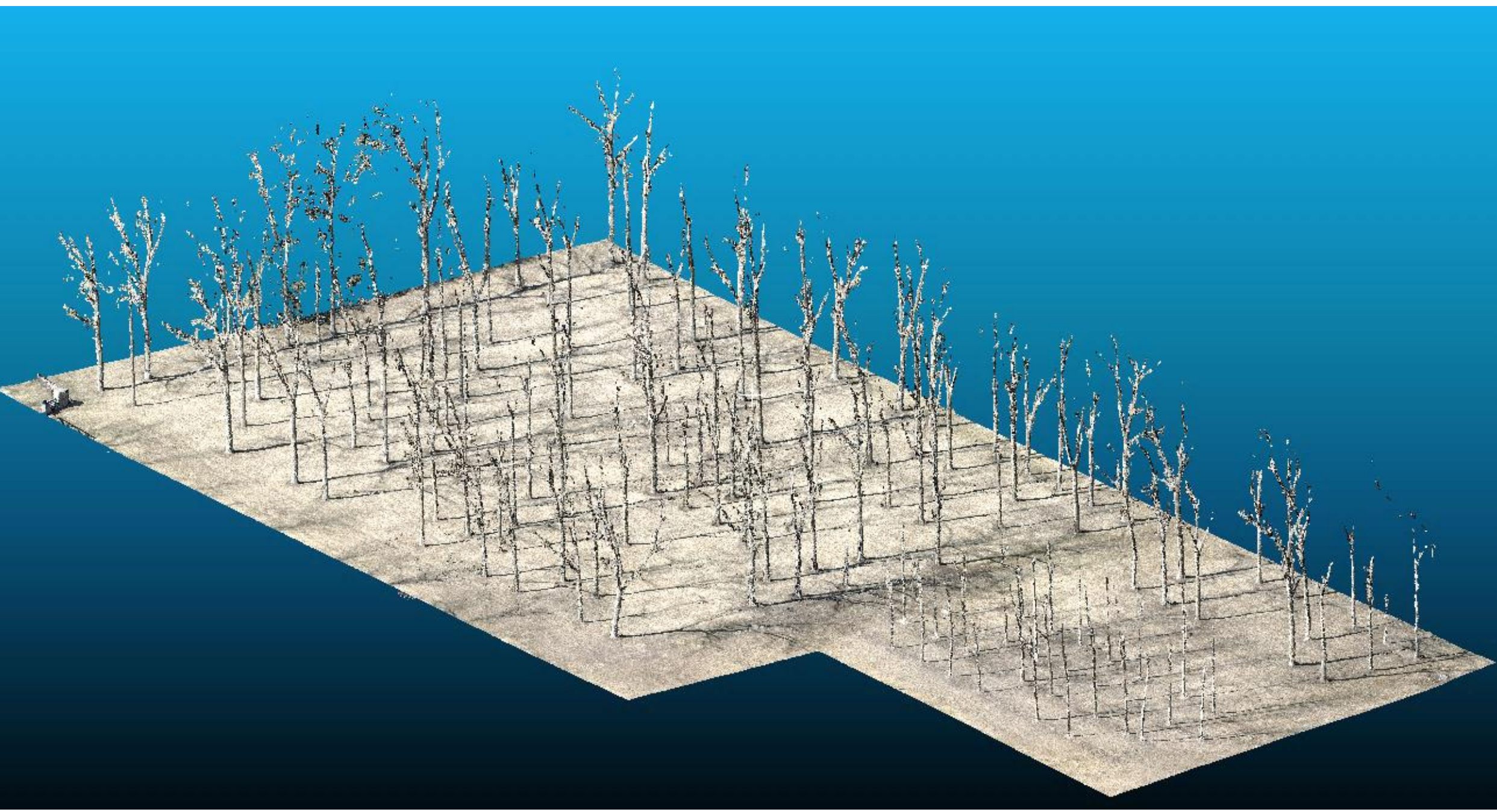
DATA ACQUISITION

Data was acquired from the DJI Zenmuse P1 mounted on the M-300.

Season: Leaf-off
Camera: 35mm 45MP
Altitude: 80m
Overlap/Sidelap: 90/90



Mission Plan over Walnut Plantation – Martell Forest

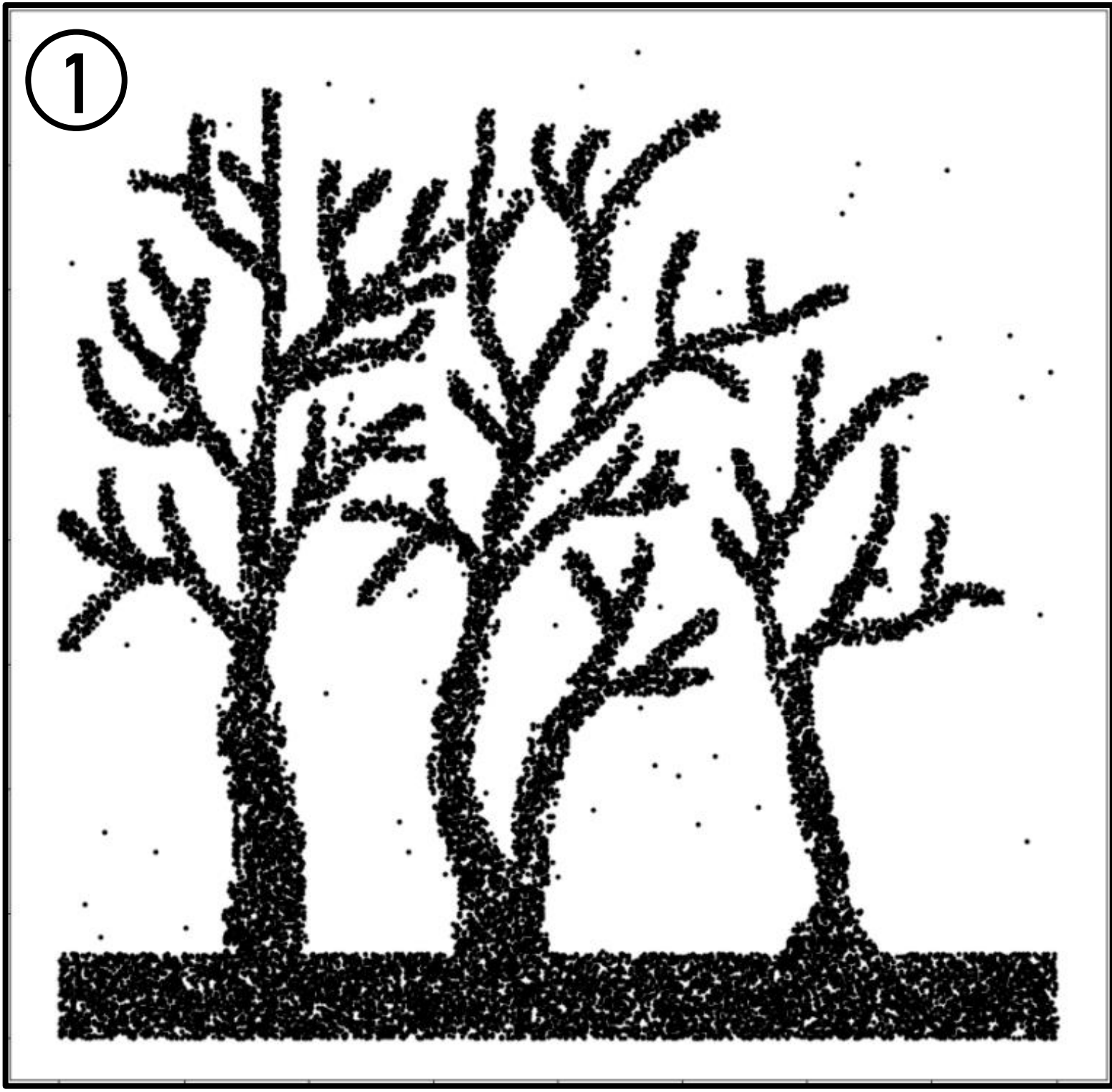


Photogrammetrically Derived Point Cloud of Plantation

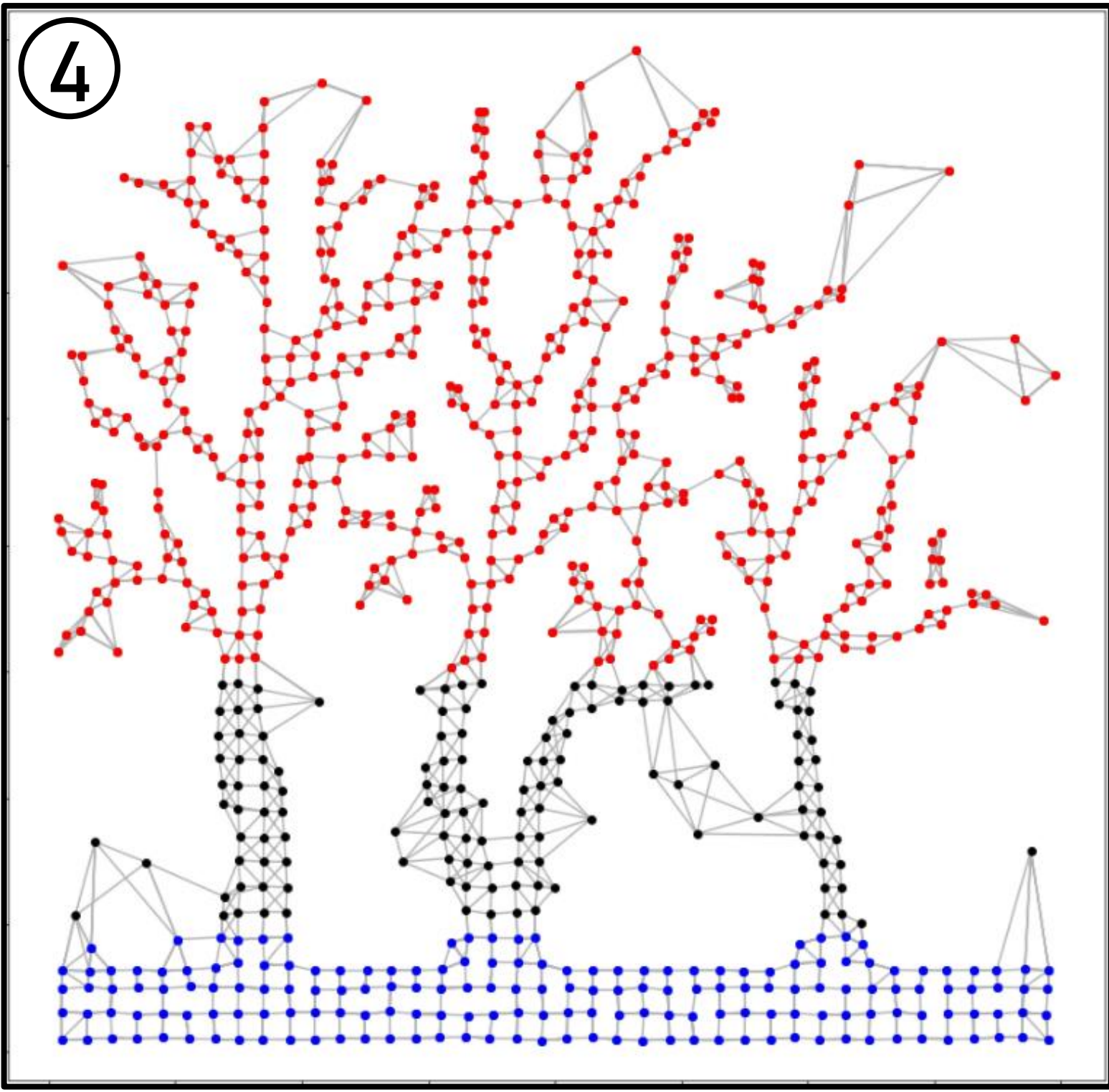
Agisoft's Metashape was used to construct a 3D point cloud from the UAV imagery. Leaf-off conditions make trunks easy to identify.

METHODOLOGY

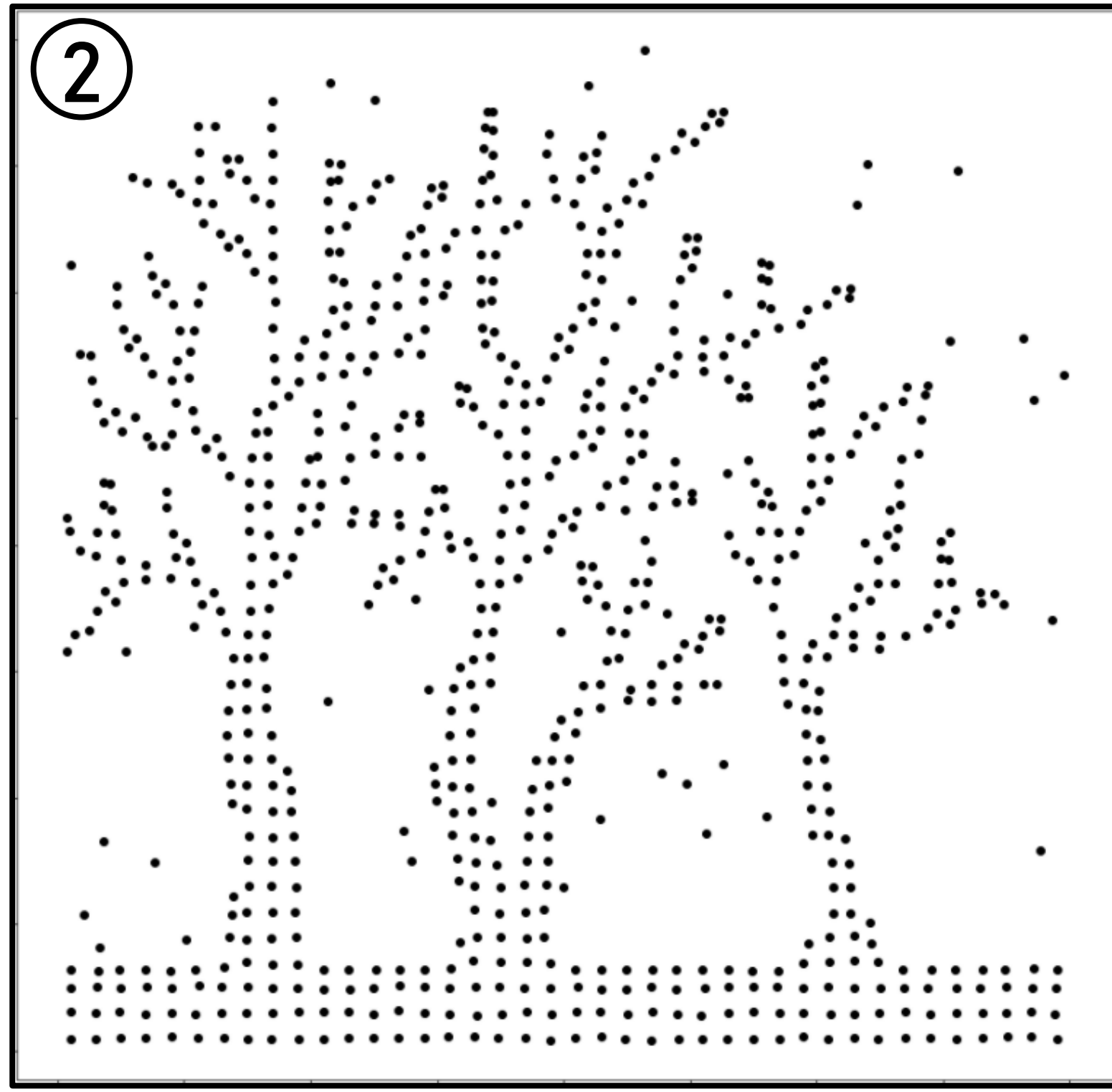
A graph-base clustering algorithm was developed to segment individual trees from the point cloud data. The following toy example demonstrates procedure utilized for segmentation



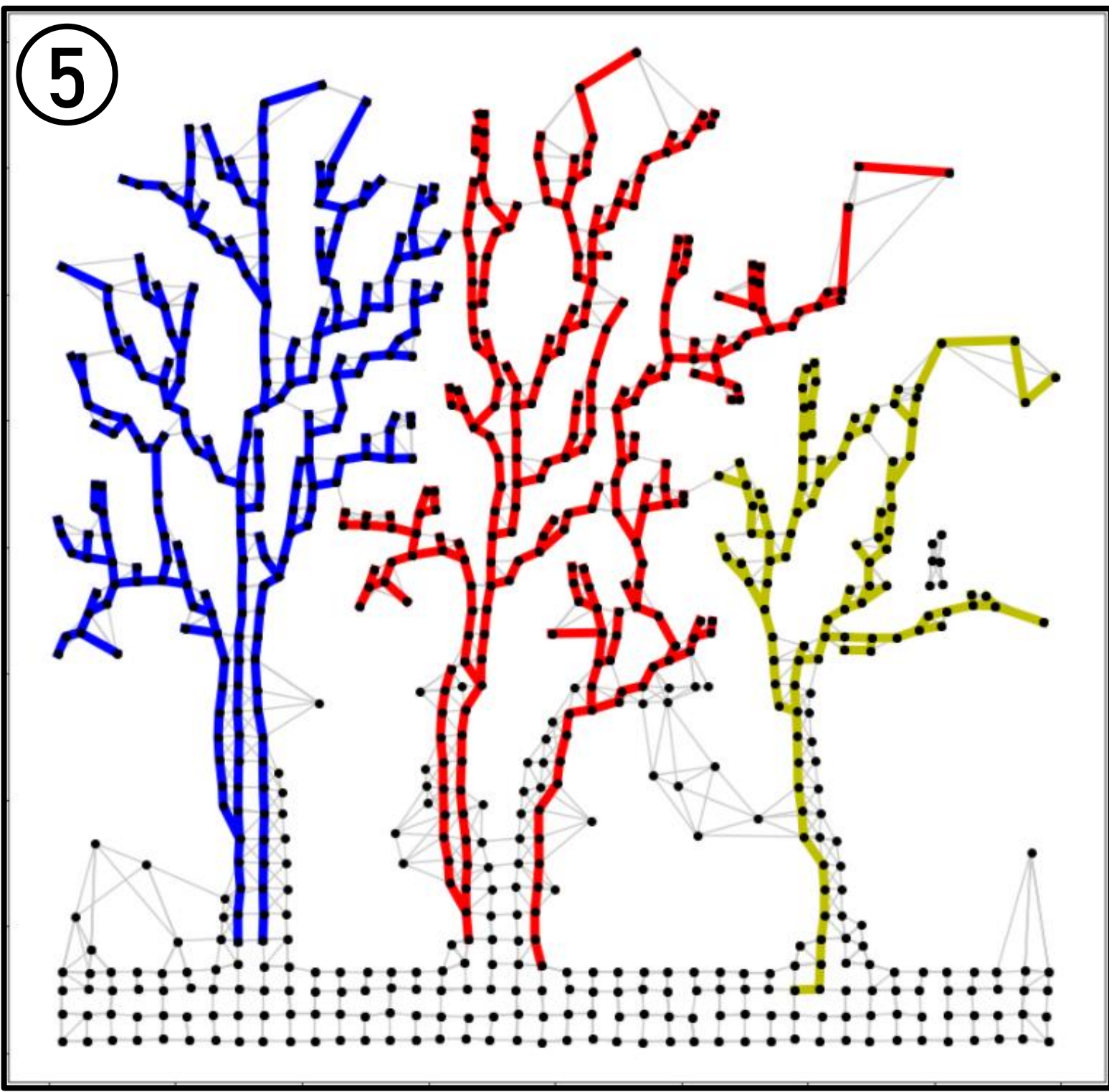
Point Cloud



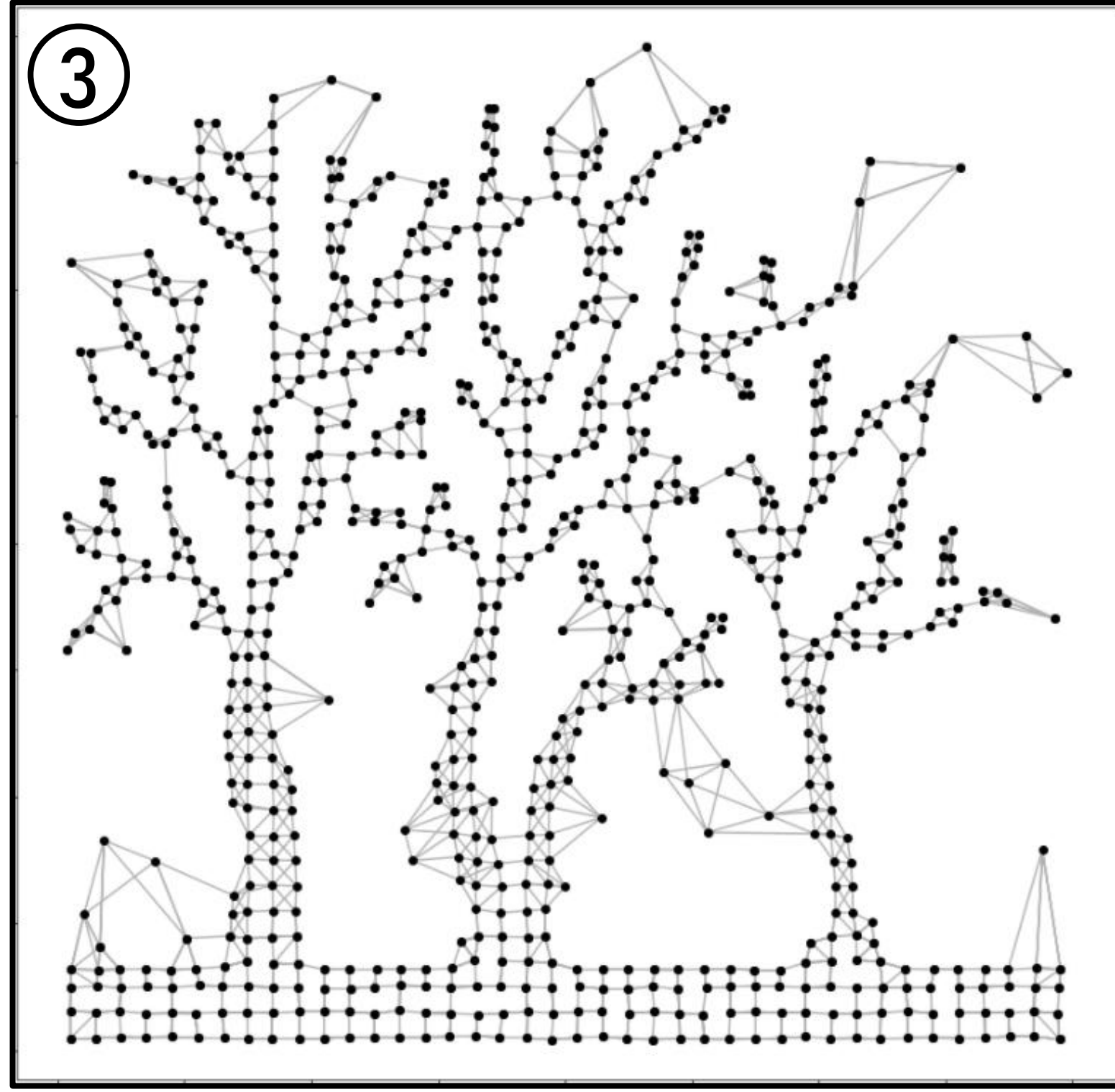
Classify: **Canopy** and **Ground**



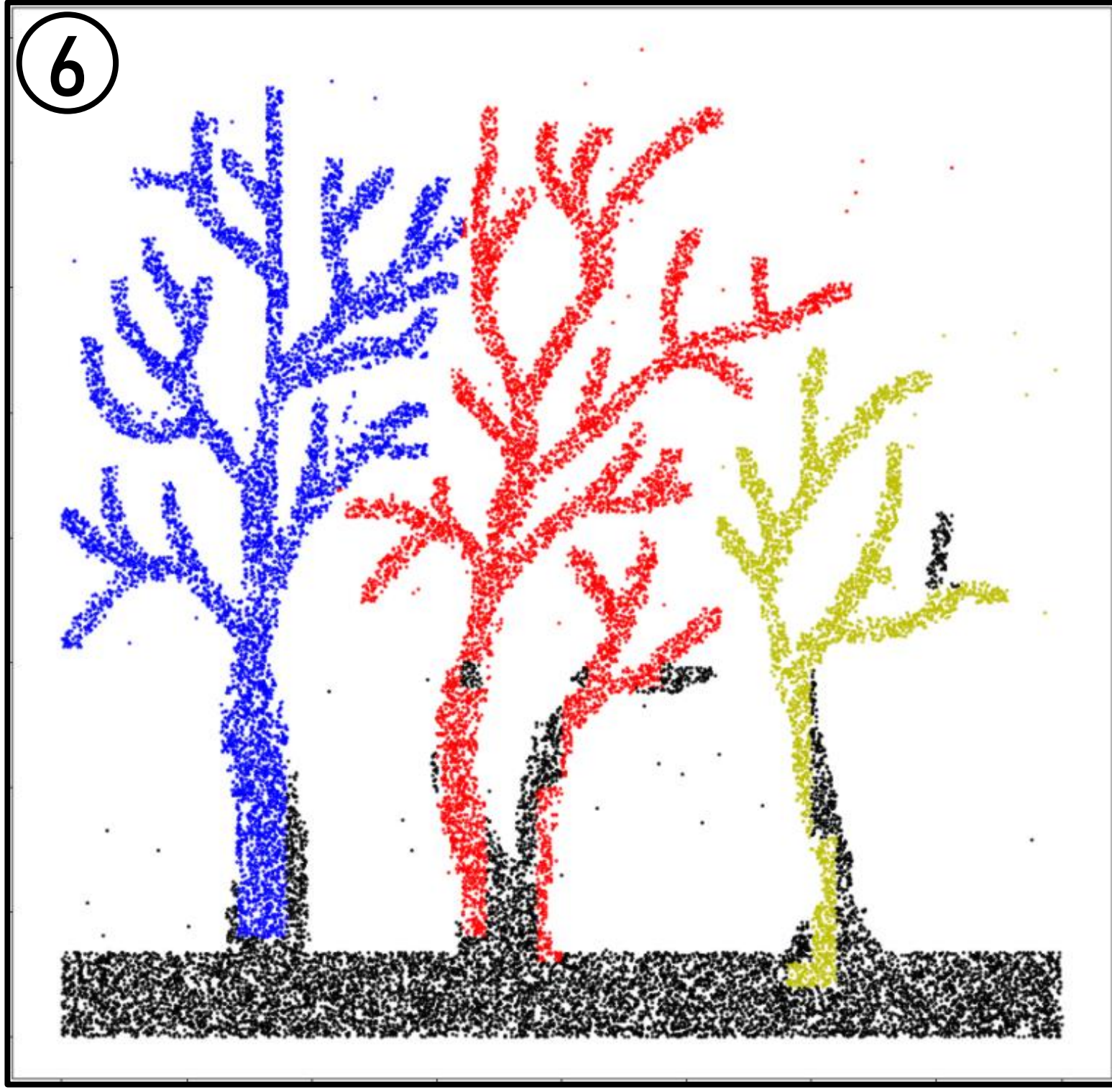
Voxel-based Reduction



Find shortest path from all canopy points to the ground.



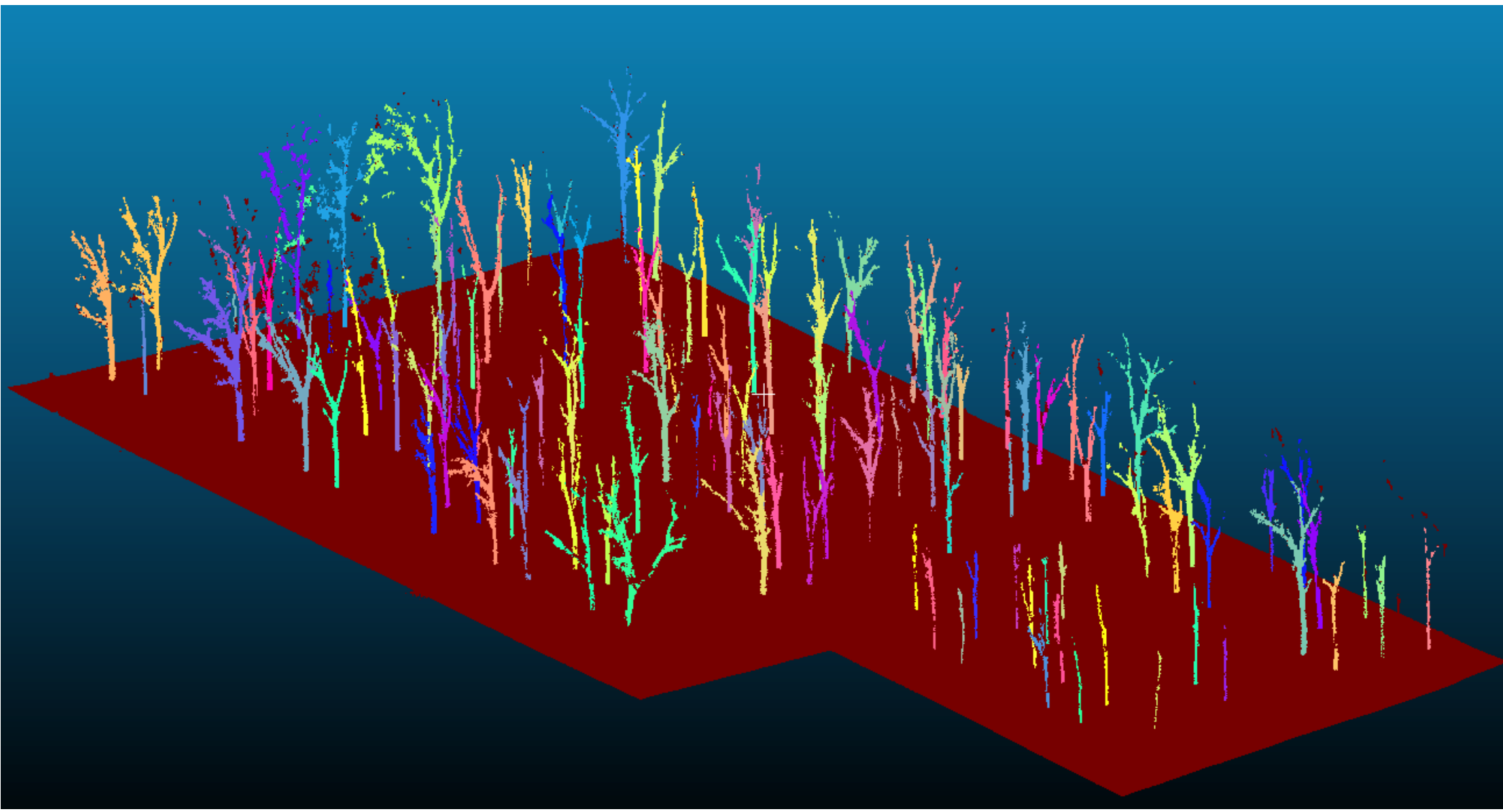
Graph Definition



Segmented Point Cloud

RESULTS

The tree extraction algorithm was applied to the photogrammetrically derived point cloud. All points were labeled by tree. Then each tree was segmented for feature extraction.



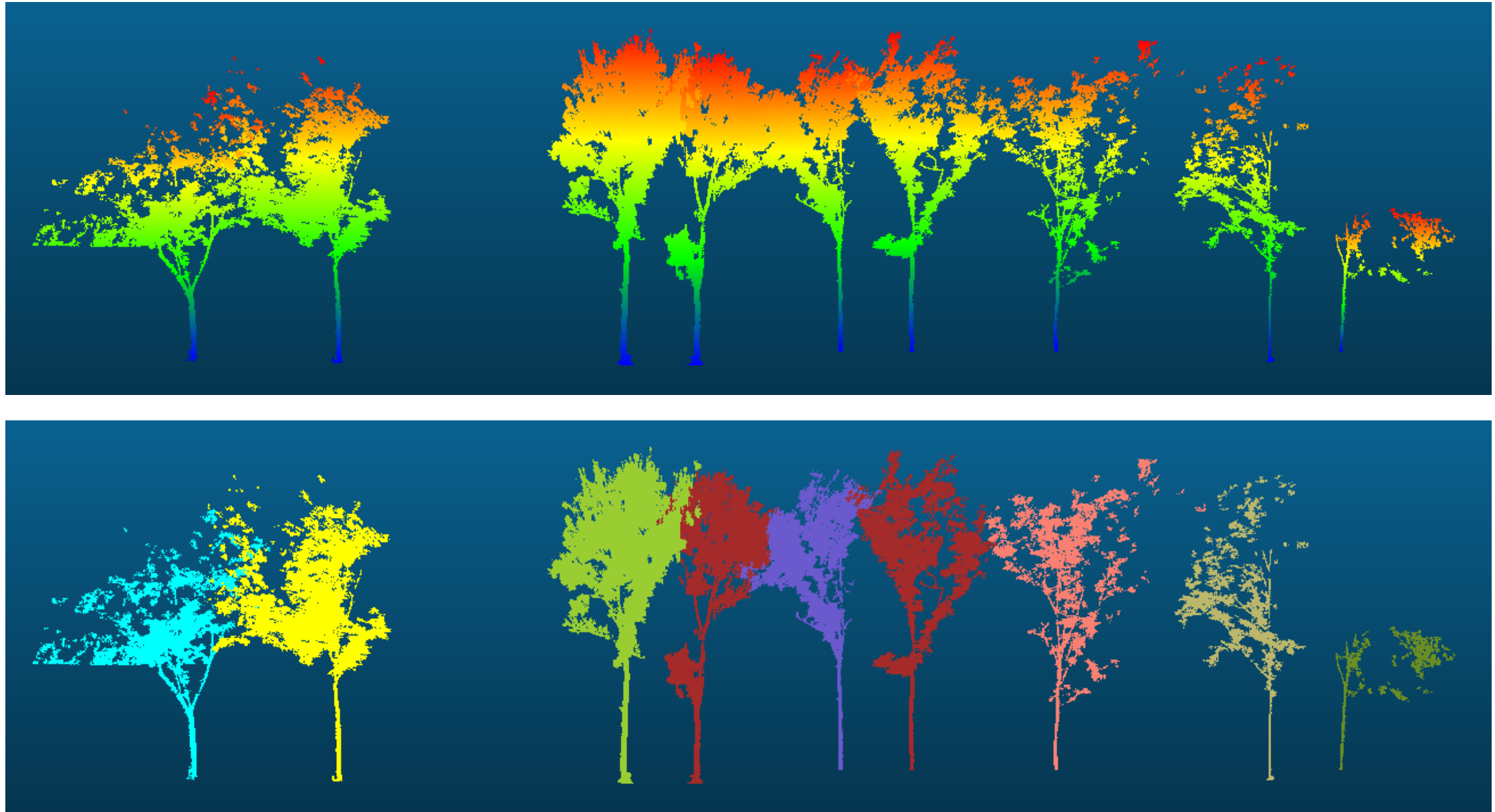
Classified photogrammetrically derived point cloud



Detected tree locations vs. known positions

The detected location of each tree ● was plotted against known centers ● showing 126/130 trees were detected with 0 commission errors.

The algorithm was applied to forest point clouds from a terrestrial laser scanner during Leaf-on conditions. Visual results indicate that the algorithm generalizes across acquisition platforms.

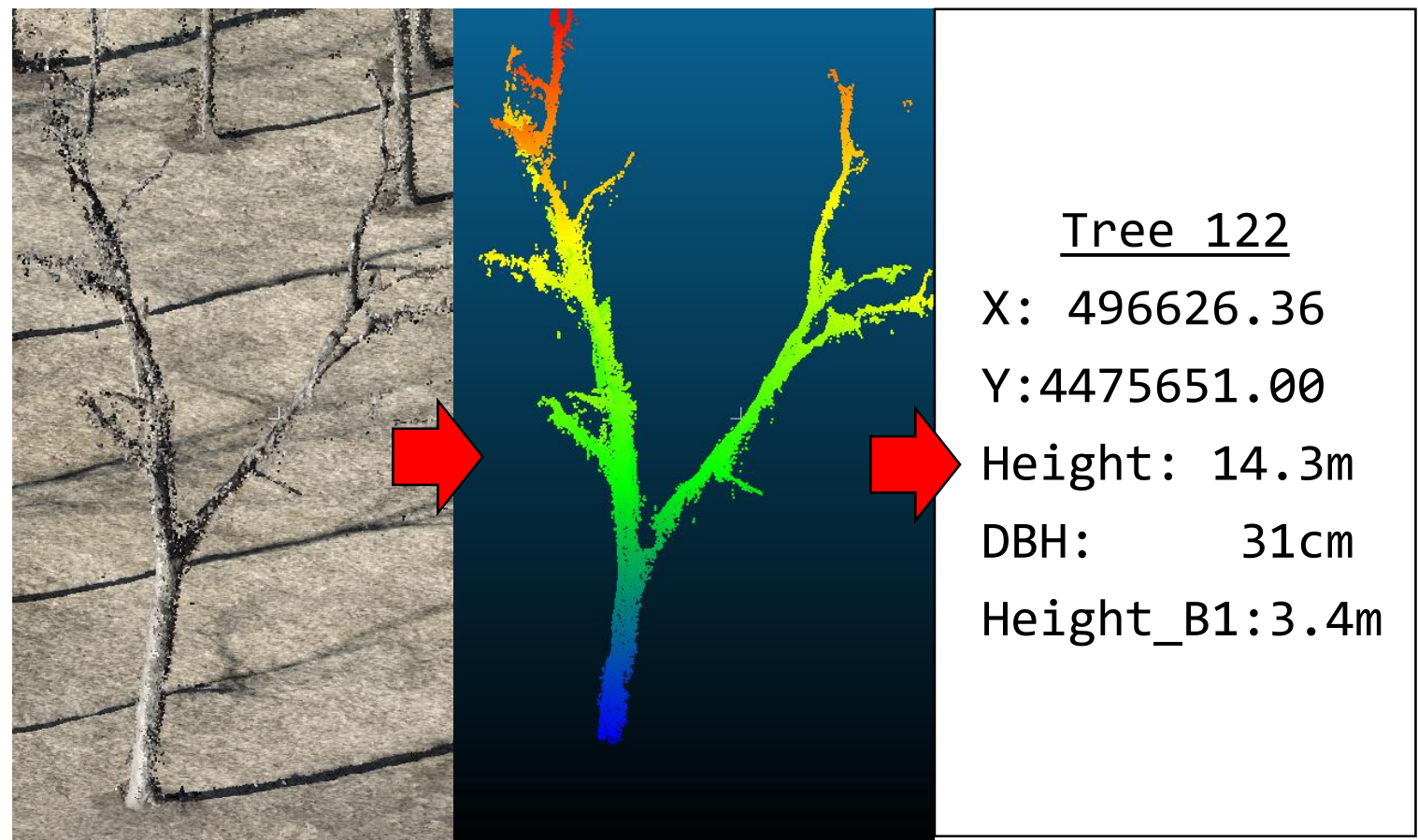


(TOP) Single plot row captured by stationary Laser Scanner
(BOT) Single plot row segmented by the presented algorithm

APPLICATIONS

UAV-mounted sensors can produce point clouds of large forest stands. The algorithm presented here segments individual trees from point clouds, paving the way for automatic tree feature extraction at the individual tree level. This capability is useful for

- completing total population forest inventories
- building high-accuracy forest biomass datasets
- monitoring and mapping orchards, and
- miscellaneous tree mapping.



Point cloud - Segmented tree -> Features

Tree_122
X: 496626.36
Y: 4475651.00
Height: 14.3m
DBH: 31cm
Height_B1: 3.4m