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Improving kinematic laser scanning point cloud accuracy with graph optimization

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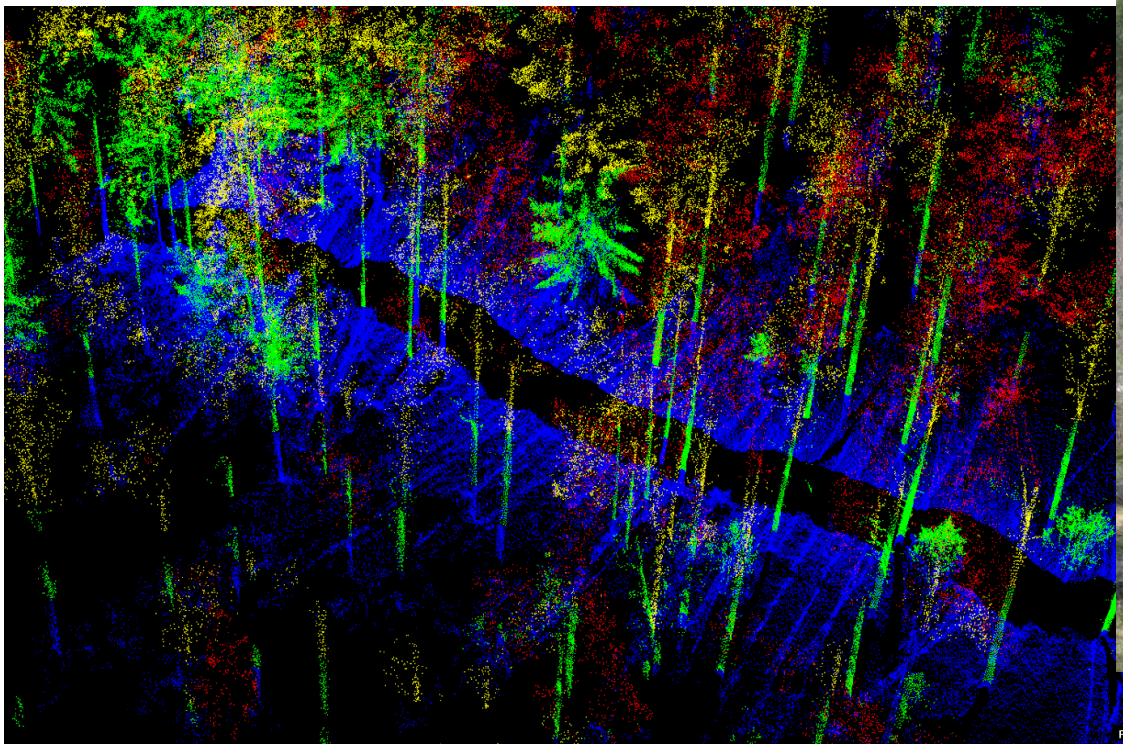
Background

- Forest inventory
  - Data from forests to support decision-making and management decisions.
  - Individual tree attributes such as height, stem curve and tree locations

- Data collection
  - 3D Laser scanning (LIDAR)
  - Set of range estimates from the scanner (point cloud in 3D-space)
  - Combining the separate point clouds using point cloud respective location data such as GPS

Backpack MLS



What happens if some point clouds don’t have GPS-timestamps?

Goal

- Improve the accuracy of 3D forest point cloud using Graph-SLAM algorithm

- Test the algorithm on data from new forest environment, report the results by comparing them to reference data and suggest improvements to the algorithm.

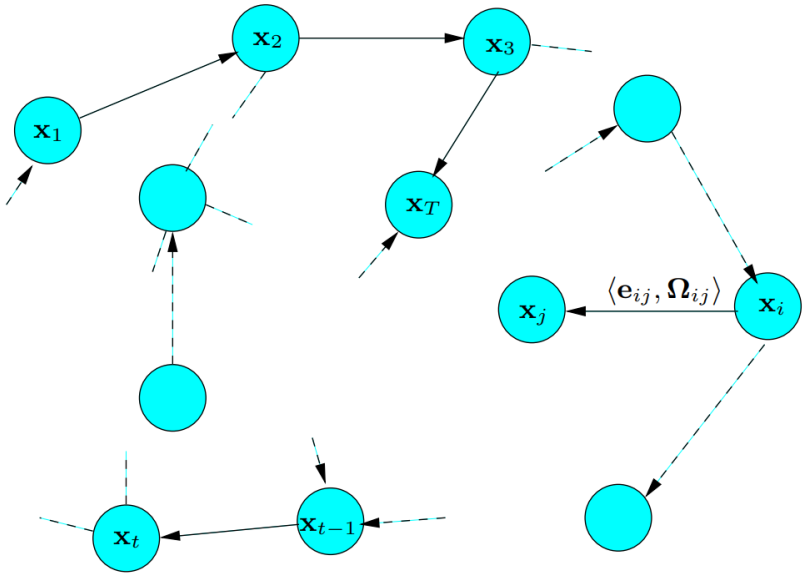
- In this new environment, is it feasible to use MLS scanning for forest inventory needs?

Methods: Forest Graph-SLAM

- Graph-SLAM
  - Numerically estimates the location and environment map of a moving sensor.
  - In this case, sensor data is in point cloud and GPS format.
  - Obtains the estimates as a solution to a non-linear least-squares minimization problem presented as a graph

- Programming tools:
  - C++ Library for the least-squares optimization
  - Python-scripts for Graph creation
  - Matlab-toolbox for point cloud and trajectory visualization and analysis.

Methods: Graph-optimization problem



$$F(x) = \sum_{i,j \in C} e(x_i, x_j, z_{ij})^T_{ij} \Omega_{i,j} e(x_i, x_j, z_{ij})$$

$$x^* = {}_x{}^{argmin} F(x),$$

Find a set of poses that minimize the value of the error function. Constraints (z) are created from GPS-data

Restrictions

- Analyze constant size forest plots of the similar environent in Evo test area

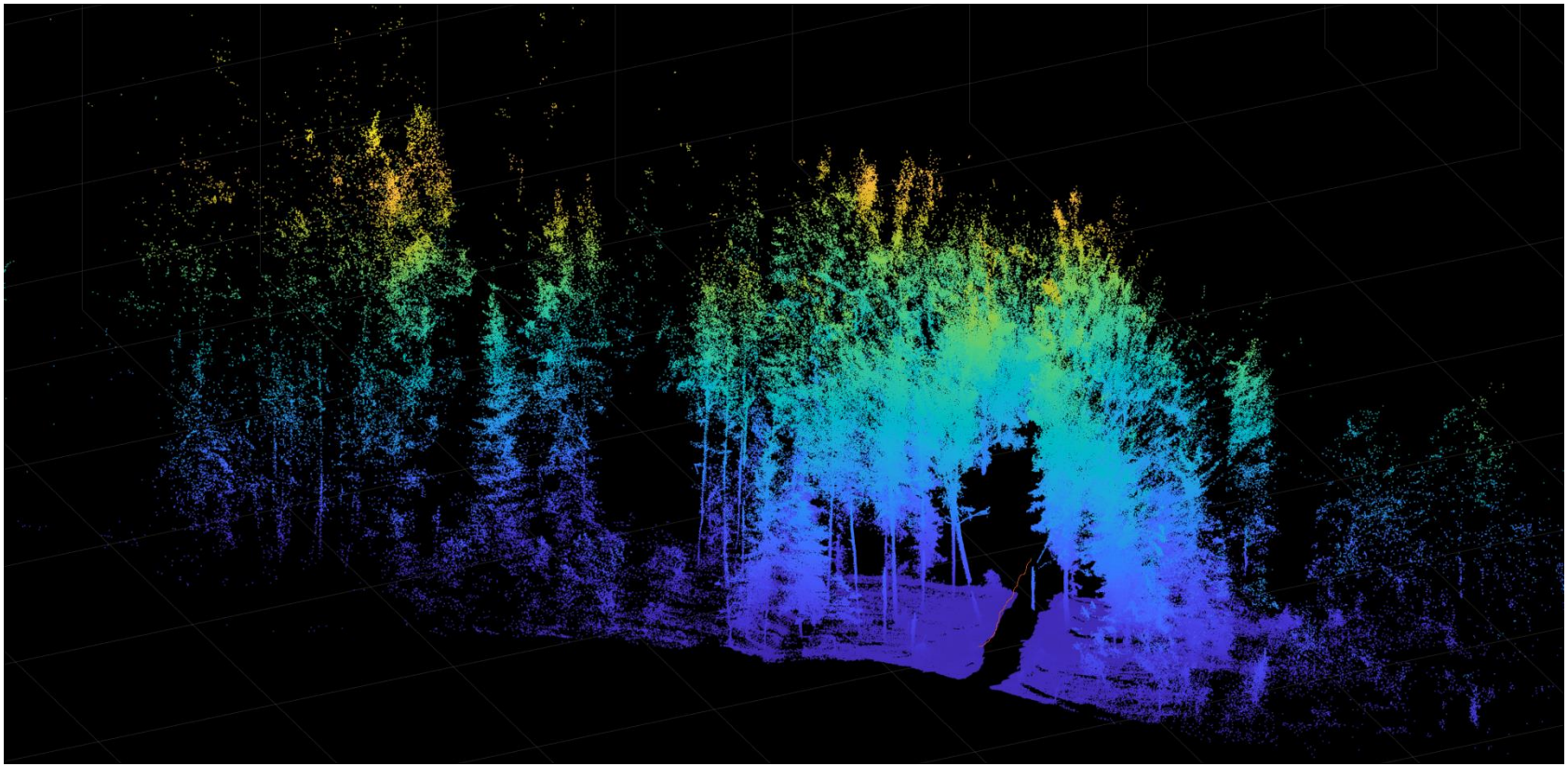
- 2 types of constraints used with tree locations data
  - Constraints between consecutive poses (GPS-data)
  - Constraints between loop closure poses (tree observations)

- Tree locations are estimated by combining stem-like arcs from the data. No reference data is used for tree locations.

Data Sources

- Georeferenced point cloud data from backpack laser scanner and GPS trajectory information
- Reference point cloud data from stationary laser scanners (guaranteed GPS-signal)
- Forest plots in Evo, Hämeenlinna

Example of single data file



Schedule

- 06/2021 – Presenting the topic
- 06-07/2021 – Adjusting the algorithm
- 07-08/2021 – Performing the optimization on the data and analysing the results
- 07-09/2021 – Writing Thesis
- 09-10/2021 – Presentation of the Thesis