EduServ 23rd Distance e-Learning Courses
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EuroSDR
European Spatial Data Research

NLS FINNISH GEOSPATIAL RESEARCH INSTITUTE FGI

Point Cloud Processing with Laser Scanning

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Dates: April 7-18, 2025

Target audience: Staff of national mapping agencies, researchers, academics, students, private companies

Prerequisites: Familiarity with the basic understanding of Remote Sensing and Surveying. There are separate exercises in modules 4 and 5 for those having a background in computer science and those wanting to learn widely basic principles (surveying background but not programming).

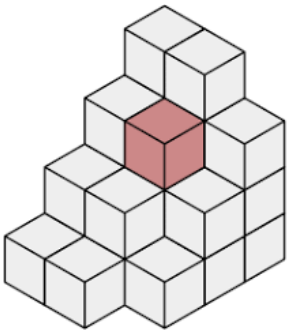
Course objectives: Today, there is a large number of mobile and airborne laser scanning point clouds acquired with a large number of different systems, such as hand-held, backpack, under-canopy and above-canopy drones, and drone systems. Laser Scanning has become a standard tool for providing 3D of surrounding environments in non-built and built environments. This course will provide an understanding of how such point clouds could be processed into informatics. Introduction is given to laser scanning physics and general point cloud processing techniques, and then more focus is given to AI, namely machine-learning and deep-learning approaches in point cloud processing. Several applications are covered. Many examples are coming from forestry, where laser scanning has already revolutionised traditional works.

Topics tackled: The lecture at a precourse seminar in Espoo will provide an introduction to understanding point cloud processing broadly with laser scanning. It will also give those not working with computer science an understanding of algorithmic thinking. A more detailed focus is given to machine/deep learning–type object detection.

Module 1: Understand of laser scanning and related physics

This introductory module refreshes the basic concepts of airborne laser scanning (ALS) and mobile laser scanning (MLS) including multispectral and single-photon laser scanning from various platforms, positioning using IMU and GNSS, Simultaneous Localization and Mapping (SLAM), and map matching/High-definition maps. MLS platforms include a) phone-based scanning, b) vehicle-based scanning, c) drone-based scanning, and d) hand-held, backpack and other personal laser scanning techniques. The physics of intensity is discussed. Basic processing of data into DEM, DSM, nDSM/CHM is covered. Module material covers articles related to these topics. Module exercise is based on multiple-choice questions from related articles.

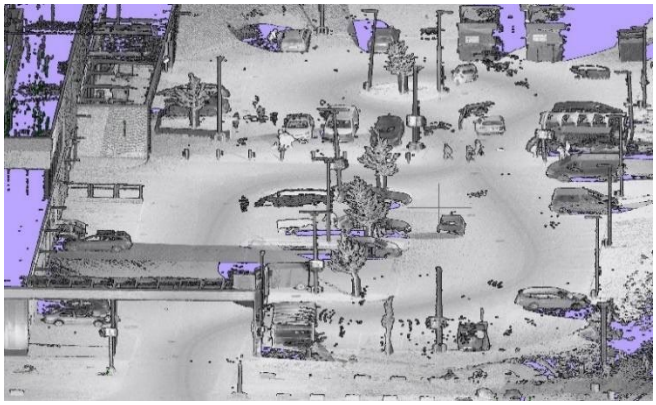
Module 2: Algorithmic thinking with laser scanning



After module 1, participants understand the working principle of laser scanning data. Algorithmic thinking is then exercised in Module 2. The basics of data processing (data types, common approaches, clustering/segmentation, use of temporal data, flow charts, computational cost, point cloud matching, change detection, classification of points, heuristic algorithms, and common computer vision tools) are covered. Module material covers articles and slides related to these topics. The module exercise is based on multiple-choice questions from related articles.

Module 3: Basic algorithms with point cloud processing

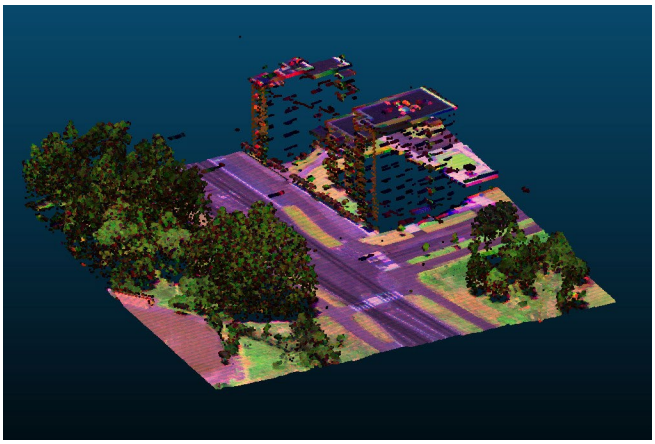
After module 2, participants have a good, basic understanding of how laser scanning data can be turned into informatics. In this module, more details of specific algorithms are studied. Change detection, coarse registration, feature extraction and classification of objects is covered. Module material covers articles and slides related to these topics.



Module 4: Advanced algorithms with point cloud processing – machine learning

Module 4 enlarges the point cloud processing knowledge of the participant more into the use of machine learning (ML). The module material covers basics and traditional shallow algorithms of ML, and how they can be used with point clouds. Module 4 also covers feature extraction as well as model selection and validation. The module contains lessons supported by articles and additional material, exercises, and a course project assignment. In the course project, students can choose between Python programming exercises and essay assignments.

Module 5: Advanced algorithms with point cloud processing - deep learning



The last module provides the course participants with an overview of Deep Learning (DL) methods, and how they are applied to point cloud data. The module material covers the basics of DL (architectural building blocks, training, hardware selection and software frameworks), presents the latest DL architectures for point cloud classification and semantic segmentation (2D and 3D raster, 3D point-wise), and discusses data preprocessing (for training and inference uses). Module material consists of lectures (lessons, slides and video recordings) and practical programming exercises. Python programming language is used in the exercises. However, previous knowledge of Python is not mandatory to pass the module.