Deep Learning for Tree Detection and Measurement with LiDAR Data

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In the context of global climate change and increasing deforestation, the importance of sustainable forest management is evident. This scientific work aims to enhance the accuracy and efficiency of forest inventory and tree detection by investigating the potential of Switzerland‘s area-wide LiDAR data from the Federal Office of Topography, swisstopo for tree detection.

Introduction and Objectives

Today‘s manual methods for tree surveying and maintaining a tree inventory are time-consuming. For this reason, LiDAR technology with its three-dimensional point clouds could be a cutting-edge solution for the detection and measurement of trees. The aim of this research is to explore how the use of LiDAR data, which is available for almost the entirety of Switzerland, can achieve these requirements. The primary objective is to improve the efficiency and accuracy of forest inventories and to investigate how this high-precision LiDAR data can contribute to the automatic detection of individual trees.

Methods

This thesis focuses on four objectives:

- Analysis and evaluation of existing research
- Creation of a dataset utilizing the tree inventory of the city of Zurich and LiDAR data from swisstopo
- Training of the deep learning model for automatic recognition in point clouds, including various preprocessing steps
- Evaluation of the model‘s performance using a dedicated test dataset; all data analysis and practical implementation is conducted using Python and the deep learning model PointNet

Results

The findings reveal that using LiDAR data for tree detection with deep learning is feasible, but the data quality and dataset balance are the main factors affecting the performance of a deep learning model. In addition to the deep learning model, the research also investigated the accuracy of LiDAR data and confirmed that the developed methods can provide high-quality results. The results clearly demonstrate the ability to use the obtained data for this purpose, showing that the determination of height and positioning based on the developed approaches is possible with a tolerance of 1 cm.

Implications and Recommendations

The results of this study underscore the significant promise of combining LiDAR and deep learning for forestry, offering a robust tool for data collection and analysis. Additionally, this research serves as a valuable foundation for future research. It is recommended that subsequent and targeted research be undertaken in the fields of dataset enhancement, tree segmentation, and the refinement of deep learning models.

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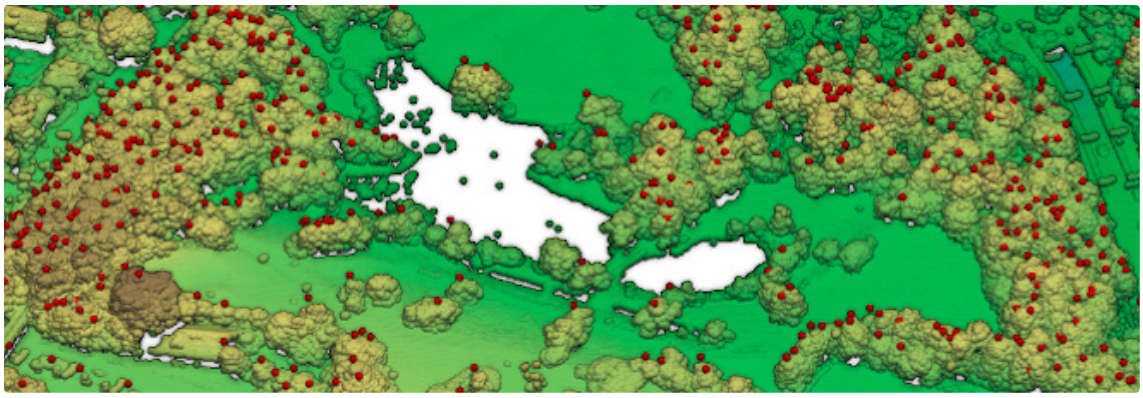

Figure 1: Tree identification based on the methods and models developed