Assignment 1

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Applied Deep Learning

Multi-Class Segmentation of Tree Species Using UAV Imagery and U-Net

1. References to Related Scientific Papers

1. Ronneberger, O., Fischer, P., & Brox, T. (2015). *U-Net: Convolutional Networks for Biomedical Image Segmentation*. This work introduced the U-Net architecture, which has become a standard for image segmentation tasks across multiple domains, including remote sensing and vegetation analysis.
2. Sinan, M. (2022). *Semantic Segmentation of Dead Trees (Picea abies) Using Deep Learning.* Master's Thesis, Hochschule für nachhaltige Entwicklung Eberswalde. This study applied deep learning for forest health monitoring using UAV imagery, providing both a methodological foundation and the dataset for this research.

2. Topic Selection

Multi-Class Segmentation of Tree Species Using UAV Imagery and U-Net

The project mainly focuses on distinguishing multiple tree species from UAV orthophotos using a convolutional neural network (CNN) architecture, specifically the U-Net model.

3. Project Type

Bring Your Own Method

This project builds upon an existing dataset and adapts a state-of-the-art segmentation method (U-Net). The goal is to apply and optimize this architecture for multi-class tree species segmentation in mixed forest environments. The project will include model development, fine-tuning, and performance evaluation using standard metrics.

4. Written Summary

a. Project Description and Approach

The goal of this project is to develop a U-Net-based deep learning model for the semantic segmentation of multiple tree species using UAV imagery. Traditional ground-based forest inventories are labor-intensive and limited in scale. By contrast, UAV remote sensing offers high-resolution spatial data that can be analyzed using machine learning to automate tree species identification.

The U-Net model will be employed due to its strong performance in semantic segmentation tasks. It uses an encoder–decoder architecture with skip connections that preserve spatial information, enabling precise per-pixel classification. The network will be trained and fine-tuned to classify multiple tree species present in the Haselberg forest area in Brandenburg, Germany.

b. Dataset Description

The dataset used in this project is titled *"Dataset used for the Master's Thesis on Semantic Segmentation of Dead Picea abies Trees Using Deep Learning"* by Muhammed Sinan (2025), published on Zenodo (DOI: 10.5281/zenodo.15168163).

The dataset consists of UAV-based orthomosaic imagery and shapefiles collected from the Haselberg study area near Prötzel, Brandenburg, Germany. The shapefiles contain individual tree crowns annotated with health classes (0 = Healthy, 1 = Slight Damage, 2 = Moderate Damage, 4 = Dead).

For this project, the dataset will be expanded with new annotations to include multiple tree species (e.g., *Picea abies*, *Pinus sylvestris*, *Quercus robur*). These new species labels will be integrated into the existing dataset to enable multi-class segmentation. All data will be preprocessed and tiled into 512×512 or 1024×1024 pixel images suitable for neural network training.

c. Work Breakdown Structure and Time Estimates

Task	Estimated Time (hours)
Literature Review and Planning	10
Dataset Preparation and Annotation	25
Network Design and Setup	15
Model Training and Fine-Tuning	30
Evaluation and Analysis	10
Report Writing and Documentation	10
Presentation Preparation	5
Total Estimated Time	**105**