R&D Project Submission

Hochschule Bonn-Rhein-Sieg
University of Applied Sciences

PROJECT SUBMISSION FORM
Master's Program in
Autonomous Systems

A. Student information

1. Name

Shrikar	Nakhye

2. Study info

Enrollment number	Started program
9050125	10 October 2025

3. Contact info

Email	Phone number
University	15219520308

B. Project information

1. Project type

R&D ☒   Thesis ☐

2. Report dated

Date (dd. mm. yyyy)
26.04.2025

3. Project duration

From	To
10.10.2024	02.05.2025

4. Project info

Title

LiDAR Point Cloud Terrain Segmentation

Abstract

Forests present a highly heterogeneous environment composed of terrain, vegetation, tree trunks, tree stumps, and other natural elements. The irregularity of Earth's topography, combined with dense vegetation and occlusions, poses a significant challenge to distinguish terrain from other environmental components, particularly when using traditional machine learning approaches. A major bottleneck in this task lies in the feature extraction process from noisy and partially labeled 3D point-cloud datasets, which often lack semantic consistency and spatial clarity. This report proposes a robust and adaptable pipeline for semantic segmentation of 3D point clouds, using 2D annotations to guide learning. Our method integrates state-of-the-art feature extraction techniques and clustering algorithms to isolate tree stumps and terrain as independent semantic clusters. The proposed approach achieves a segmentation accuracy of 34.23\% for terrain and XX\% for tree stump detection classification in a forest UAV dataset of benchmark containing more than 2.5 million points. Furthermore, it demonstrates resilience to noise and generalizes well across different terrains. The results of this work are highly applicable to forest monitoring based on UAVs, with potential extensions to vegetation indexing, biomass estimation, and land use analysis in both forested and urban settings. The pipeline not only addresses the limitations of existing methods, but also sets a strong foundation for scalable, real-time environmental perception in ecological research and smart forestry initiatives.

5. Supervisors

1st supervisor's name	1st supervisor's affiliation
Prof. Dr. Sebastian Houben	

2nd supervisor's name	2nd supervisor's affiliation
Ahmad Drak	

3rd supervisor's/advisor's name	3rd supervisor's/advisor's affiliation
Maximilian Johenneken	

4th supervisor's/advisor's name	4th supervisor's/advisor's affiliation

C. Agreement

1. Candidate

Date (dd. mm. yyyy)	Signature

Please ensure that the items listed below are complete before submission to the department office:
 ☐ **A hard copy of the report/thesis per supervisor (in the case of a thesis, copies should be signed and dated)**

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 ☐ **One additional signed and dated hardcopy of the thesis**
 ☐ **For each hard copy (there should be number of supervisors + 1 copies), a CD/DVD containing:**
  ☐ **The thesis in pdf format**
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   include the name of the company with whom the thesis was written
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