Automated Vegetation Management for High-Voltage Transmission Lines

Using Drones and Photogrammetry

Graduate

Dominik Gschwind

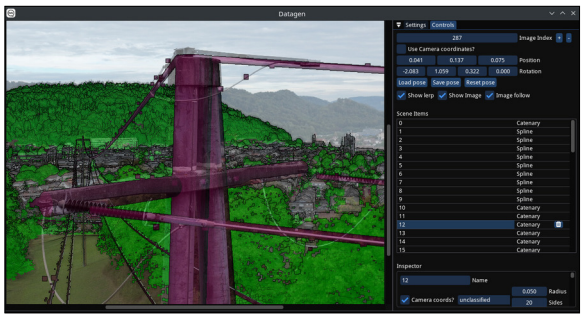
Alejandro Gloor

Introduction: Linia AG develops and distributes software for the automated inspection of high-voltage lines using drones. For this purpose, Linia has developed flight planning software that employs a digital twin of high-voltage lines to calculate an optimal flight pattern which is then automatically flown by a drone. In addition to monitoring, vegetation management is also a significant concern for operators of transmission lines. This entails verifying the safety distances to vegetation. Up to this point, vegetation management has been conducted manually. However, many power lines are not easily accessible, which makes checking the clearances more difficult and labor-intensive.

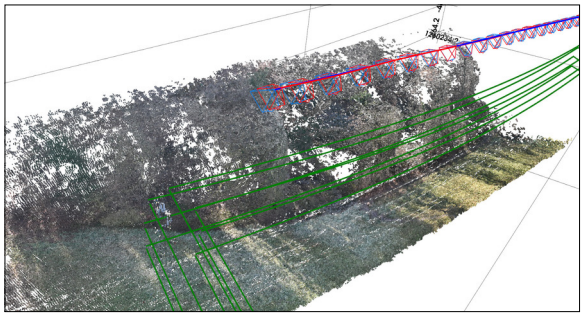
Objective: The objective of this thesis is to utilize drone-captured images for the purpose of automated vegetation management. To this end, the images must first be processed to recognize both the transmission lines and the vegetation. This is accomplished through SLAM (Simultaneous Localization and Mapping), which generates a 3D model of the transmission lines and the vegetation. This model is then used to calculate and verify the safety distances. A deep learning approach is employed to create the 3D model, as conventional methods are known to perform worse.

Result: A 3D labeling tool was developed for reconstructing important scene features and to align each frame's pose to an environment point cloud provided by swisstopo. The labeled dataset and rendered depth maps were used to train a deep-learning SLAM system based on DROID-SLAM. It is capable of generating a point cloud and camera trajectory from a stream of images which is then georeferenced using recorded per-frame orientation and GPS data. Both our trained and the baseline models exhibit bad performance when reconstructing power lines and pylons. As a solution, an algorithm was developed for finding power lines in the swisstopo point cloud given a set of cable suspension points. Measurement of safety distances becomes possible when combining detected power lines and the reconstructed point cloud.

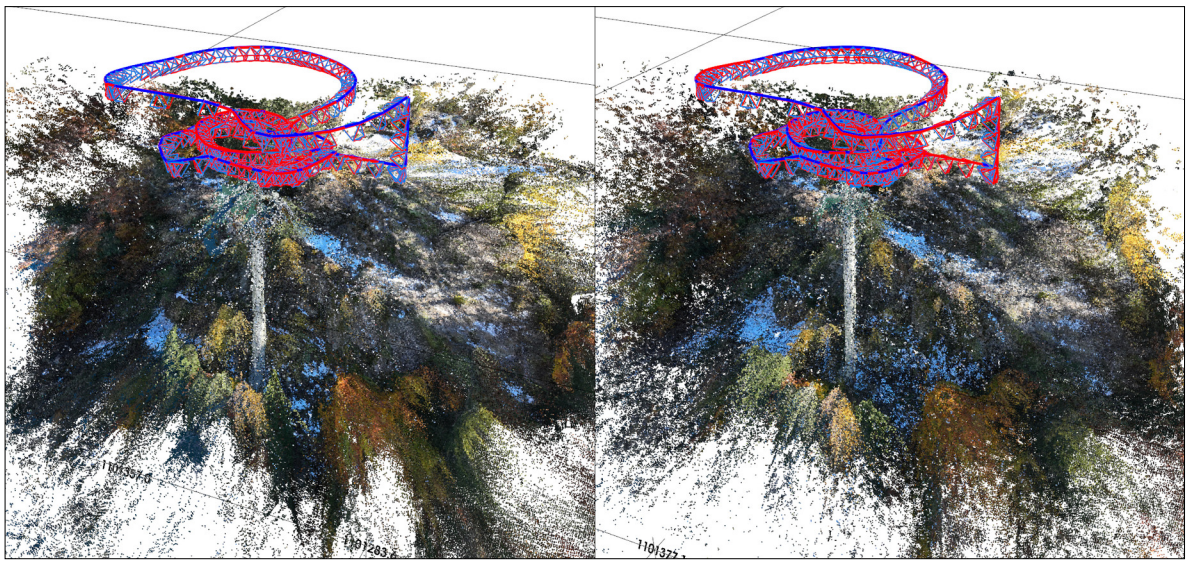
3D Labeling Tool.
Own presentment



Georeferenced 3D reconstruction including camera poses and detected power lines.
Own presentment



Comparisson of a reconstructed scene between the baseline (left) and our trained model (right).
Own presentment



Advisors
Hannes Badertscher, Michael Schmid

Co-Examiner
Gabriel Sidler, Teamup Solutions AG, Zürich, ZH

Subject Area
Artificial Intelligence

Project Partner
ICAI Interdisciplinary Center for Artificial Intelligence, OST - Ostschweizer Fachhochschule, Rapperswil, SG / Linia AG, Zürich, ZH