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Master's Thesis
Outdoor 3D Reconstruction using a Combination of Laser Scanners and Camera Drones

3D reconstruction describes the process of calculating spatial information of a real scene and is an important task in the research fields of computer graphics and computer vision. Over the years, several approaches were developed and improved to create digital representations of real-world objects. A method, called photogrammetry, solves this problem by interpreting photographic images by using projective geometry and another method, based on Lidar technology, uses laser beams to calculate the distance to objects. The field of application is manifold and includes for example human body reconstruction for VR movie production and building reconstruction for digital monument conservation. Building reconstruction is considered in more detail in this thesis.

The goal of this thesis is to create a 3D reconstruction of the building of the Ernst-Abbe-Hochschule by combining two individual reconstruction results (photogrammetry and lidar technology) to show the benefit of this fusion strategy.

(a) 3D reconstruction using photogrammetry

(b) 3D reconstruction using Lidar technology

(c) 3D reconstruction from the Google Dataset

Figure 1: Different 3D reconstruction models resulted from different techniques and sources

In detail, the following tasks have to be worked on:

- **Research** on the theory of 3D mesh comparison metrics and 3D reconstruction, especially:
  - Photogrammetry and
  - Lidar technology
- **Data capturing** of the outdoor area of the EAH building (house 1, 2, 3) using the following two methods:
  - Capturing RGB images using the Mavic 2 drone
  - Capturing raw 3D point clouds using the Artec Ray lidar scanner
- **3D reconstruction** of the captured data in order to create the following three datasets:
  - Using existing tools (e.g. Meshroom, Colmap, Metashape) to create 3D meshes from the drone images by photogrammetry (Pg Dataset)
  - Using Artec Studio to post-process the raw 3D point clouds to create 3D meshes (Lidar Dataset)
  - Combine the above mentioned datasets to create an optimised dataset (Fusion Dataset)
- **Evaluation** of the three datasets using appropriate metrics by:
  - Comparing the Pg Dataset with the Lidar Dataset
  - Comparing the Fusion Dataset with both, the Pg Dataset and the Lidar Dataset to show the benefit of the fusion
  - Comparing the Fusion Dataset with the Google Dataset
- Automatic **segmentation** and labelling of the resulting 3D models using artificial intelligence

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