Uncertainty-aware 3D Reconstruction from Multi-view Stereo

Proposal for a Master thesis topic (DE/EN)

Nienburger Straße 1, 30167 Hannover
Fakultät für Bauingenieurwesen und Geodäsie

Institut für Photogrammetrie
und GeoInformation

Prof. Dr.-Ing. habil. Christian Heipke

Dr.-Ing. Max Mehltretter

Tel.: +49 511 762-2981
Fax: +49 511 762-2483
E-Mail:
mehltretter@ipi.uni-hannover.de

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Multi-view stereo matching is commonly one of the first steps of a reconstruction pipeline aiming to reconstruct the 3D geometry of a scene using multiple images taken from different viewpoints. Inaccurate or erroneous results of this first step often have a negative impact on the subsequent processing steps and thus on the final 3D reconstruction itself if such errors are propagated unknowingly. One way to overcome this limitation is the estimation of the uncertainty associated to the depth estimates that are the result of the multi-view stereo matching process. While a number of approaches for uncertainty estimation have been presented in the literature for the binocular stereo case in recent years, the more general case of multi-view stereo has mostly been neglected.

The objective of this master thesis is to develop a methodology for predicting the uncertainty associated to multi-view stereo matching-based depth estimates, using a Convolutional Neural Network (CNN). For this purpose, first, a suitable baseline addressing the task of multi-view stereo matching is to be defined based on methodology presented in the literature. Afterwards, this baseline is to be extended to allow the prediction of both, depth and its associated uncertainty. The developed approach is to be evaluated with respect to the quality of the predicted uncertainties using different datasets to investigate the suitability of the employed model as well as the approach's general validity.

Thus, in addition to the conceptual elaboration, this master thesis also includes a practical implementation of the developed methodology. As basis for this implementation, methodology and software is provided, that was developed earlier at the Institute of Photogrammetry and GeoInformation. For the purpose of evaluation, the developed approach is to be tested on different publicly available datasets with known reference for the scene geometry. The acquisition of own data is not necessary within the scope of this work.

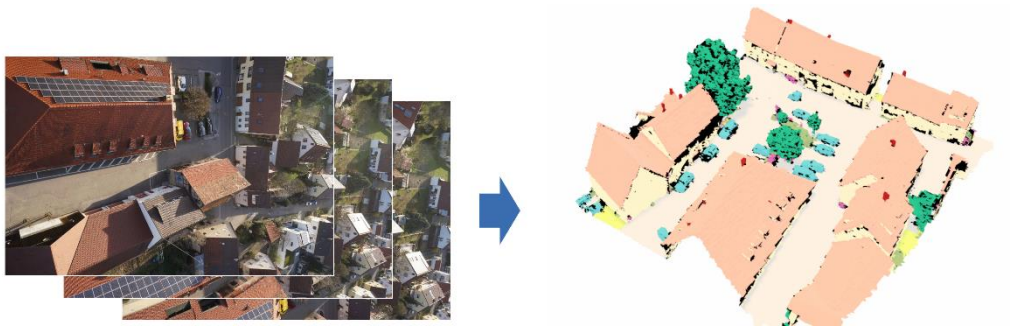

Figure 1: Example of a multi-view stereo reconstruction. Multiple images of the same urban scene taken from different viewpoints under slightly varying conditions serve as input to the multi-view stereo procedure to be developed to reconstruct the 3D geometry of this scene.

This thesis will be supervised by Max Mehltretter.

Besucheradresse:
Nienburger Straße 1
30167 Hannover
www.ipi.uni-hannover.de