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Deep Learning-based Epistemic Uncertainty Estimation for Dense Stereo Matching

Proposal for a Master thesis topic (DE/EN)

In recent years, various approaches have been presented in the literature to assess the uncertainty associated to depth in the context of dense stereo matching (see Fig. 1). Most of these approaches focus only on aleatoric uncertainty, which describes stochastic effects and is contained in the data or measurements. Typical effects causing aleatoric uncertainty in the context of dense stereo matching are sensor noise, occlusion and matching ambiguities caused, for example, by texture-less areas or repetitive patterns within a scene. In contrast, epistemic uncertainty is often neglected in the context of dense stereo matching. However, epistemic uncertainty accounts for simplifications or incorrect assumptions with respect to the model hypothesis formulated to estimate depth from stereo images and is therefore important to be consider to obtain an accurate estimation of the overall uncertainty contained in a system of interest.

The objective of this master thesis is to investigate different deep learning-based approaches for estimating epistemic uncertainty, such as Monte Carlo dropout, Ensemble Learning and Bayesian Neural Networks, in the context of dense stereo matching. The approaches that appear to be suitable are to be applied on a dense stereo matching method from the literature and the effects that arise from these approaches are to be examined and compared. Besides the quality of the estimated uncertainty, the influence on the quality of the depth estimates is of major interest and is to be investigated together with more practical aspects, such as the amount of training data required and the computational effort for training and testing.

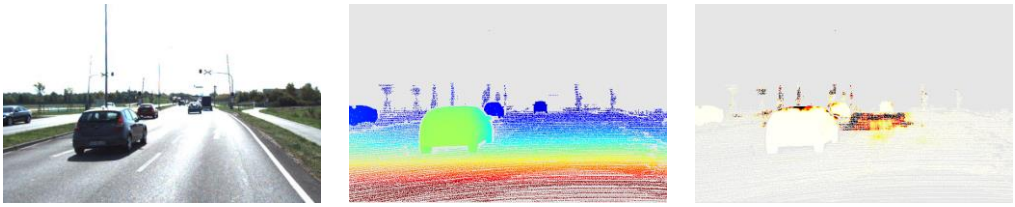

Figure 1: Example from the KITTI 2015 stereo dataset. From left to right: Left RGB image, depth map (close objects in red to far away ones in blue) and uncertainty map (small uncertainties in white to high ones in red and black).

This thesis will be supervised by Max Mehltretter.

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