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Praxis der Forschung:

Geometric and Semantic Scene Reconstruction for SLAM Based on Non-parametric Learning

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Karlsruhe, September 30, 2018

Keywords: Semantic Perception, Simultaneous Localization and Mapping, Non-parametric Learning, Geometry-driven Statistics

Simultaneous Localization and Mapping (SLAM) denotes the technique of ego-motion tracking and constructing or updating a map of unknown surroundings at the same time. It plays a central role in a variety of application scenarios, such as autonomous driving, virtual/augmented reality etc. In order to endow better autonomy and interaction capability for mobile robots, techniques such as vision-based semantic understanding are required and have become an active research field in recent years. Though the deep learning-based methods have shown impressive results for image processing such as semantic segmentation, there is still much potential to exploit for making robotic vision more robust, efficient and semantically accurate.

In this project, novel non-parametric learning methods will be investigated and developed for robotic perception in the context of SLAM. In particular, we focus on learning methods proposed on the Riemannian manifolds such that better tracking and mapping performance can be realized both geometrically and semantically. More specifically, the project is composed of the following work packages.

Work Packages:

- Literature review of existing vision-based semantic SLAM frameworks and non-parametric learning based on Riemannian geometry, especially techniques from geometric deep learning and Gaussian process.
- Development and implementation of a proper vision-based 3D mapping method, based on which a learning framework for semantic understanding is then proposed.
- Development of a SLAM framework and deployment on a real robotic platform mounted with visual sensors, e.g., LiDAR and stereo-camera.
- Evaluation based on real-world dataset and experiments in multiple application scenarios, e.g., 3D object detection, large-scale tracking and semantic reconstruction, etc.

Prerequisites:

- Highly self-motivated and willing to take on challenges.
- Having solid coding skill with C++/Python and good mathematical foundations.
- Experience with deep learning and computer vision is a plus.

At least one joint publication is planned as one of the goals of the project. The topic will be tailored individually in the initial meeting.
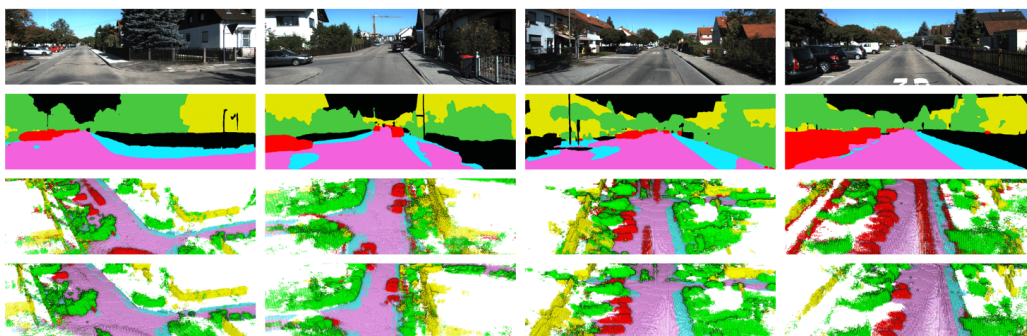

Figure 1: An example of semantic mapping (Courtesy Jongmin Jeong et al.)