Visual Odometry and Mapping Based on Non-Parametric Learning on Riemannian Manifolds

Conventional stochastic filters for pose estimation typically rely on the pre-knowledge about specific systems and employed sensors. Besides, there are always assumptions for noise distribution which lead to considerable effort for parameter tuning. In particular, when the underlying manifold has a strong nonlinearity, parametric stochastic filtering algorithms might be inaccurate and inefficient as they typically require parameter fitting based on approximative. The aforementioned limitations motivate the development of non-parametric pose estimators which are trained by the data using machine learning approaches, e.g., neural network or Gaussian Process. As the poses mathematically belong to the SE(3), corresponding training approaches should thus be performed on nonlinear manifolds. In this thesis, a non-parametric visual odometry and mapping system will be developed based on an existing framework by using Gaussian Process or neural network on manifold. More specifically, the thesis is divided into the following working packages:

- Investigation of the state-of-the-art manifold learning methods for pose estimation.
- Development of non-parametric trackers using on-manifold learning methods based on Riemannian geometry.
- Incorporation of the trackers into an existing visual SLAM framework and evaluation based on real-world datasets.

Requirements:
Students with background of computer science, mathematics or other engineering majors. Solid C++ programming skills, pre-knowledge in machine learning and computer vision are essential. Strong self-motivation, reliability and critical mind are expected. The thesis can be tailored to Hiwi-job as preperation for the beginning stage.

Emphasis:
- Theoretical Study
- Software Implementation
- Hardware Implementation

We offer:
- good support and advice
- highend infrastructure
- contact to industry and research partners

Contact:
Kailai Li
E-Mail: kailai.li@kit.edu
Daniel Frisch
E-Mail: daniel.frisch@kit.edu

www.kit.edu