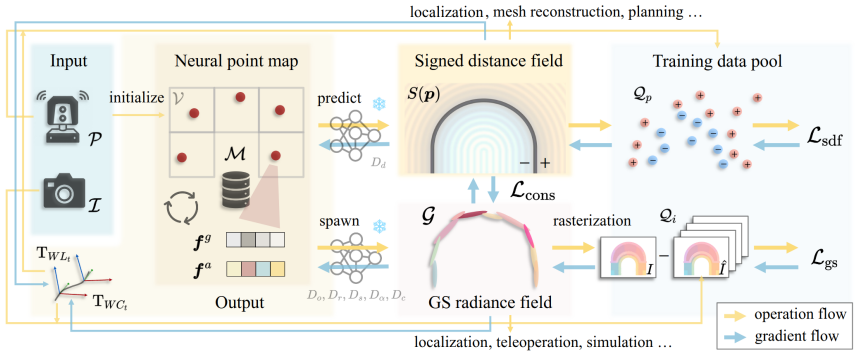
Karlsruhe Institute of Technology

Master Thesis



Gaussian Splatting based LiDAR-Camera Calibration within a Implicit Neural MAP

LiDAR-camera extrinsic calibration remains a challenging problem in research. Traditional approaches typically rely on auxiliary calibration targets to determine the relative pose between the LiDAR and camera coordinate frames. In this work, a targetless calibration should be investigated using the LiDAR-visual SLAM system PINGS.
PINGS jointly maps a Gaussian Splatting radiance field and a signed distance field to represent the observed environment in both the LiDAR and camera domains. This approach allows joint optimization of both representations, enforcing geometric consistency between them. Moreover, because the rendered images are differentiable with respect to the camera pose, the geometric consistency can be directly optimized with respect to the camera pose. While in PINGS each camera pose is optimized independently, one should parameterize the camera pose as a transformation of each frame's LiDAR pose and optimize with respect to extrinsic calibration.

The proposed thesis consists of the following parts:

+ Literature research about Gaussian Splatting and point-based implicit neural map representation
+ Implementation of the extrinsic calibration as an additional opimization parameter
+ Investigation of different loss functions to enforce geometric consistency
+ Evaluation of the implemented method

I am happy to answer any questions you might have. Feel free to ask for an appointment or directly ask at my office!

Literature

1. Pan, Yue, et al. "PIN-SLAM: LiDAR SLAM using a point-based implicit neural representation for achieving global map consistency." `https://arxiv.org/pdf/2401.09101`
2. Matsuki, Hidenobu, et al. "Gaussian splatting slam." `https://arxiv.org/pdf/2312.06741`
3. Pan, Yue, et al. "PINGS: Gaussian Splatting Meets Distance Fields within a Point-Based Implicit Neural Map." `https://arxiv.org/pdf/2502.05752`

Institute of Measurement and Control Systems (MRT)
Prof. Dr.-Ing. Christoph Stiller

Advisor:
Nils Rack, M.Sc.

Programming language(s)[1]:
C++ advanced
Python proficient

System, Framework(s):
Linux

Required skills:
- Solid theoretical foundation in deep learning and robotics
- Highly motivated and independent working style

What we offer:
- Work with state-of-the-art methods and cutting-edge research
- Access to large GPU servers and HPC clusters

Language(s):
German, English

A (partially) successful thesis may lead to a joint **international conference publication** of the scientific work

---

For more information please contact:

Nils Rack

Room: 233 → just come by!
Phone: +49 721 608-43788
Email: nils.rack@kit.edu

Or directly send in your application including your current grades as well as our questionnaire!

---

[1] **skill levels:**
beginner < 500 lines of code (LOC)
advanced 500 – 5000 LOC
proficient > 5000 LOC