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Institute of Vehicle System Technology
Institute of Mobile Machines

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MOBIMA
MOBILE MACHINES

Masterarbeit

Motion Estimation in GNSS-Denied Environments from Temporal Bird's-Eye View Occupancy Grid Maps using Deep Sequence Models

With the increasing deployment of autonomous navigation and SLAM in mobile machines, reliable motion estimation becomes essential, especially in GNSS-denied environments such as forests or construction sites. While vehicle motion is typically estimated from wheel encoders or GNSS measurements, these sources may become unreliable due to wheel slip, poor satellite reception, or challenging terrain conditions. In such cases, perception-based approaches provide an alternative way to infer vehicle motion directly from environmental observations.
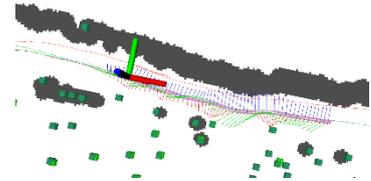
In this thesis, the environment will be represented as Bird's-Eye View (BEV) Occupancy Grid Maps generated from LiDAR point cloud data. Each map corresponds to a time-stamped frame, forming a temporal sequence that captures the motion of the vehicle relative to its surroundings. The objective is to develop a learning-based method to estimate vehicle motion from these sequential BEV representations using deep sequence models (e.g., RNNs or Transformers). The work will build upon an existing dataset of LiDAR recordings and motion measurements collected from sensor-equipped mobile platforms, including forestry machines and backpack-based mapping systems. The student will design a standardized BEV occupancy representation, implement the learning pipeline, and evaluate the model across different driving scenarios.

Planned Tasks:

- Literature review on perception-based motion estimation and sequence modeling (e.g., RNNs, Transformers)
- Familiarization with LiDAR point cloud data and the generation of Bird's-Eye View (BEV) occupancy grid maps
- Design of a standardized BEV occupancy representation (e.g., map size, grid resolution)
- Development of a learning pipeline for motion estimation from sequential BEV maps
- Implementation and training of deep learning models for sequence-based motion prediction
- Evaluation of model performance on real-world datasets collected from mobile platforms
- Documentation and presentation of results, with publication as a potential goal

Type of thesis:

- Focus: Learning-Based Motion Estimation in GNSS-Denied Environments
- Fields: Machine Learning, Sequence Modeling, Autonomous Systems

Start and Duration:

- Start: To be agreed upon
- Duration: 6 months

Prerequisites:

- Basic understanding of deep learning concepts like sequence models
- Practical experience with Python and ML frameworks (e.g., PyTorch)
- Interest in robotics perception and autonomous systems
- Strong self-motivation and good scientific writing skills in English
- Experience with ROS 2, LiDAR data processing from rosbags

If you are interested in this topic, feel free to get in touch. The scope of the work can be adapted or extended based on your individual strengths and interests.

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