Learning For Self-Driving Cars and Intelligent Systems

Practical Course

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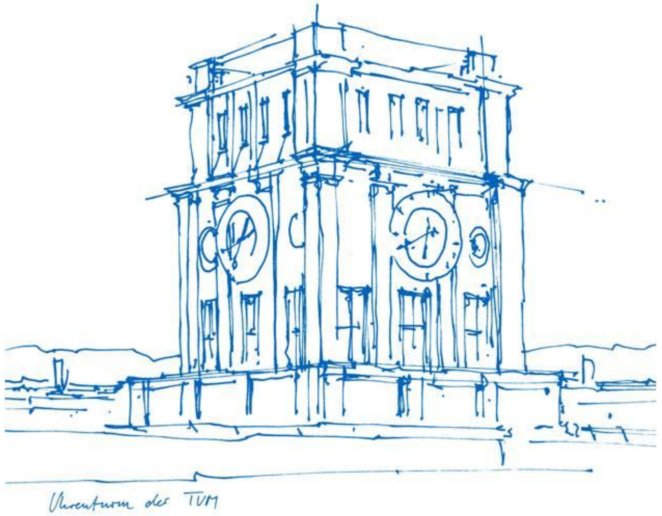
Winter Semester 2022

Course webpage:

https://vision.in.tum.de/teaching/ws2022/intellisys_ws2022



Structure

- Masters practical course
- Data modalities: images, GNSS, IMU, point clouds, sets, graphs etc.
- Programming assignments in the initial weeks
- Research oriented projects
- max. 2 persons per each group
- Dynamic research goals
- One-on-one meetings with supervisors for updates and resolving issues
- Final Presentations
- Weekly summaries of the work progress
- Tuesday, 11 am - 1 pm [Online]
- You will be provided remote access to compute resources via ssh for this course.
- Final Evaluation will be a combination of the programming assignments, weekly/final reports, presentation, viva, project code and results etc.

Prerequisites

- Proficient in python programming
- Familiar with version control (git)
- Comfortable with DL frameworks: PyTorch, Tensorflow etc.
- Good knowledge of basic mathematics, linear algebra,probability, numerics, analysis etc.
- Participation in at least one of the offered **deep learning** lectures at TUM, e.g. [1,2,3 ...]
- Or participation in at least one of **Multi-View Geometry** courses / labs, e.g. [1, 2, 3...]
- We may consider other courses offered outside of TUM if the contents match with the example courses referenced above. Please highlight the content of those courses in your application.

Application

- Assignement to the course done via the matching system: https://matching.in.tum.de/
- Select your preference of the lab course between 22 to 27 July on the system
- Application documents to be sent separately
- **Send your CV and Transcripts by 28 July 2022 to**: **intellisys-ws21.vision.in@tum.de**
  Please see the email format on the next slide
- We **only** consider the candidates who applied to the matching system **AND** sent their application documents

Application Email Format

In order to easily evaluate your profile for matching, we ask you to follow the format below:

Subject: Application [Your Matriculation Number]

In the body please give at least the following details:

- *Matriculation #:*
- *Name:*
- *Name of Degree:*
- *Masters Semester #:*
- *Average Grade:*
  - *Bachelor:*
  - *Master (For the previous semester, if available)*
- *List of Relevant courses taken with grade*

Please remember to also attach your CV and transcripts(Bachelor + Master) with the email.

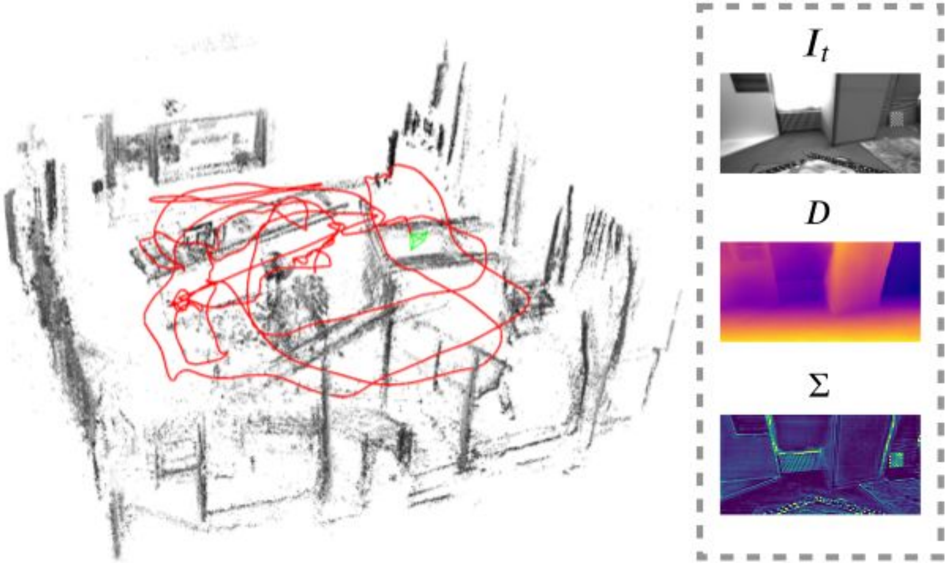
Feel free to share any additional documents, information (for eg. link to git, past research projects) that could support your application. *Optional*: If you also have a project suggestion matching the theme of the lab course, please briefly describe.

Projects

- Practical project experience with real-world problems
- Novel application-oriented research challenges
- Project Assignment to be done after the initial weeks of programming tasks
- Projects specifics will be decided later
- However, if you have project proposals prior to beginning of the semester. It may be considered
- Nevertheless, some general research areas can be found in the next slides

Projects

- SLAM
  - Deep depth **D**, deep pose and deep uncertainty **Σ** based on a single view $\mathbf{I}_t$ [1]
- 3D reconstruction
  - Dense reconstruction using a deep neural network [2]



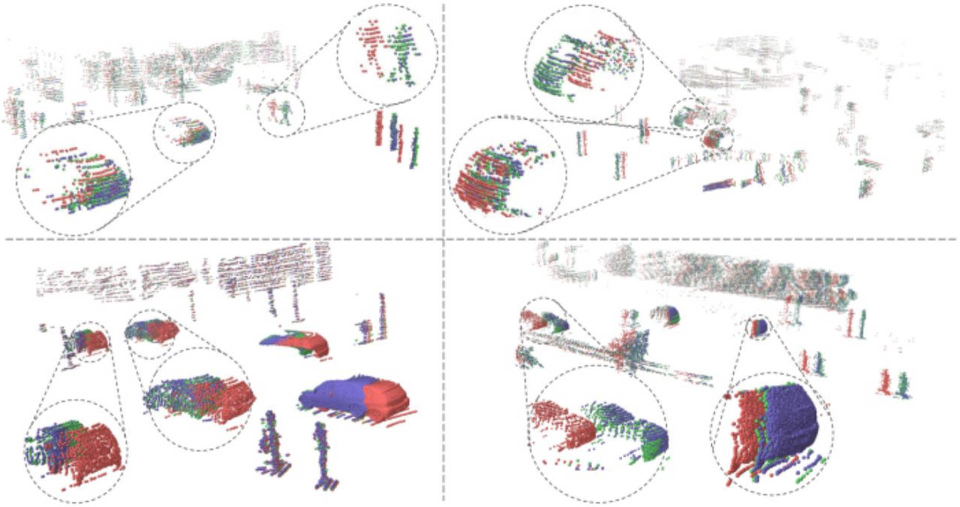
Top: https://vision.in.tum.de/research/vslam/d3vo

Bottom: https://vision.in.tum.de/research/monorec

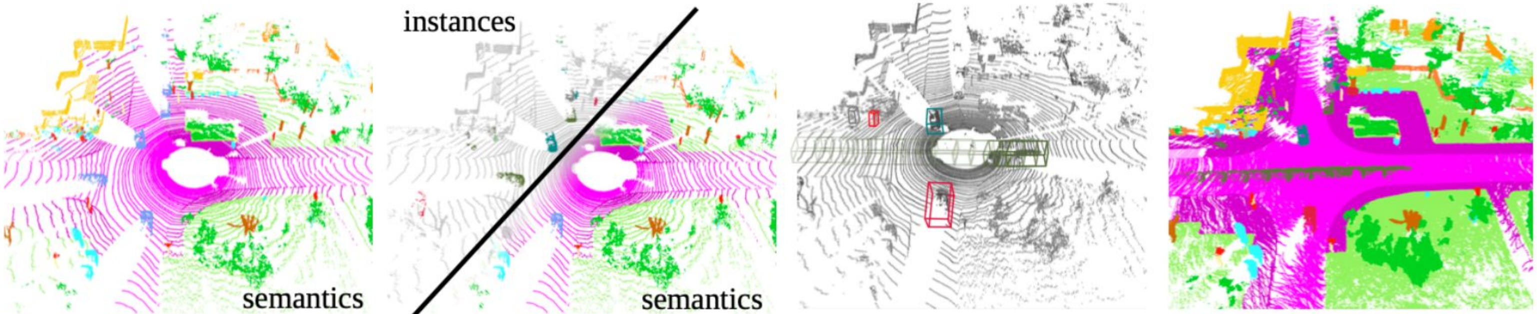
[Accessed on 15.07.2022]

Projects

- 4D dynamic scene reconstruction
- 4D panoptic segmentation



points as from frame 1, frame 2 or as translated points (point cloud 1 + scene flow)

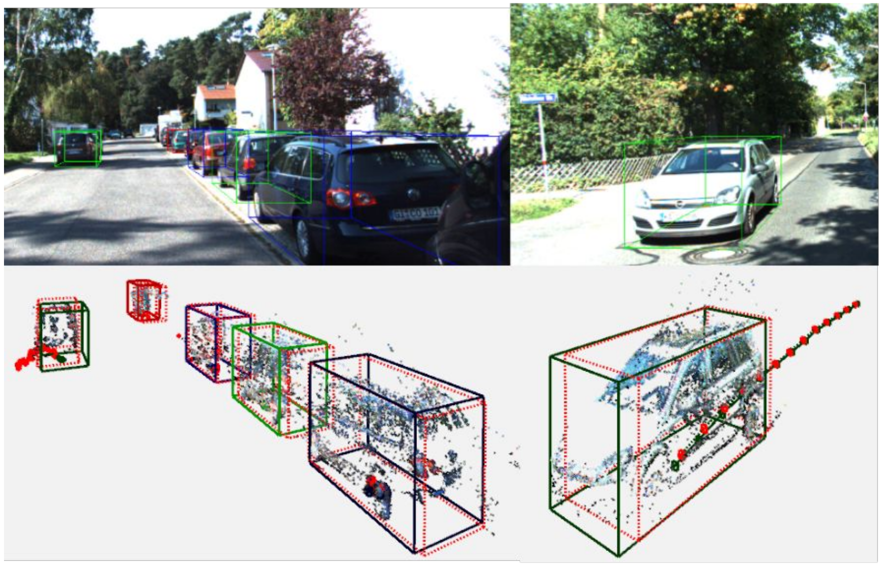


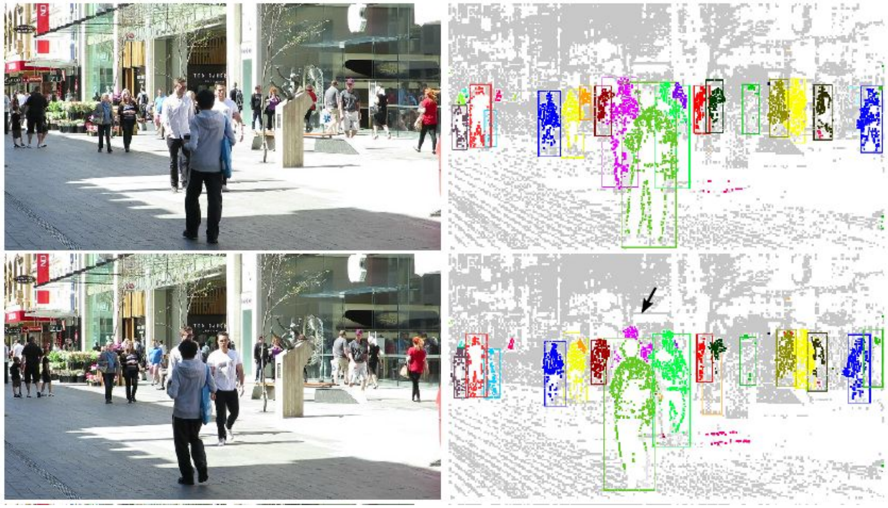
semantic segmentation | panoptic segmentation | multi-object tracking | 4D panoptic segmentation

Top: https://openaccess.thecvf.com/content_CVPR_2019/papers/Liu_FlowNet3D_Learning_Scene_Flow_in_3D_Point_Clouds_CVPR_2019_paper.pdf
Bottom: https://mehmetaygun.github.io/4DPLS.html
[Accessed on 15.07.2022]

Projects

- Multi-Object Tracking
- Object detection and segmentation

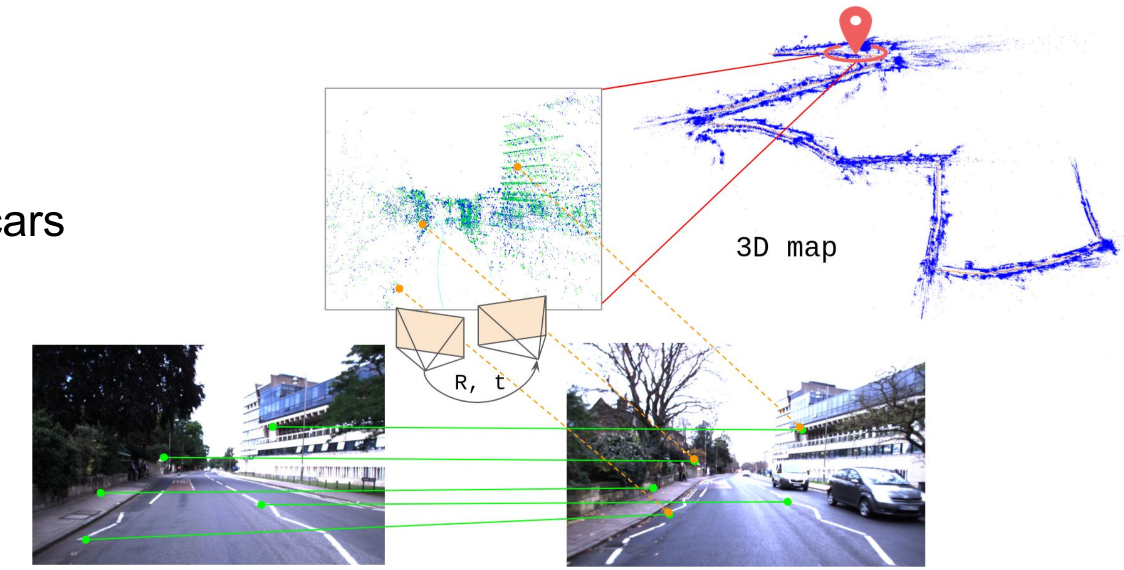




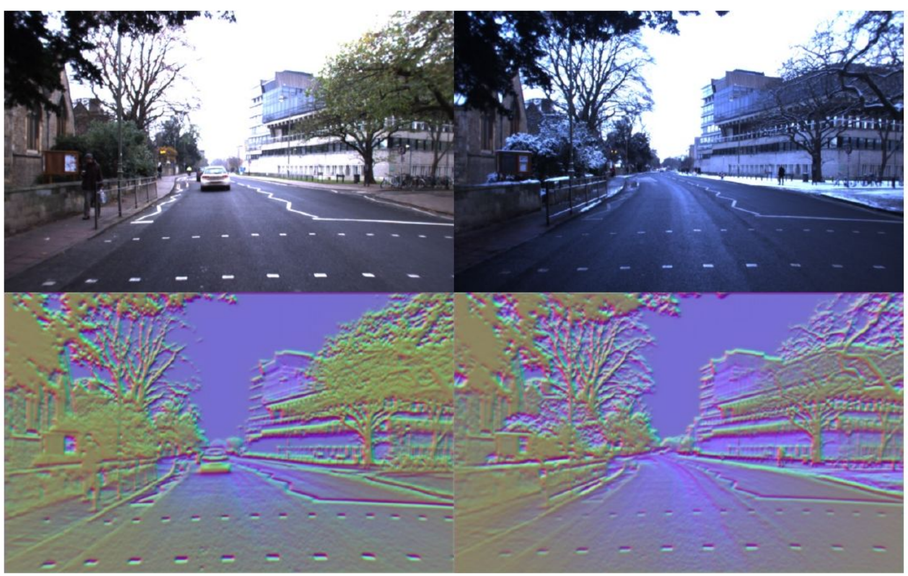
Top: Gladkova et al. “DirectTracker: 3D Multi-Object Tracking Using Direct Image Alignment and Photometric Bundle Adjustment” (to appear)
Bottom: https://ps.is.mpg.de/uploads_file/attachment/attachment/468/motion_segmentation_tracking_clustering.pdf
[Accessed on 18.07.2022]

Projects

- Perception for self-driving cars
- Scene understanding
- Global localization



Current image   Map reference image



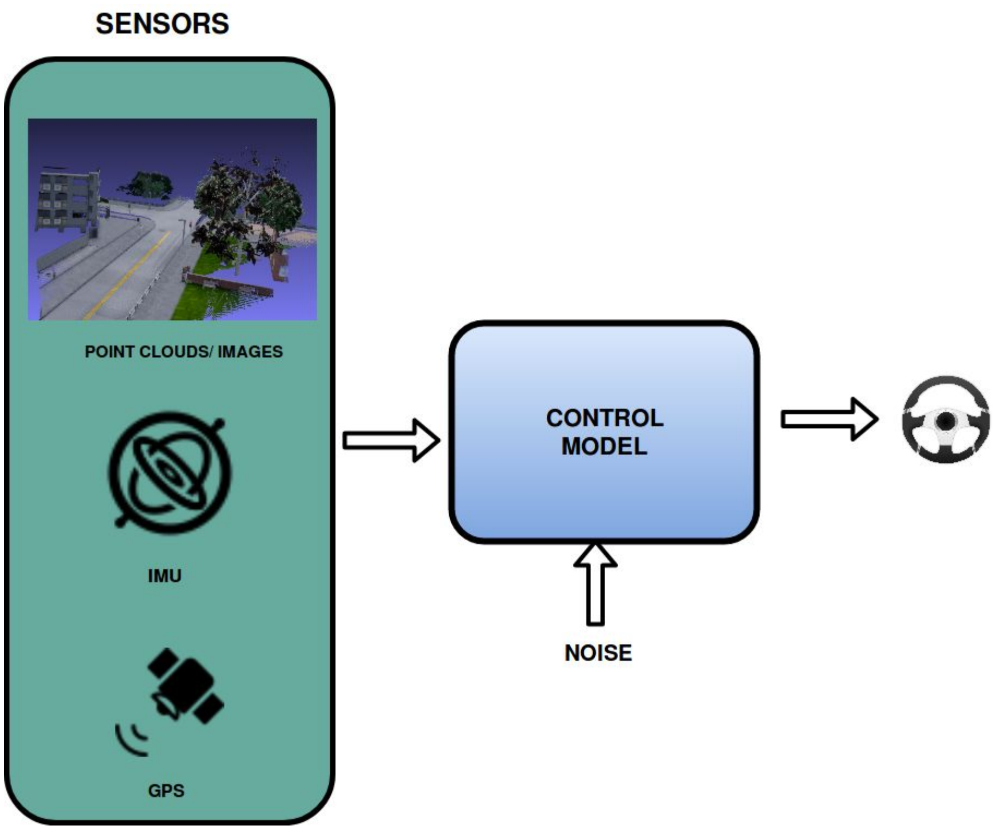
Top: https://vision.in.tum.de/research/vslam/tirdso

Bottom: https://vision.in.tum.de/research/vslam/gn-net

[Accessed on: 15.07.2022]

Projects

- Robot control
    - Embodied agents (Next slide)
    - Robustness to noisy data
    - Multiple Input Modalities



Projects

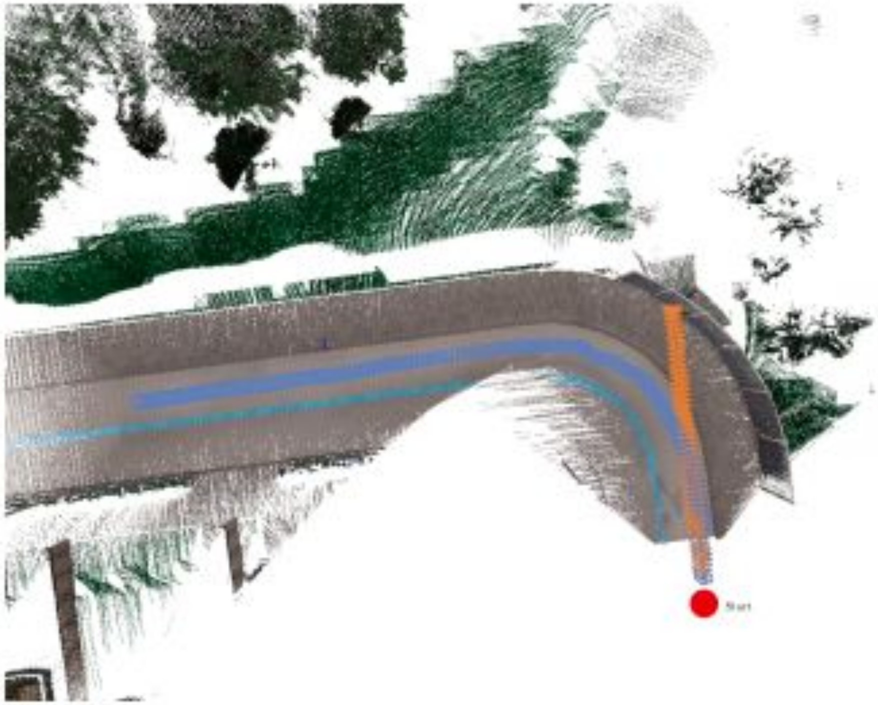
- Testing control algorithms on embodied agents
- Interaction with the environment
- Supervised, self-supervised, reinforcement learning

Visual Odometry Trajectory | Online Evaluation

Reference: https://arxiv.org/pdf/2103.11204.pdf,
[Accessed on 15.07.2022]

Projects

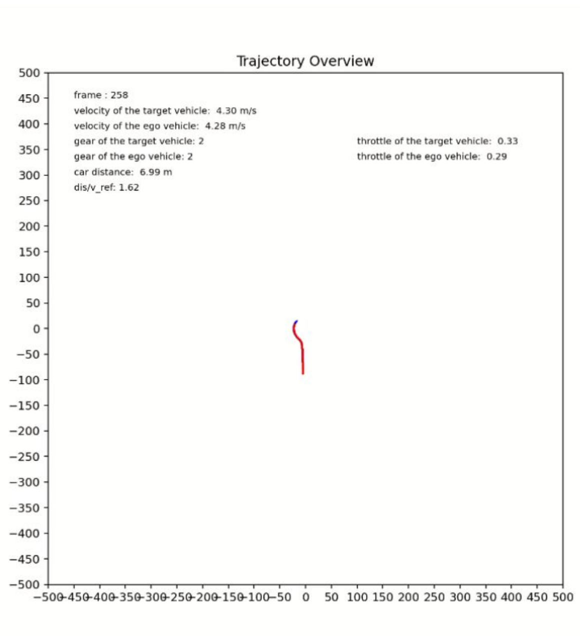
- Control using Point clouds



BEV of the vehicle trajectories in the point cloud
https://vision.in.tum.de/_media/spezial/bib/pccontrol_2022.pdf
[Accessed on 18.07.2022]

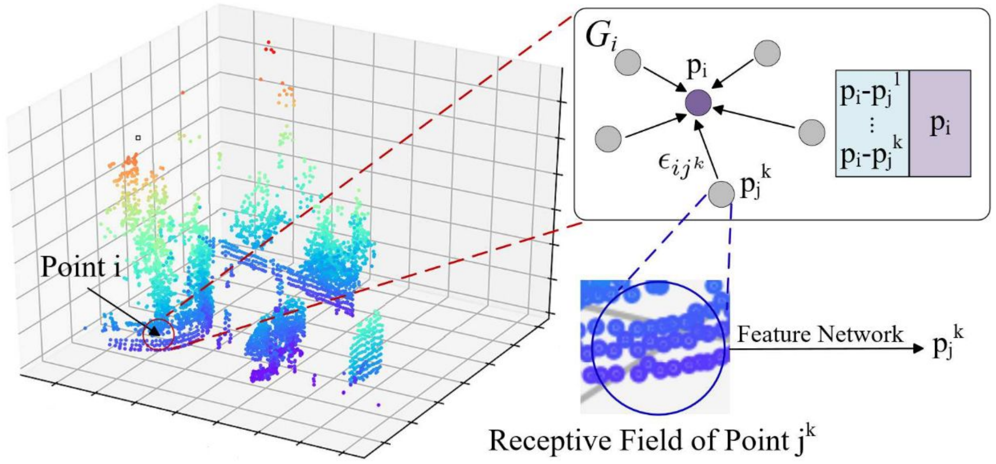
Projects

- Vehicle platooning
  - Multiple vehicles autonomously following the first target vehicle



Projects

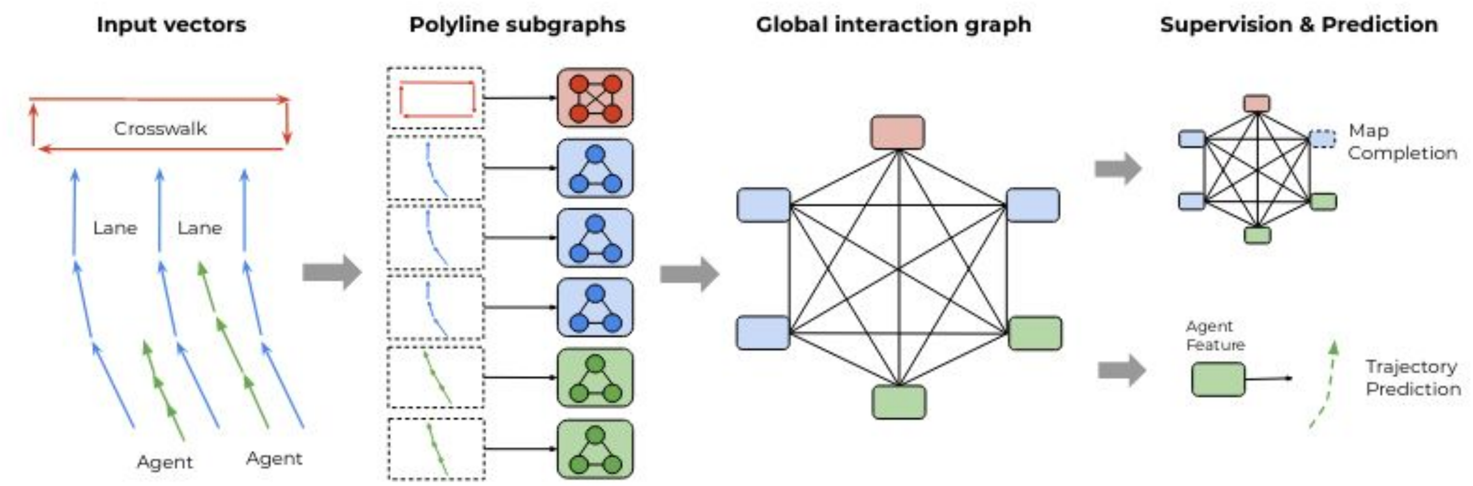
- Global localization / Place recognition using Graph Neural Networks (GNN)



https://openaccess.thecvf.com/content_ICCV_2019/papers/Liu_LPD-Net_3D_Point_Cloud_Learning_for_Large-Scale_Place_Recognition_and_ICCV_2019_paper.pdf [Accessed on 15.07.2022]

Projects

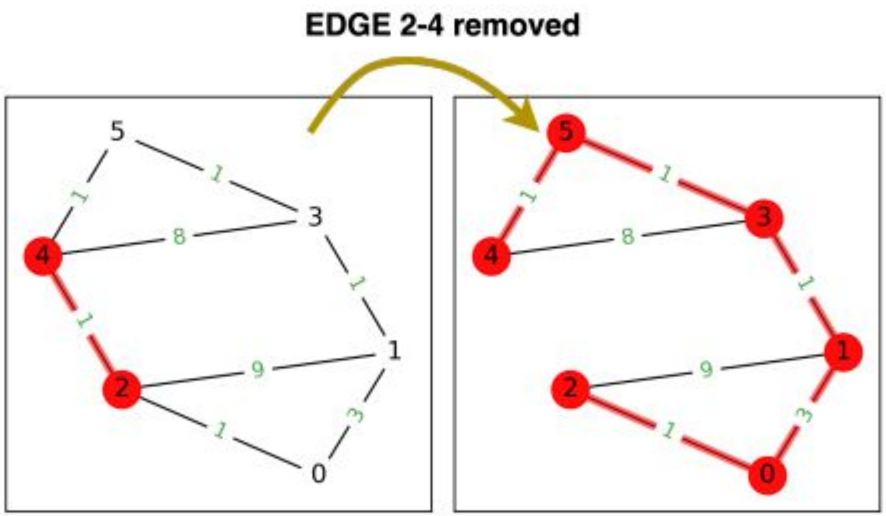
- Trajectory prediction for multiple vehicles using GNNs



https://arxiv.org/pdf/2005.04259.pdf [Accessed on 15.07.2022]

Projects

- Optimal path finding using GNNs



https://arxiv.org/abs/2206.05971 [Accessed on 18.07.2022]

QUESTIONS