Learning For Self-Driving Cars and Intelligent Systems

Practical Course

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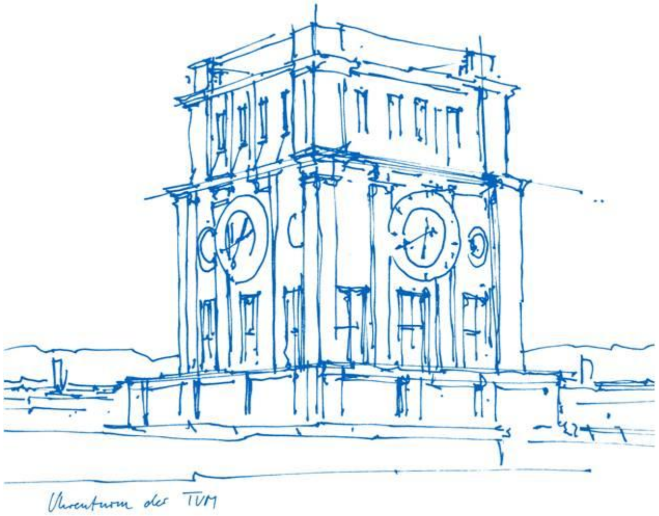
Summer Semester 2023

Course webpage:

https://vision.in.tum.de/teaching/ss2023/intellisys_ss2023



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 [on-site]
- 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 9 to 14 February in the system
- Application documents to be sent separately
- **Send your CV and Transcripts by 14 February 2023 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 Documents

Please send all the relevant documents to us by email on:**intellisys-ws21.vision.in@tum.de**

The subject of your email should be: *Application [Your Matriculation Number]*

In the body please give at least the following details:

- *Matriculation #:*
- *Name:*

You should attach the following documents:

- CV
- Transcripts (Bachelor + Master)
- Application form (see next slide)
- [Optional] any project suggestion matching the theme of the lab course

Application Form

In order to easily evaluate your profile for matching, we ask you to fill the Application template on excel which can be downloaded from [here]

It contains columns **A to O**.

Fill this row, replace "-1" with your info!

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Student Matriculation Number (8 digit number For e.g. 03xxxxxx)	First name	Last name	Current Semester # (For e.g. if this winter semester is your 1st Masters semester Then write 1)	Bachelor grade	Bachelor University	Bachelor grade (Converted to German scale) Between 1 and 4.0 if Bachelor From Non-German University	Master grade	Grade for Introduction to Deep Learning (TUM)	Grade for Multi-View Geometry (TUM)	Grade for Machine Learning (TUM)	Grade for 3D Scanning and Motion Capture (TUM)	Other Relevant Courses you took a For e.g. Advanced deep learning for compu Vision Based Navigation
2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
3													
4													
5													
6													
7													
8													

Please also read the Notes given in the downloaded Application form.

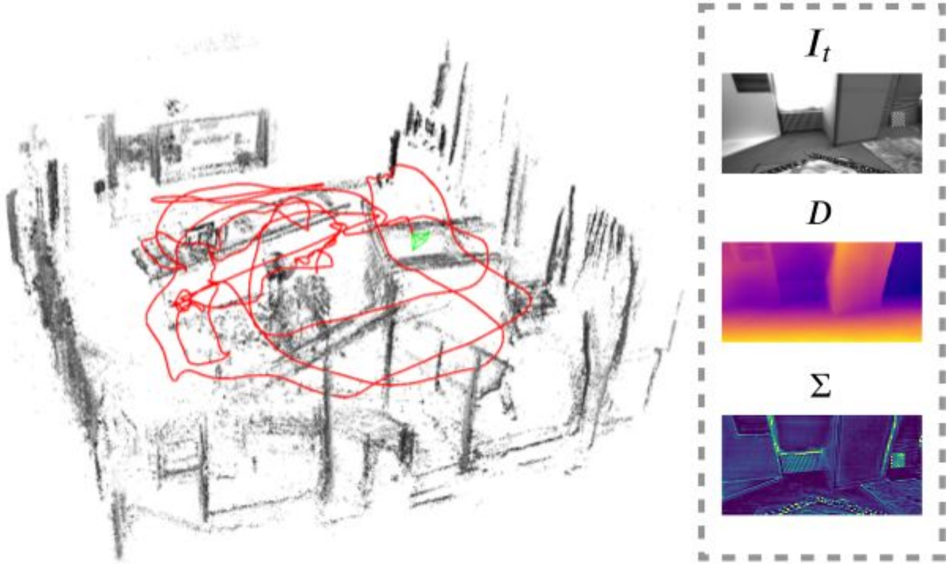
IMPORTANT: When you send the filled template to us by email, the filename should be your matriculation ID i.e. <Your_Matriculation_ID>.xlsx for e.g. 03xxxxxx.xlsx

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]



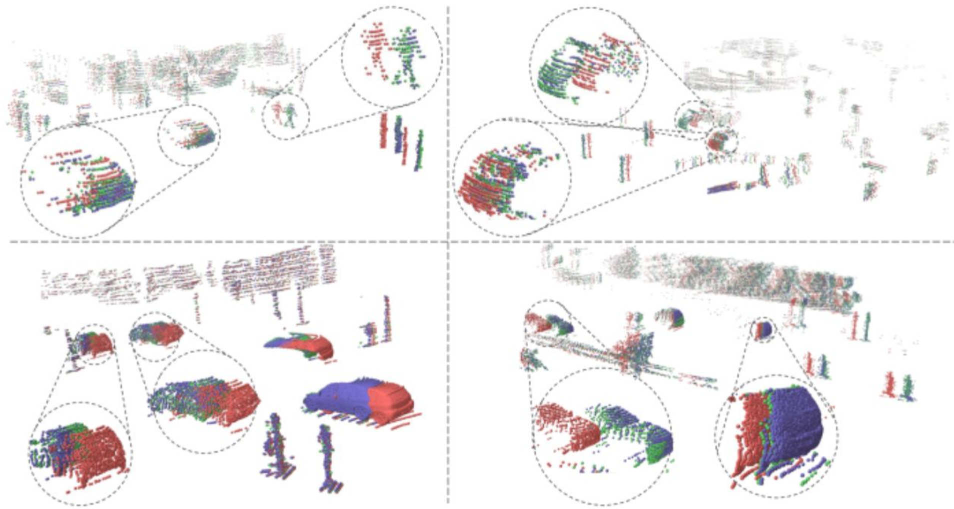
Top: https://vision.in.tum.de/research/vslam/d3vo

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

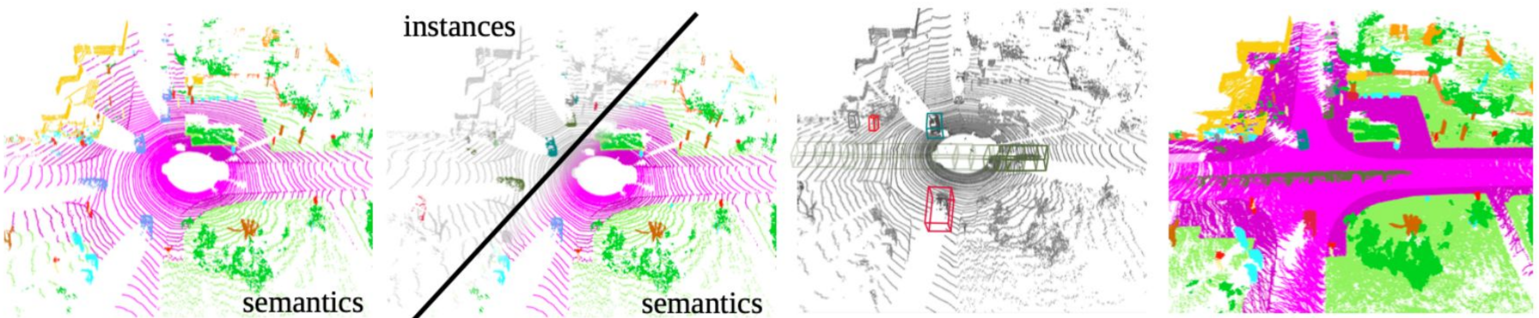
[Accessed on 06.02.2023]

Projects

- 4D dynamic scene reconstruction
- 4D panoptic segmentation



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

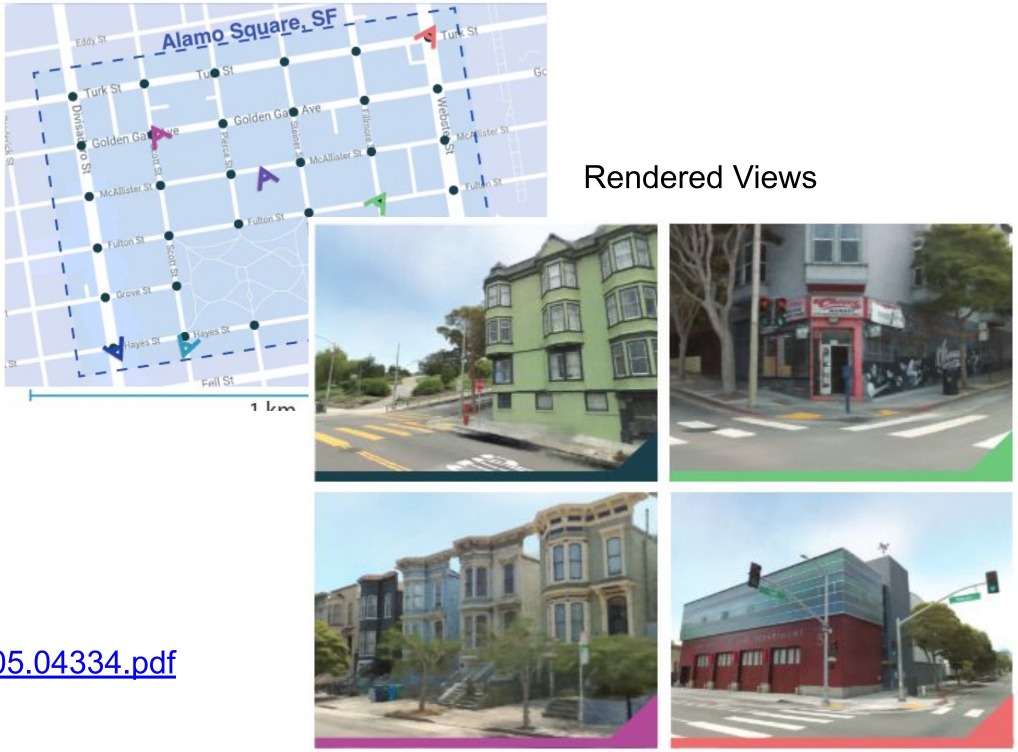


semantic segmentation panoptic segmentation multi-object tracking 4D panoptic segmentation

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 06.02.2023]

Projects

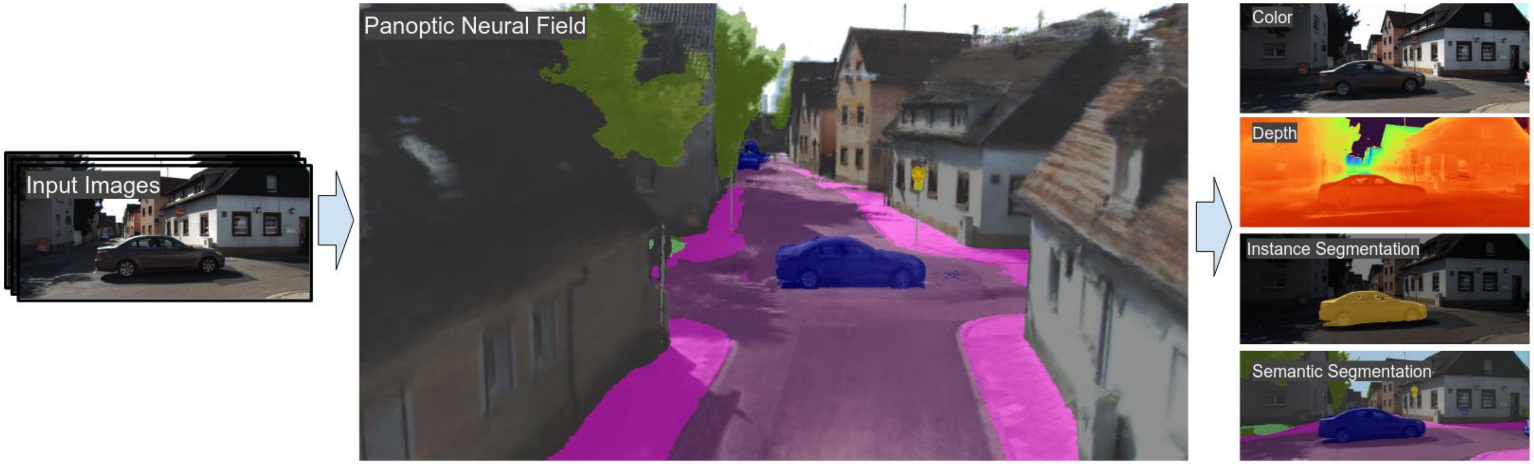
- Novel view synthesis
- Photorealistic reconstruction
- Neural Radiance Fields (NeRFs)
  - https://arxiv.org/pdf/2003.08934.pdf



Top: Block-NeRF https://arxiv.org/pdf/2202.05263.pdf

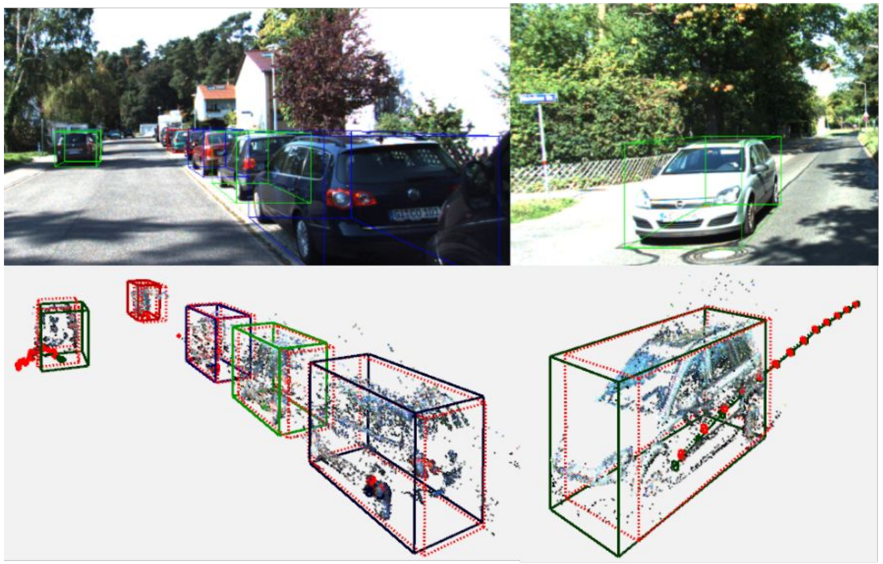
Bottom: Panoptic Neural Fields https://arxiv.org/pdf/2205.04334.pdf

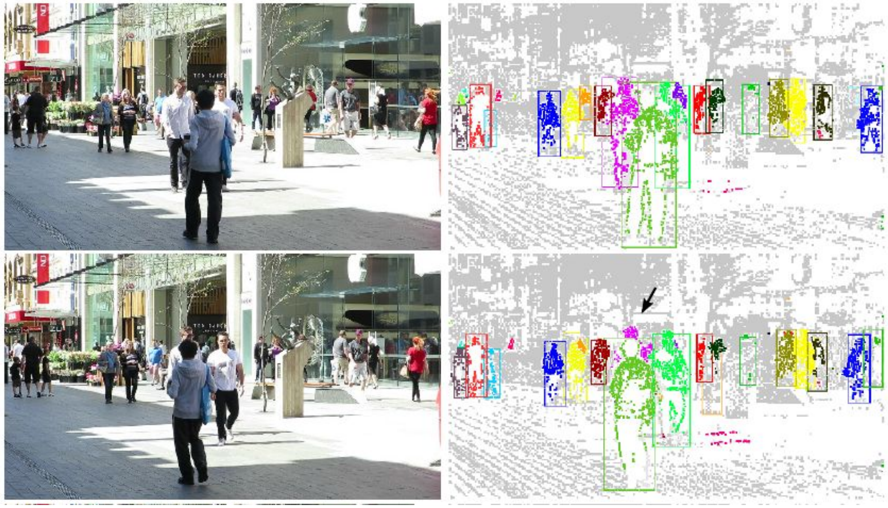
[Accessed on 06.02.2023]



Projects

- Multi-Object Tracking
- Object detection and segmentation

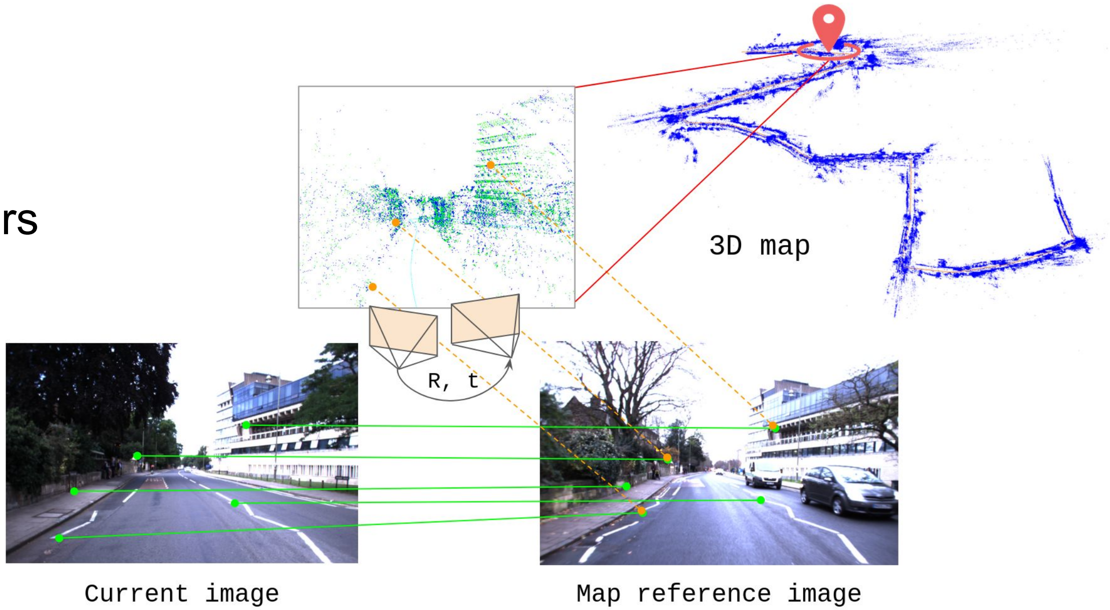


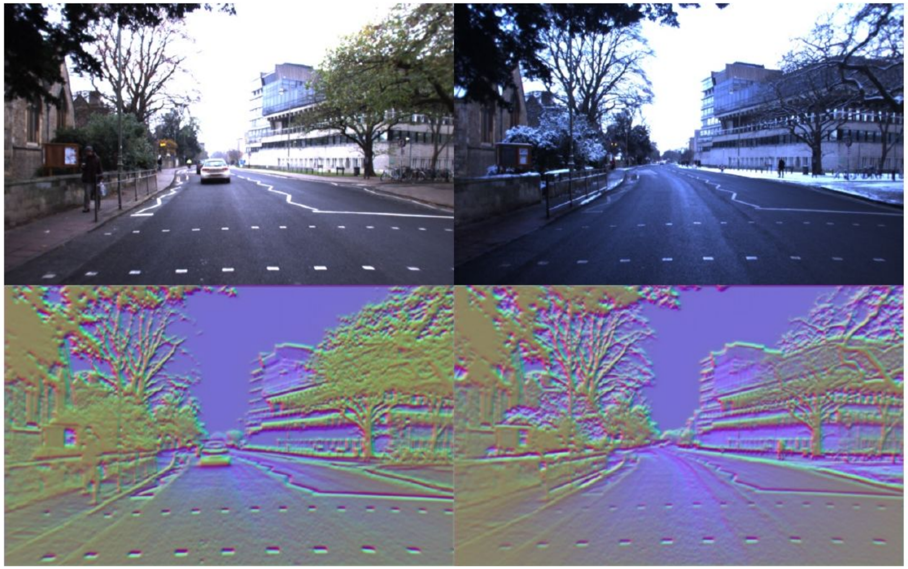


Top: https://vision.in.tum.de/research/vslam/directtracker
Bottom: https://ps.is.mpg.de/uploads_file/attachment/attachment/468/motion_segmentation_tracking_clustering.pdf
[Accessed on 06.02.2023]

Projects

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





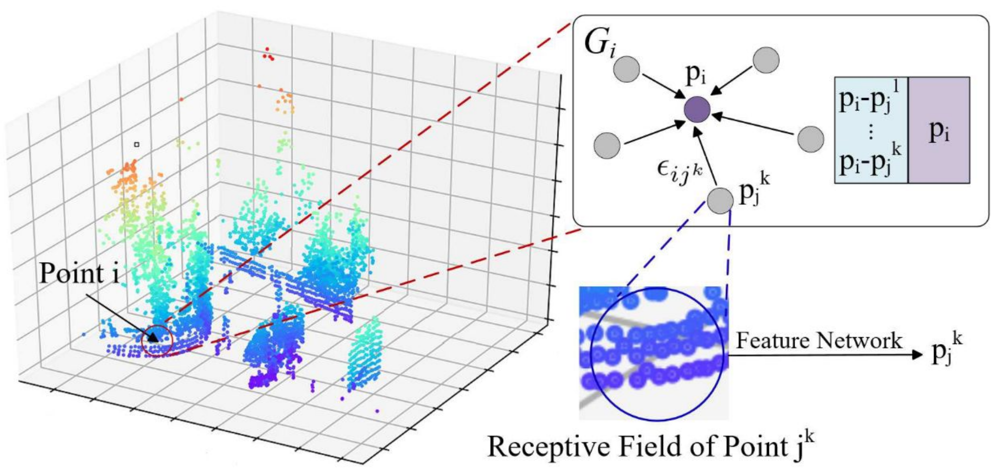
Top: https://vision.in.tum.de/research/vslam/tirdso

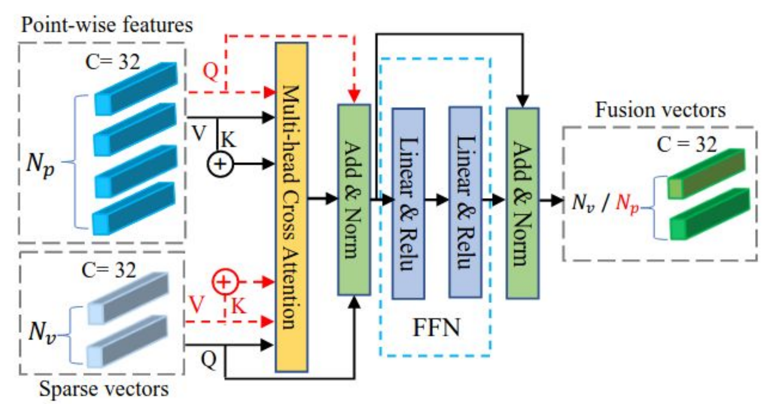
Bottom: https://vision.in.tum.de/research/vslam/gn-net

[Accessed on: 06.02.2023]

Projects

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

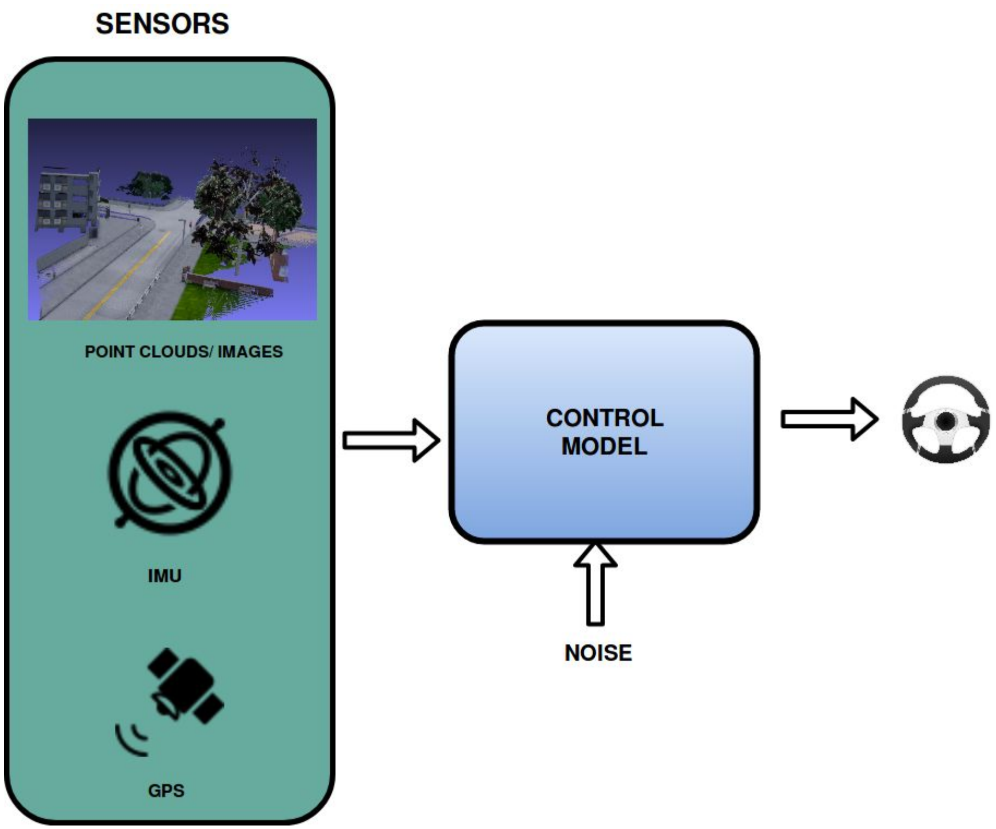




Left:
https://openaccess.thecvf.com/content_ICCV_2019/papers/Liu_LPD-Net_3D_Point_Cloud_Learning_for_Large-Scale_Place_Recognition_and_ICCV_2019_paper.pdf
Right: https://arxiv.org/pdf/2211.12542.pdf [Accessed on 06.02.2023]

Projects

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



Projects

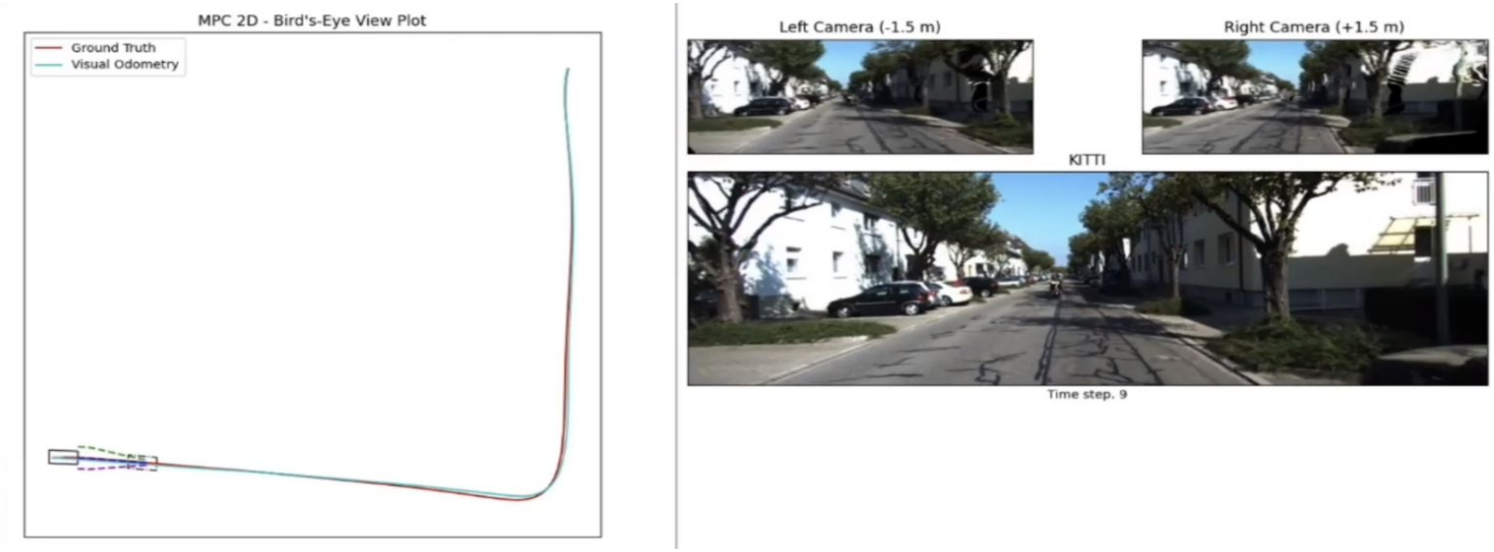
- Testing control algorithms on embodied agents
- Interaction with the environment
- Supervised, self-supervised, reinforcement learning

Visual Odometry Trajectory | Online Evaluation

Reference: https://arxiv.org/pdf/2103.11204.pdf, [Accessed on 06.02.2023]

Projects

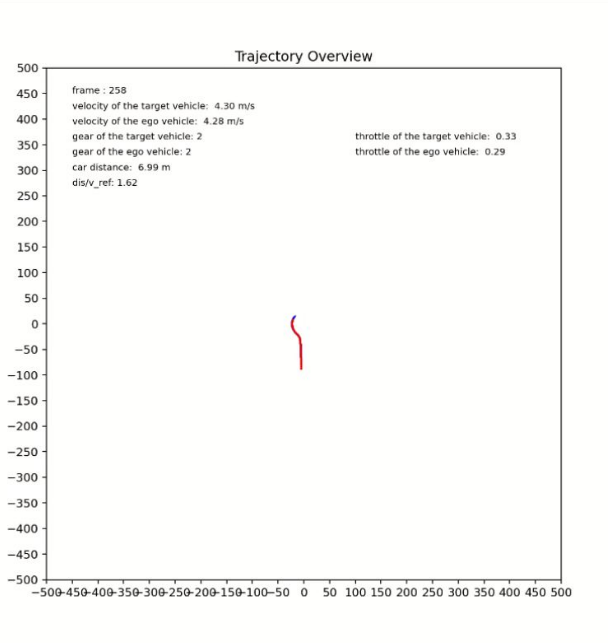
Uses image synthesis and model predictive control to determine the labels so as to follow the visual odometry trajectory



https://vision.in.tum.de/_media/spezial/bib/nndriving2023.mp4
[Accessed on 07.02.2023]

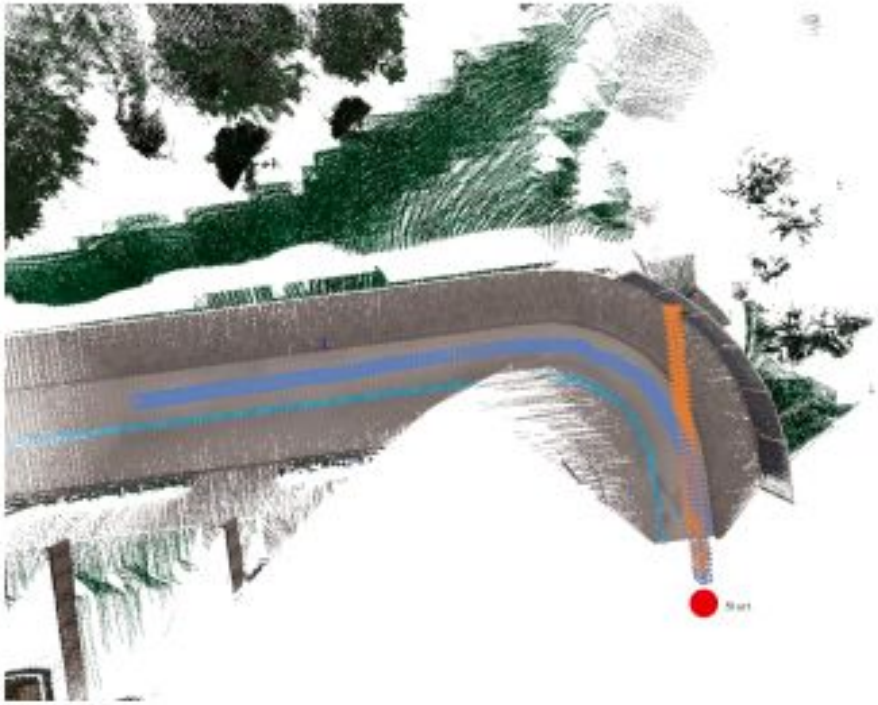
Projects

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



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 06.02.2023]

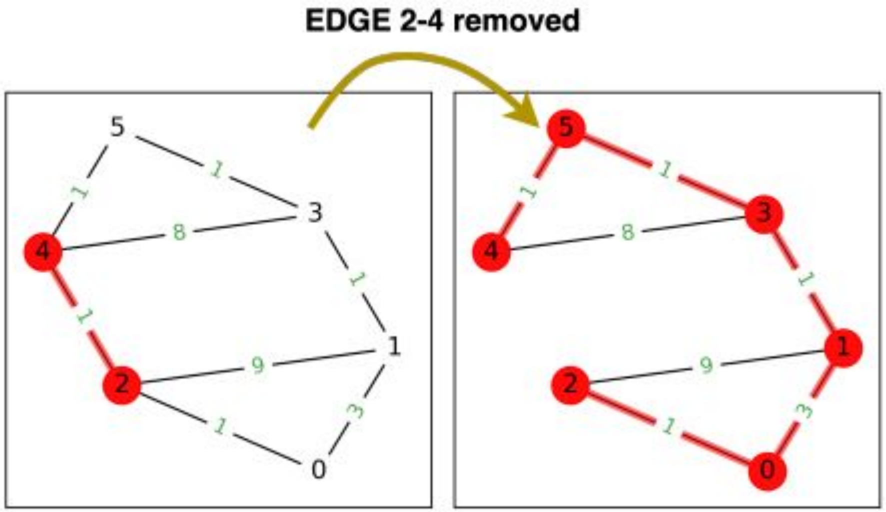
Projects

Multi-vehicle trajectory prediction

https://vision.in.tum.de/_media/spezial/bib/multivehicle2023.pdf
[Accessed 06.02.2023]

Projects

- Optimal path finding using GNNs



https://link.springer.com/chapter/10.1007/978-3-031-15037-1_27
[Accessed on 06.02.2023]

QUESTIONS