Lehrstuhl für Fahrzeugtechnik
Fakultät für Maschinenwesen
Technische Universität München

4 x IDP

# Task Force Real-World Autonomous Driving: Object Tracking and Motion Prediction in Urban and Racing Applications

To advance the field of autonomous driving (AD), we leverage our research platforms - EDGAR (Figure 1, left) and TUM Autonomous Motorsport, TAM (Figure 1, right) - to develop state-of-the-art AD software. While urban and racing AD application domains differ significantly, the symbiotic relationship between these platforms allows us to transfer independent learnings, enhancing our overall AD capabilities.

This IDP project, composed of 4 individual topics, aims to establish a robust evaluation benchmark for AD perception software across both urban and racing domains, and to implement state-of-the-art (sota) algorithms on EDGAR and TAM. Our primary focus is on perception, the critical discipline of understanding a vehicle's environment in the present and future. Perception encompasses three key tasks: detection, tracking, and prediction.

Recent research underscores the importance of improved tracking and prediction, revealing their potential to deliver substantial performance gains. Tracking enables the association of objects over time, providing a foundation for accurate prediction, which involves forecasting the motion of agents into the future.

Through this project, we aim to:

1) Develop a modular pipeline to evaluate and benchmark tracking and prediction algorithms for use on EDGAR and TAM.
2) Implement sota tracking and prediction algorithms on EDGAR for real-world applications.

These efforts will help identify potential improvements in tracking and prediction, pushing the limits of autonomous driving performance in both urban and racing scenarios.

Figure 1: EDGAR at the Wies'n Shuttle demonstration, TAM at Abu Dhabi Racing League

## IDP Topics (Figure 2, with the corresponding description below):

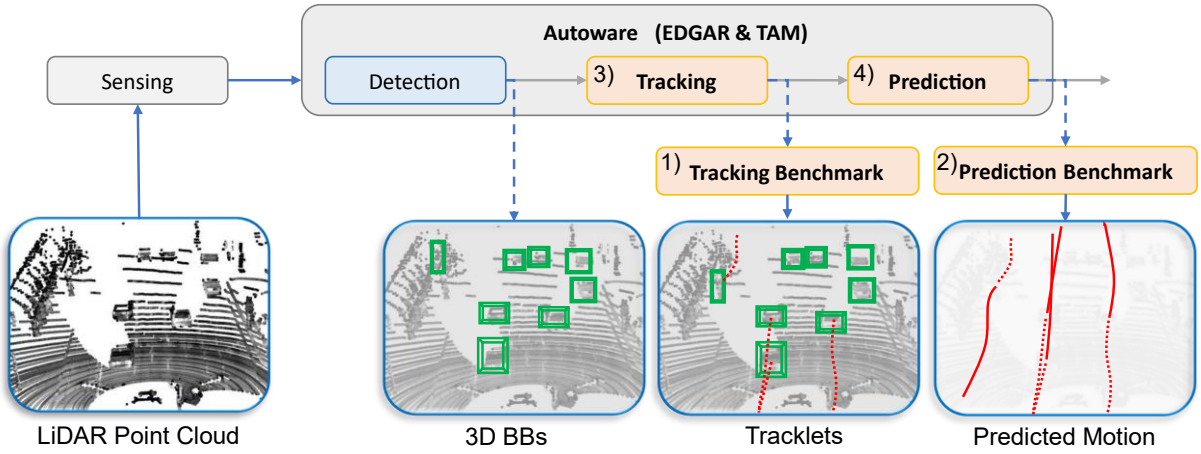


Figure 2: IDP Topics

**1) Object-Tracking Performance Evaluation**
**2) Motion Prediction Performance Evaluation**

- Development of an object-tracking/ motion prediction evaluation pipeline **for EDGAR and TAM applications**.
- Should allow for the comparison of input data in both NuScenes/ EDGAR & TAM rosbag format.
- Should include common performance evaluation metrics and be extendable in a modular way.
- Comparison to multiple existing algorithms and comprehensive benchmark with this evaluation pipeline. *
- The evaluation does not have to be real-time capable.

**Outcome:** An offline evaluation pipeline that can be used to evaluate the on-vehicle object-tracking/ motion prediction performance of EDGAR and TAM. The implementation should be modular and robust.

**3) Object-Tracking Algorithm Development for On-Vehicle Use**
**4) Motion Prediction Algorithm Development for On-Vehicle Use**

- Identification and comparison of sota algorithms for **use on EDGAR**. *
- Implementation of selected algorithms as external packages into Autoware.
- Testing and improvement of the algorithm performance (resources, real-time capabilities)
- Comparison against sota with the evaluation pipeline at the end of the project.
- Real-time capable implementation in Python or C++.

**Outcome:** Autoware packages that can be deployed on the vehicle in real-world (Primarily EDGAR), for object tracking/ motion prediction use.

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* While each person focuses on their topic individually, the project is designed to benefit from partial teamwork, both in the generation of a common foundation and for knowledge transfer. Each topic is designed to be worked on by one person. The final thesis will be graded on individual performance.

Requirements:

- Good programming skills in Python or C++
- Ideally experience with ROS2.
- High personal motivation and independent working style
- Very good language proficiency in German, English or French

**If you are interested in any of these topics, please apply for one specific topic or inform us of your preferences.**

The thesis should clearly document the individual work steps. The candidate undertakes to complete the term paper independently and to indicate all scientific aids used.

The submitted work remains the property of the chair as an examination document.

Prof. Dr.-Ing. M. Lienkamp

Betreuer: Loïc Stratil, M. Sc.

Ausgabe:_____

Abgabe: _____