



# Master thesis Project

## Investigation of SLAM algorithms for autonomous vehicles

**Company background:** AVL with ~8000 employees is the world's largest independent company for development, simulation and testing technology of powertrains (hybrid, combustion engines, transmission, electric drive, batteries and software) for passenger cars, trucks and large engines. AVL is focusing on the five elements of powertrain which are combustion engine, transmission, control unit, E-Motor and battery. The scope of business in AVL can be categorized as:

- **Development of Powertrain Systems:** AVL develops and improves all kinds of powertrain systems and is a competent partner to the engine and automotive industry. In addition AVL develops and markets the simulation methods which are necessary for the development work.
- **Engine Instrumentation and Test Systems:** The products of this business area comprise all the instruments and systems required for engine and vehicle testing.
- **Advanced Simulation Technologies:** The developed simulation software is focusing on design and optimization of powertrain systems and covers all phases of the development process.

**Project background:** Development of autonomous vehicles is a hot topic in the automotive industry. Several automotive companies are investing in this field, and all the big players in the automotive field are conducting research regarding different aspects of autonomous vehicles. The autonomous vehicle field is quite young, and there are many open research questions in the related topics. One of the main topics in the field of autonomous vehicles is localization and mapping. Different Simultaneous localization and mapping (SLAM) algorithms are used with their own pros and cons. Selection of proper method can directly affect performance of the vehicle in real traffic. Performance of some of the methods are very good in the simulation environment, but they suffer from the heavy computation load. They can also affect the selection of the sensors and hardware, thus affecting the cost of the vehicle.

**Research Question:** What are the pros and cons of different SLAM algorithms which are suitable for autonomous vehicles?

**Aim:** The main objective of the thesis is to do a thorough literature study on different SLAM algorithms, select the algorithms which are more suitable for implementation on different vehicles, test the algorithms in simulation environment, implement the algorithms on a platform, and do test on a real scaled vehicle. A comprehensive comparison of different methods is expected at the end of the project.



The algorithm can be developed either in Matlab/Simulink or C/C++. The suggested tool for simulation is V-Rep (<http://www.coppeliarobotics.com/>), which is a software for robot simulation. The test vehicle is a 1/10 RC car. Selection of the hardware platform and the sensors needs to be done during the thesis by the students. The selected algorithms need to be applicable on the RC car considering that the algorithms need to be applied on a real car. The algorithm should be able to work without accessing GPS. Other criteria are cost of hardware platform and sensors. Computation load and memory requirements of the algorithms need to be considered. The algorithms need to be run online on the hardware platform which should be installed on the vehicle.

The algorithms which are not satisfying the mentioned criteria need to be discussed in the literature review, but they do not need to be implemented on the car.

**Eligibility:** The applicant/s should be familiar with mechatronics topics, both theory and implementation. You should have general skills in Matlab/Simulink and C/C++. You should be able to develop your own algorithms, implement them in simulation environment, and test them on a platform. Knowledge about artificial intelligence and SLAM algorithm is merit.

**Number of students:** 2

**Planned start of thesis:** As soon as possible

**Duration:** 20 weeks (30 ECTS)

