1.1.1 Signalprocessing for Autonomous Systems

Module title: Signal Processing for Autonomous Systems

Module summary
Module code: EITM 220M
Module coordinator: Prof. Dr. Jan Bauer
Credits (ECTS): 5 CP workload: in lecture 60 h, independent study time 90 h
Semester: 1st or 2nd semester
Pre-requisites with regard to content: System Theory, Linear Algebra, Image Processing
Pre-requisites according to the examination regulations: none
Competencies: Upon successful completion, the students • know the required sensory hardware (camera, radar, lidar) and its required functionality of autonomous vehicles • are able to assess the communication architecture of autonomous vehicles • understand the safety requirements for electrical systems in vehicles • can design protected data and video transmission for safety systems • can prepare video content for the driver, transmission-technology and processing systems (e.g., content aware video enhancement, denoising, data reduction, compression) • the possibilities of neural networks for autonomous cars (e.g., object- or lane detection) • are aware of different hardware possibilities for signal processing in autonomous cars
Assessment: Assessment is done by either a written exam (90 minutes) or an oral examination (20 minutes) or a combination/selection of assignment, term paper and/or course project. The form of examination will be announced at the beginning of the semester
Usability: *General:* The module provides the foundations of signal processing for autonomous systems on the example of autonomous vehicles. The course content is based on the scientific fundamentals and complements the modules of the specialization. *Connection with other modules:* Signal Processing is one of the key techniques used in modern vehicles to enable autonomous driving. Its applicability, however, is not limited to the area of autonomous vehicles, but has links to many areas of autonomous systems.

Course: Signal Processing for Autonomous Systems
Module code: EITM 221M
Lecturer: Prof. Dr. Jan Bauer
Contact hours: by arrangement
Semester of delivery: yearly, summer semester
Type/mode: lecture 2h/week; mandatory in the study field E-Mobility and Autonomous Systems, optional in the other study fields of the program
Language of instruction: English or German; the course language will be announced at the beginning of the semester
Content: • Introduction: Autonomous Systems • Probability and Information Theory • Numerical Computation / Optimization • Machine Learning Basics • Learning Algorithms

- Multilayer Neural Networks & BP
- Deep Learning in Convolutional Neural Networks
- Recurrent Neural Networks, and LSTM
- Reinforcement Learning
- Evolutionary Algorithms I
- Neuroevolution

Recommended reading:

- Handbook of Neuroevolution Through Erlang, Gene I. Sher, Springer, 2013
- Evolving Neural Networks through Augmenting Topologies, Kenneth O. Stanley, Risto Miikkulainen, Evolutionary Computation 10(2): 99-127, 2002
- Computational Intelligence A Methodological Introduction, Third Edition; Rudolf Kruse, Springer Nature Switzerland AG, 2022
- Deep Learning; Ian Goodfellow, Yoshua Bengio, Aaron Courville; MIT Press, 2016, http://www.deeplearningbook.org
- Reinforcement Learning; Richard S. Sutton, Andrew G. Barto; A Bradford Book; second edition, 2018
- Artificial Intelligence - A Modern Approach; Stuart J. Russell and Peter Norvig; Pearson, 4th edition, 2021
- Evolutionäre Algorithmen; Karsten Weicker; Springer Fachmedien, 3. Auflage, 2015
- Soft Computing; Wolfram-Manfred Lippe; Springer-Verlag, 2006
- Lectures on Reinforcement Learning; David Silver; Google DeepMind London, 2015

Comments: -

Course: Signal Processing for Autonomous Systems Lab

Module code: EITM 222M

Lecturer: Prof. Dr. Jan Bauer

Contact hours: by arrangement

Semester of delivery: yearly, summer semester

Type/mode: Laboratory, mandatory in the study field E-Mobility and Autonomous Systems, optional in the other study fields of the program

Language of instruction: English or German; the course language will be announced at the beginning of the semester

Content:

- Project work, present a top-tier (peer reviewed, impact factor >1) technical research paper related to course subjects
- Including e.g., technical writing, reading, presentation, simulation, experiments

Recommended reading:

- Handbook of Neuroevolution Through Erlang, Gene I. Sher, Springer, 2013
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