WM918-15 Automotive Sensors and Sensor Fusion

21/22

Department
WMG
Level
Taught Postgraduate Level
Module leader
Valentina Donzella
Credit value
15
Module duration
2 weeks
Assessment
Multiple
Study location
University of Warwick main campus, Coventry

Description

Introductory description

The module aims to provide the students with a comprehensive knowledge of different types of sensors used in autonomous vehicles, their relevance for the control of advanced driving assistance systems (ADASs), and the architectures for the fusion of information coming from the plethora of sensors available. The module aims to systematically analyse industry motivations, legislations, roadmaps and customer requirements. Key parameters to critically compare different sensors are discussed, and issues related to sensor limitations and different performance are evaluated with an emphasis on system architecture and control. Topics are introduced from a practical viewpoint thus allowing the students undertaking this module to be able to critically evaluate key design parameters and independently apply the learning to a wide range of practical electronic sensors and systems deployed to achieve smart connected and autonomous vehicles.

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Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

- Introduction to sensors, their function, properties and classifications;
- Introduction to automotive sensors and their classification (general sensing, perception, virtual sensors);
- Automotive sensors: key design attributes and limitations;
- Automotive sensors: working principles and interaction with the environment;
- Role of automotive sensors in different ADASs and in autonomous vehicles;
- Introduction to actuators, their classification and their use in advanced driving assistance systems;
- ADAS architecture and control theory;
- Use of control theory in automotive electronics systems with sensors and actuators;
- Introduction to sensors fusion;
- Sensor fusion and its relationship with automotive electronic system architecture and different strategies for sensor fusion;
- Challenges related to automotive sensor fusion and connected vehicles;
- Automotive sensors and advanced driving assistance system testing: state of the art, research trends and challenges;
- Latest trends in research on sensors and sensor fusion for autonomous vehicles.

Learning outcomes

By the end of the module, students should be able to:

- Comprehensively understand and analyse the state of the art of automotive sensors and the control systems in ADAS/autonomous vehicles deploying them
- Critically evaluate different automotive sensors, their working principles, advantages, disadvantages, limitations and test techniques to evaluate their performance
- Interpret the role of the sensors in an advanced driving assistance system (e.g. adaptive cruise control) and independently evaluate the impact of sensors’ limitations on the system limitations
- Critically compare and evaluate different strategies for sensor fusion on autonomous vehicles
- Evaluate and practically represent the coverage of automotive sensors and analyse the effects of different external factors
- Critically interpret and criticise up to date peer-reviewed journal papers on sensor and sensor fusion

Indicative reading list

- KALA, Rahul. On-road Intelligent Vehicles: Motion Planning for Intelligent Transportation Systems. Butterworth-Heinemann, 2016. (ISBN: 0128037563)
- ESKANDARIAN, Azim (ed.). Handbook of intelligent vehicles. Springer, 2014. (DOI: https://doi.org/10.1007/978-0-85729-085-4)
- WATSON, Joseph. Automotive sensors. Momentum Press, 2009. (ISBN: 1-60650-011-2)
- TERZIS, Anestis (ed.). Handbook of camera monitor systems: The automotive mirror-replacement technology based on ISO 16505. Springer, 2016. (DOI: https://doi.org/10.1007/978-3-319-29611-1)
- QU, Zhihua. Cooperative control of dynamical systems: applications to autonomous vehicles. Springer Science & Business Media, 2009. (DOI: https://doi.org/10.1007/978-1-84882-325-9)
- FOSSEN, Thor I.; PETTERSEN, Kristin Y.; NIJMEIJER, Henk (ed.). Sensing and Control for Autonomous Vehicles: Applications to Land, Water and Air Vehicles. Springer, 2017. (DOI: https://doi.org/10.1007/978-3-319-55372-6)
- REIF, Konrad. Automotive Mechatronics. Springer Fachmedien Wiesbaden, 2014. (DOI: https://doi.org/10.1007/978-3-658-03975-2)
- JAIN, Vipul; HEYDARI, Payam. Automotive Radar Sensors in Silicon Technologies. Springer Science & Business Media, 2012. (DOI: https://doi.org/10.1007/978-1-4419-6775-6)

A variety of up-to-date sources including:

- Latest government / UK Automotive Council roadmaps for autonomous vehicles
- Latest automotive legislation and standards
- Current academic research in the field of smart connected autonomous vehicles

View reading list on Talis Aspire

Subject specific skills

Sensor metrics; automotive sensor performance; automotive sensor classification; automotive sensor basic principles, limitations, strengths; automotive sensor models; automotive sensor fusion.

Transferable skills

Team work; Work effectively in a group or team to achieve goals; Personal Motivation, Organisation and Time Management skills; Research and Analytical Skills; presentation skills; Oral and written communication skills.

Study

Study time

Type	Required
Lectures	18 sessions of 1 hour (12%)
Tutorials	1 session of 2 hours 30 minutes (1%)
Demonstrations	1 session of 2 hours (1%)
Other activity	19 hours 30 minutes (13%)
Assessment	108 hours (72%)
Total	150 hours

Private study description

No private study requirements defined for this module.

Other activity description

Module introduction: 0.5hr
Class presentations: 3 hr
Case studies/seminars: 5 hr
Syndicate exercises: 2 x 4 hr
Module review and PMA introduction: 1 hr
individual preparatory work: 2hr

Costs

No further costs have been identified for this module.

Assessment

You do not need to pass all assessment components to pass the module.

Assessment group A2

	Weighting	Study time
Post module assignment	70%	108 hours
Set of problems to be solved and solutions to be justified		
In-module assessments	30%	
Based on self-study hours specified in section 5. The marks will be spit between some small written assignments and/or oral presentations.		

Assessment group R1

	Weighting	Study time
Resubmission Assignment	100%	
New assignment to cover all module learning outcomes		

Feedback on assessment

IMA and PMA: Scaled ratings for Comprehension, Effort and Presentation. Individual written feedback and overall mark.
Formative assessment during the group activities, tutorials, class quizzes using on-line tools (e.g. kahoot quizzes).

Availability

Courses

This module is Core optional for:

- Year 1 of TWMS-H33L Postgraduate Award Smart, Connected and Autonomous Vehicles
- Year 1 of TWMS-H33M Postgraduate Certificate Smart, Connected and Autonomous Vehicles
- Year 1 of TWMS-H33N Postgraduate Diploma Smart, Connected and Autonomous Vehicles
- Year 1 of TWMS-H33P Postgraduate Taught Smart, Connected and Autonomous Vehicles