Universidade Federal de Santa Catarina
Centro Tecnológico
Departamento de Informática e Estatística
Programa de Pós-Graduação em Ciência da Computação

Teaching Plan

10. Identification

Course title: INE 41XXXX – Autonomous Embedded Systems II
Contact hours: 60 (30 theory, 30 practice) **Credits**: 4
Professor: Antônio Augusto Fröhlich **Semester:** 2021/2

11. Prerequisites

INE 410144 – Autonomous Embedded Systems I

12. Syllabus

Introduction and review of Autonomous Embedded Systems I. Timing in autonomous systems, time sources and synchronization protocols, timed data. Localization in autonomous systems, global navigation satellite systems, sensor-based localization, sensor fusion. Autonomous system safety, safety models, principles of safe software design and implementation, isolation, virtualization, algorithms, protocols, runtime verification. Project of a real autonomous system and implementation of secure execution environment featuring runtime safety verification.

13. Objectives

Enable students to execute embedded autonomous systems projects, considering both, design and implementation aspects, covering timing, location, safety, isolation, and runtime safety verification.

13.1 Student Learning Outcomes

- Introducing concepts, technologies and tools related to the project of embedded autonomous systems;
- Instructing in the design and implement of embedded autonomous systems components pertaining timing, location, isolation and runtime safety verification;
- Instructing in the integration and validation of embedded autonomous systems components pertaining timing, location, isolation and runtime safety verification;;
- Supporting in the development of an autonomous system.

14. Contents

8 - Introduction [2 hours]

9 - Timing in Autonomous Systems [8 hours]

9.1 - Time sources [2 hours]

9.2 - Time synchronization protocols [4 hours]

9.3 - Timed data [2 hours]

10 - Localization in Autonomous Systems [6 hours]

10.1 - Global navigation satellite systems [2 hours]

10.2 - Sensor-based localization [2 hours]

10.3 - Sensor fusion [2 hours]

11 - Safety in Autonomous Systems [12 hours]

11.1 - Safety models [4 hours]

11.2 - Safety model enforcement [8 hours]

11.2.1 - Component isolation and replacement [4 hours]

11.2.2 - Runtime model verification [4 hours]

12 - Autonomous System Project [30 hours]

13 - Discussion and closing [2 hours]

15. Methodology

The theoretic part of the course will be covered in lectures and in discussion of read materials. Lectures will take place face to face in the classroom whenever possible. Alternatively, they will be held synchronously online over the Internet. The practical elements of the course will be carried out asynchronously by students, with access to LISHA being granted whenever necessary. All pertinent materials, activities and grading will be carried out via Moodle. Evaluation and grading will be performed based on the project that will be developed by groups of students. Experts might be invited to lecture on specific topics.

16. Grading

Grading will be focused on the project of autonomous system conducted by the students organized in groups and working asynchronously, with at least two synchronous presentation at class time. Synchronous seminars related the specific project topics will also be used for grading purposes.

S: Seminar
P*n*: Project in *n* phases of equal weight
Grade = S * 0,3 + P * 0,7

Note: since 50% of the course is practical, there will be no replacement of partial grades as dictated by arcticle 70 of Resolution 17/CUn/97.

17. Time Plan

Seminar: between 3rd and 6th weeks
Project plan: 8th week
Project intermediate check: 12th week
Project final evaluation: 16th week

18. Textbook and Readings

- S. Liu, L. Li, J. Tang, S. Wu, J. Gaudiot, *Creating Autonomous Vehicle Systems*, Morgan & Claypool, 2020 (ISBN 978-1681739359).
- D. Resner and A.A.Fröhlich, *Speculative Precision Time Protocol: sub-microsecond clock synchronization for the IoT*, In: Proceedings of ETFA, 2016 (DOI: 10.1109/ETFA.2016.7733533).
- A. Chehri, N. Quadar, S. Rachid, *Survey on localization methods for autonomous vehicles in smart cities*, In: Proceedings of SCA, 2019 (DOI: 10.1145/3368756.3369101).
- S. Shalev-Shwartz, S. Shammah, A. Shashua, *On a Formal Model of Safe and Scalable Self-driving Cars*, Mobileye, 2017.
- Mobileye, *Responsibility-Sensitive Safety: a mathematical model for automated vehicle safety*, 2017.
- Aptiv, AUDI, BMW, Baidu, Continental, Teves, Daimler, FCA, HERE Global, Infineon, Intel, Volkswagen; *Safety First for Automated Driving*, 2019.
- NVIDIA, *Self-driving Safety Report*, 2021.