Human-Centered Collaborative Automated Driving under Safety and User Experience Requirements

PhD offer in the Laboratory of Automatic Control, Mechanics, Industrial and Human Computer Science (LAMIH) — UMR CNRS 8201 and e-Controls/UFAM Research Group

Universities	Université Polytechnique Hauts-de-France (UPHF) and Universidade Federal do Amazonas (UFAM)
PhD candidate in	Automatic Control and Electrical Engineering
Duration	3 years
Starting date	March 2025
Location	Valenciennes, France (18 months) and Manaus, Brazil (18 months)
Closing date:	January 10, 2025

Research context

Collaborative driving is an emerging topic in the development of modern transportation systems [3]. This paradigm aims to develop autonomous vehicles that can interact effectively with human beings. However, it is a challenging problem since collaborative driving must balance different requirements such as comfort, safety, and energy efficiency.

Most of the approaches to collaborative autonomous driving fail in providing effective solutions because they focus more on automating the driving task than on supporting the human driver. Collaborative autonomous driving must consider the following issues inherent in human-machine collab- oration: (i) the human driver must trust in the automation control capabilities; (ii) the modellingand prediction of human behaviour are tough and usually inaccurate since it is multifactorial and time-varying; (iii) the final responsibility for the driving always lies with the human driver.
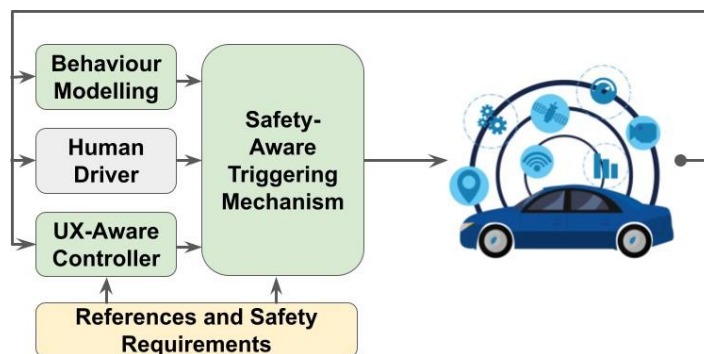

Figure 1: Human-Centered Collaborative Automated Driving.

Therefore, developing an effective collaborative autonomous driving system requires the ability to sense human behaviour and adaptation of the control system to that. Moreover, the automatic control systems should be able to improve the user experience (UX) [4] while preserving safety, security, and efficiency. In this sense, this project aims to develop human-centered automated driving systems that are able to combine human and automatic control in a robust and adaptive framework as depicted in Figure 1. The proposed framework must be able to estimate and exploit human behaviour and driving experience in the synthesis of UX- and safety-aware collaborative control strategies. Since the human behaviour model is too complex and uncertain, data-driven and artificial intelligence methods [1] might be combined with robust and nonlinear control approaches [2] to leverage the development of the proposed human-centered collaborative autonomous driving.

Real-time experiments can be conducted at LAMIH with the testbenches facilities (figure 2). Moreover, the facilities include a smooth integration; from trials in simulators (that can use extra information to validate the approaches), to real-time tests including experiments on tracks, with the necessary back and forth between methodology, simulation, simulators and real-time.

| SHERPA Hybrid Simulator for Automotive Studies | Equipped Autonomous Vehicle at LAMIH | Available Transalley technopole test track Valenciennes |

Figure 2: facilities at LAMIH: from simulator (left) to real-time experiments on closed track (right).

Main requirements

· Master degree or equivalent in Automatic Control, Electrical Engineering, or related fields

· Excellent background in control theory

· Good programming skills

· Professional English (French and Portuguese are not necessary)

How to apply

· Send your CV with two academic referees, a cover letter (explaining why you are interested in this offer and how you can contribute to this project), and your transcript of records.

· Contacts: Iury Bessa (iurybessa@ufam.edu.br), Márcia L. C. Peixoto (marcialuciana.dacostapeixoto@uphf.fr), and Thierry-Marie Guerra (guerra@uphf.fr)

Institutions

Universidade Federal do Amazonas (UFAM) is located in Manaus, a place with countless natural resources and welcoming people. Founded in 1909, UFAM is one of the largest and oldest Brazilian universities. The e-Controls research group is installed at UFAM and integrated to its Graduate Program in Electrical Engineering (PPGEE/UFAM). The e-Controls develops research and development in the following six fields: control theory and applications; autonomous and trustworthy computational intelligence; industrial automation and Industry 4.0; safety and security of embedded and cyber-physical systems; future energy systems and electromobility; and autonomous and collaborative

robotics.

Université Polytechnique Hauts-de-France (UPHF) is a French public university, based in Valenciennes. This project will be developed by the LAMIH UMR CNRS 8201 (Laboratory of Automation, Mechanics, and Industrial and Human Informatics). LAMIH is a collaborative research unit between the UPHF and the National Center for Scientific Research (CNRS). LAMIH is a multi-disciplinary laboratory and a recognized research entity in transportation and mobility-related fields such as non-polluting vehicles, intelligent transportation, driving assistance, eco-driving, lightweight structures, transport logistics, mobility for all, and intelligent mobility. The laboratory has expertise in human interaction with technical systems.

References

[1] Luiz A. Q. Cordovil, Pedro H. S. Coutinho, Iury Bessa, Márcia L. C. Peixoto, and Reinaldo Mart´ınez Palhares. Learning event-triggered control based on evolving data-driven fuzzy granular models. *International Journal of Robust and Nonlinear Control*, 32(5):2805–2827, January 2022.

[2] Anh-Tu Nguyen, Jagat Jyoti Rath, Chen Lv, Thierry-Marie Guerra, and Jimmy Lauber. Human-machine shared driving control for semi-autonomous vehicles using level of cooperativeness. *Sensors*, 21(14):4647, July 2021.

[3] Yang Xing, Chen Lv, Dongpu Cao, and Peng Hang. Toward human-vehicle collaboration: Review and perspectives on human-centered collaborative automated driving. *Transportation Research Part C: Emerging Technologies*, 128:103199, July 2021.

[4] Wei Xu. From automation to autonomy and autonomous vehicles: challenges and opportunities for human-computer interaction. *Interactions*, 28(1):48–53, December 2020.