CESAM Project: PhD position

Title	**Supervised Driving Automatic Railway Shuttle based on a New Physical and Dynamic Simulation Environment**
Supervisor(s)	Michel Basset (Director, Full professor, IRIMAS, UHA) David Vieira (Co-supervisor, Associate Professor, IRIMAS, UHA) Thomas Weisser (Co-supervisor, Associate Professor, IRIMAS, UHA)
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Place	ENSISA, 12 rue des Frères Lumière, 68093 Mulhouse Cedex, France
Keywords	Mechanical modelling, Automation, Control Theory, ROS
Project description	The CESAM (Charging Electric train with Safe Autonomous Mobility) project aims to develop an automated system for ground charging traction batteries on railway vehicles. This is a collaborative project involving two industrial partners, the CRAN laboratory of Nancy and the IRIMAS institute of the University Haute-Alsace. The thesis proposed here will be carried out at the IRIMAS institute in collaboration with the other partners. In this project, the IRIMAS laboratory proposes to develop an innovative simulator specifically designed for the railway context. The goal is to provide partners and the scientific community with an advanced digital simulation tool in this field. Key contributions will focus on safety, efficiency, and control, utilizing the simulator for testing before implementation and validation in real-time conditions. The train will operate under uncertain conditions, such as varying wheel-rail contact adherence. Initial movements, conducted without passengers, will occur at the station and depot to maneuver trains to and from their charging points. An automatic driving mode, activated with driver authorization, will manage deceleration and approach curves to the charging station, ensuring a precise stop. The approach curve to the charging point will be calculated and controlled. Various traction and braking control strategies will be tested in simulation, and a comprehensive and realistic rail simulation environment will be developed during the project. Eventually, the train will be tested in full autonomy, navigating to its charging point at the depot or terminal at low speed without driver presence. The contribution of the thesis will focus on the rail simulation environment for the development, testing and validation of perception, low-speed precise positioning and control laws. More specifically, the work focuses on: • Defining use cases and simulation scenarios; • Modeling of the train dynamics including wheel/rail contact aspects (theoretical approach and numerical implementation on a multi-physics engine);

	• Designing and validating traction and braking control approaches in the presence of obstacles; • Modeling and developing global control approaches for obstacle detection. • Validating deceleration path control algorithms in the presence of obstacles, based on the dedicated numerical simulator; • Experimental validation of the derived control architectures and algorithms on a test prototype (based on ROS environment).
References	• Kalker, J. J. (1979) 'Survey of Wheel—Rail Rolling Contact Theory', *Vehicle System Dynamics*, 8(4), pp. 317–358. doi: 10.1080/00423117908968610. • Tasora, A. *et al.* (2016). Chrono: An Open Source Multi-physics Dynamics Engine. In: Kozubek, T., Blaheta, R., Šístek, J., Rozložník, M., Čermák, M. (eds) High Performance Computing in Science and Engineering. HPCSE 2015. Lecture Notes in Computer Science(), vol 9611. Springer, Cham. https://doi.org/10.1007/978-3-319-40361-8_2 • G. D'Amico *et al*., "TrainSim: A Railway Simulation Framework for LiDAR and Camera Dataset Generation," in *IEEE Transactions on Intelligent Transportation Systems*, vol. 24, no. 12, pp. 15006-15017, Dec. 2023, doi: 10.1109/TITS.2023.3297728. • D. Chikurtev, "Mobile Robot Simulation and Navigation in ROS and Gazebo," *2020 International Conference Automatics and Informatics (ICAI)*, Varna, Bulgaria, 2020, pp. 1-6, doi: 10.1109/ICAI50593.2020.9311330.
Job description	**Thesis start date and duration:** October 2024, for a 36-month contract Funding and salary: Academic funding. Salary according to current regulations **2100€ monthly gross salary**
How to apply	**Required skills:** You have a general engineering background or university equivalent with a specialization in Automation and Control and/or Mechatronics. A solid scientific background in dynamic systems modelling and control theory (advanced control algorithms such as MPC) is requested. You are autonomous and curious. You have the ability to work as part of a team and to engage in dialogue. You are fluent in English. **Application procedure:** Please send CV, Master's/engineer's transcripts from the last two years and cover letter. **Contacts:** Michel BASSET (michel.basset@uha.fr), Thomas WEISSER (thomas.weisser@uha.fr), David VIEIRA (david.vieira-gois-fernandes@uha.fr).