# ACCROBOT Project: PhD position

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| Title | Advanced Control for Collaborative Mobile Robots in Urban Environments<br>**A**rchitectures de **C**ommande **C**ollaborative d'une flotte de **ROBOT**s (ACCROBOT) |
| Supervisor(s) | Michel Basset (Director, Full professor, IRIMAS, UHA)<br>Jonathan Ledy (Co-supervisor, Research engineer, IRIMAS, UHA)<br>David Vieira (Co-supervisor, Associate Professor, IRIMAS, UHA) |
| Laboratory | Institut de Recherche en Informatique, Mathématiques, Automatique et Signal<br>IRIMAS UR 7499, Université de Haute-Alsace (UHA) |
| Place | ENSISA, 12 rue des Frères Lumière,<br>68093 Mulhouse Cedex, France |
| Keywords | Collaborative control, multi-agent system, energy reduction |
| Project description | The ACCROBOT project is part of the ongoing research efforts of the MIAM team at IRIMAS Institute. It aims to advance research in "Experimental Modeling, Identification, Advanced Control, and Monitoring," leveraging the team's expertise. The project focuses on the collaborative control of robot fleets and aligns with various projects undertaken by the team in this domain.<br><br>Among the research themes, collaborative multi-robot systems are increasingly active. Issues related to navigation and the safety of autonomous robot fleets represent a complex multi-agent, multi-objective problem that requires innovative control architectures. This project proposes developing collaborative control strategies for managing autonomous robot fleets using advanced control methods. The originality of this project lies in its structured approach, from the design of control laws through simulation to integration on real platforms. Validation in real conditions, as described in the literature, represents a significant challenge, providing a concrete dimension to the results. The main objective is to propose new collaborative control architectures using theoretical tools like Model Predictive Control (MPC) and exploring new artificial intelligence techniques (Reinforcement Learning, Data Driven, etc.).<br>The project will also account for mathematical models of robots that closely reflect their dynamic behavior, unlike the point-mass models typically described in the state-of-the-art multi-agent literature. This approach allows better consideration of constraints (variabilities, parametric uncertainties, unknowns, energy consumption) in synthesizing new control strategies.<br><br>In addition to theoretical advancements, the project will involve advanced simulators for testing, proving, and validating proposed solutions. The open-source simulator CARLA will be used extensively, allowing for simulation of structured environments with communicating vehicle fleets, where the control of each agent can be managed. Environmental perception information will complement the necessary data in the global collaborative control architecture to ensure fleet navigation safety. |

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| | The final objective is to integrate control algorithms into a dedicated robotic environment (ROS). This middleware tool facilitates interfacing between software and hardware layers of the platforms used. Real-world testing and validation of various proposed approaches will be conducted in a shared urban environment, as exemplified by the AMI France 2030 project.<br><br>The contribution of the thesis will be achieved according to the following methodology and timeline:<br>1. Literature Review on Collaborative Control Approaches (Centralized, Distributed)<br>2. Development of Collaborative Controls (Stability Analysis, Optimization)<br>3. Definition of a Global Collaborative Control Architecture<br>4. Development of a Validation Model under CARLA Simulator<br>5. Integration of Control Architecture in Real Case |
| References | **[1]** Tihay, D., & Perrin, N. (2018). Robotique collaborative : perception et attentes des industriels. Hygiène et Sécurité du Travail, INRS, 250, 50-57.<br>**[2]** Lemonnier S., Simonin J., Lanfranchi J-B. (2023). Robots collaboratifs dans l'industrie française en 2021 : acceptation des opérateurs et points de vue d'industriels. In Proceedings of the 34th Conference on l'Interaction Humain-Machine (IHM '23). Association for Computing Machinery, New York, NY, USA, Article 18, 1–8. https://doi.org/10.1145/3583961.3583979<br>**[3]** Ammour, M., Orjuela, R., Basset, M. (2022). A MPC Combined Decision Making and Trajectory Planning for Autonomous Vehicle Collision Avoidance. IEEE Transactions on Intelligent Transportation Systems, 23(12), 24805-24817.<br>**[4]** Schader, M., Luke, S. (2023). Exploring Planner-Guided Swarms Running on Real Robots. In : Mathieu, P., Dignum, F., Novais, P., De la Prieta, F. (eds) Advances in Practical Applications of Agents, Multi-Agent Systems, and Cognitive Mimetics. The PAAMS Collection. PAAMS 2023. Lecture Notes in Computer Science, vol 13955. Springer, Cham. https://doi.org/10.1007/978-3-031-37616-0_26<br>**[5]** Ammour, M., Orjuela, R., & Basset, M. (2023). A Cooperative Centralized MPC for Collision Avoidance of a Fleet of AVS Check for updates. *Recent Developments in Model-Based and Data-Driven Methods for Advanced Control and Diagnosis*, 297. |
| Job description | **Thesis start date and duration:** October 2024, for a 36-month contract<br>Funding and salary: Academic funding. Salary according to current regulations<br>**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 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.<br><br>**Application procedure:** Please send CV, Master's/engineer's transcripts from the last two years and cover letter.<br><br>**Contacts:** Michel BASSET (michel.basset@uha.fr), David VIEIRA (david.vieira-gois-fernandes@uha.fr), Jonathan LEDY (jonathan.ledy@uha.fr) |