We invite applications for a fully funded Ph.D. research position on Control Allocation for Autonomous Over-Actuated Off-Road Vehicles. The position is joint between:

- **Technology & Strategy** ([https://www.technologyandstrategy.com](https://www.technologyandstrategy.com)), Strasbourg, France
- **UHA** ([https://www.irimas.uha.fr/index.php/equipes/equipe-miam/](https://www.irimas.uha.fr/index.php/equipes/equipe-miam/)), Research Lab IRIMAS, University de Haute Alsace, Mulhouse, France

The position is for 36 months (the usual duration in France for a Ph.D.)

**Keywords:** Control Allocation, Off-Road Vehicle, Robust, Over-Actuated, Electric Single Wheel Actuator, Deformable Soil.

**Context & Objectives**

Autonomous off-road vehicles start conquering new challenging fields such as agriculture, defense, construction industry, mining, and industrial logistics. These environments present strong constraints, especially about the terrain whose soil nature can vary from hard to soft as well as from adherent to slippery conditions. In addition, the navigable terrain can be comprised of potholes, bumps, and slopes.

An advanced actuators control strategy contributes to ensuring the vehicle’s motion in safe conditions. A robust control design is then required to deal with any change in the immediate environment, like the nature of the soil and the slopes’ change.

Over the last three years, the Innovation Lab of Technology & Strategy introduced these control strategies in its research work. A first thesis CIFRE deals with the modeling of the wheel/deformable soil interaction, which allows getting a simplified synthesis model to develop specified control algorithms. A sliding mode control has been developed from the model, which adjusts the torque applied to the wheels to let the tire into an optimal slipping working mode.

A first prototype (figure 1), named KIPP, allows for validating the dynamic and cinematic models and test control performances with different terrains (agriculture field, beach, park ...).
A second vehicle prototype is being designed. Each wheel will be equipped with a single actuator for the traction and a single actuator for the steering. Moreover, an active suspension will be able to adjust the height of each wheel from the body of the vehicle. The market of the off-road autonomous vehicle trends increasingly toward this kind of vehicle architecture, because of their many degrees of freedom which improve their drivability and their agility which have become necessary to perform their mission with good performances.

The objective of this thesis is to propose a new architecture of longitudinal and lateral vehicle control. As the second generation is an over-actuated vehicle, a control allocation strategy could be implemented. It would be necessary to integrate the wheel / deformable soil interaction model which was developed during the first thesis. Moreover, the controller will have to deal with the concept of virtual differential gear and take care of synchronizing the steering of each wheel.

Location

The Ph.D. student will be co-hosted by Technology & Strategy and the University of Haute Alsace in Mulhouse, France.

Technology & Strategy was created in 2008 in Strasbourg. Specialized in Engineering, IT, Digital and Project Management, Technology & Strategy is a reference partner for its customers in the development of innovative projects. Technology & Strategy also has an integrated engineering service to meet the requirements of its customers who are primarily R&D departments of industrial companies.

With a strong international focus and a Franco-German DNA, Technology & Strategy is proud of its 1,800 employees and is present with more than 40 nationalities in 16 offices in 6 countries (France, Germany, Switzerland, Belgium, UK, South East Asia). Technology & Strategy is proud to keep its headquarters in the East of France, near Strasbourg.

Our know-how has since been extended to the off-road autonomous vehicle. The Innovation Lab team continues working on many applications, like safe and accurate geolocation from sensor fusion, robust motion control, path coverage planning for agriculture, obstacles, and path detection in an unstructured environment or remote vehicle dashboard.

The University of “Haute-Alsace” (UHA) is a multidisciplinary teaching and research center based in the two cities of Mulhouse and Colmar, France. Research and teaching at UHA concentrate mainly on science, technology, economics, management, arts, and humanities. In 2017, UHA has more than 8000 students with about a hundred courses offered. The founding of UHA was driven by social and business players, among them was Jean-Baptiste Donnet.

With its 2 universities, 12 Grandes Ecoles, 250 laboratories and over 4,300 researchers, Alsace is the third-largest scientific hub in France.

Skills

Candidates should have solid skills in:

- Vehicle dynamics modeling
- Linear and robust control theory design
- Notions in time-discrete controller design
- Observers and state estimators design
- Optimization algorithms knowledge
• Knowledge in control allocation would be a plus
• Embedded systems programming will be appreciated

Software and programming skills

Candidates will be required to:
• Have a significant Matlab/Simulink programming experience
• Have Embedded C programming knowledge
• Knowledge of C++ programming skills would be a plus

Application

Applications should be submitted by email to:
michel.basset@uha.fr and m.spisser@technologyandstrategy.com

They must include:
• A Curriculum Vitae;
• List of 2 or 3 references to contact (position, email address)
• Transcripts of undergraduate and graduate studies
• Link to MSc thesis, and publications if applicable
• Link to personal software repositories (e.g. GitHub)

Please prefix the filenames of your application with your last name.