The **French-German Research Institute of Saint-Louis (ISL)** situated in the border triangle of Germany, France and Switzerland is an internationally renowned research institute belonging to a global industrial and economic network.
The spectrum of our core activities comprises a variety of topics: aerodynamics, energetic and advanced materials, lasers and electromagnetic technologies, protection, security and situational awareness. Our activities are related to both basic and applied research.

ISL is offering a **PhD Position**

Research field: Flight techniques for projectiles

Guidance strategies for a class of long range guided projectiles

Context

The Long Range Guided Projectile (LRGP) project is ISL's commitment to increase the range of a new generation of guided ammunition, especially of low-cost artillery projectiles. Conventional 155 mm ammunition can claim a maximal range of about 35 km. The scientific goal of the LRGP project is to develop new projectile concepts, devoid of propulsion or base-bleed systems, that can significantly augment this range while maintaining a competitive advantage in terms of hit accuracy and flight time duration. Preliminary investigations suggest a clear potential for hitting long range targets, however further aerodynamic optimizations and appropriate guidance strategies need to be jointly considered in order to optimize the maximum achievable range for a given class of projectiles.

Research objectives & timeline

From the guidance perspective, in order to increase the range for a given aerodynamic configuration, the slope of the gliding phase shall be minimized. For constant velocities, a well-known result maximizing the lift-to-drag ratio can be applied. However, due to changing flight conditions, this strategy may no longer be optimal for the LRGP concept. Similarly, classical guidance laws such as proportional navigation are not suited for optimizing the range as they were adapted to achieve good terminal hit while ignoring range optimization and manoeuvrability constraints. Hence, the goal of this PhD project is to research on appropriate guidance strategies (guidance laws and flight scenarios) which exploit the given aerodynamic configuration to maximize the projectile range, while not compromising other important aspects such as terminal target-hit accuracy, manoeuvrability limitations, and flight time. It is of paramount importance to understand the various effects that the particular aerodynamic configuration and different flight scenarios (initial launch angle and velocity, spin rate, etc.) have on the resulting ballistic flight trajectory.

Then, the challenge will lie in developing general methods which will allow the derivation of optimal guidance strategies leading to the maximum possible range. For special cases, analytical solutions are expected, while for more general cases, only numerical solutions are probably possible.

The main tasks of the project will consist of the following steps. Development of a mathematical model of the projectile with appropriate force and moment modelling depending on the aerodynamic configuration. An extended literature survey to assess the existing knowledge on guidance laws which could be promising for projectile range extension. The core of the PhD will then focus on the development of new guidance strategies to satisfy the mission criteria described above, while respecting implementation simplicity and mathematical rigour.

Candidate profile and embedding

The PhD candidate shall be able to work independently as well as in a multidisciplinary environment collaborating with scientists, engineers, and other PhD students working in the field of aerodynamics, exterior ballistics, flight mechanics, guidance, navigation, and control. Desired qualities and knowledge:

- Motivated, diligent, and committed in realizing his/her duties
- Knowledge on dynamical systems, control systems, and MATLAB/Simulink
- Knowledge in aerodynamics and flight mechanics is not essential, but would be considered as an asset

The PhD candidate will join the GNC group of ISL, one of the four groups in the division "flight techniques for projectiles". The GNC group has a particular expertise and a proven track record in designing and implementation of high performance algorithms for flying vehicles.

French-German Research Institute of Saint-Louis (ISL)

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