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: Sensors, Telemetry and Communication

Development of a flexible target detection system based on Software-Defined Radio for embedding inside a gun-fired ammunition

Context

This study is proposed by the French-German research Institute of Saint-Louis (ISL) and the Institute of Electronics and Digital Technologies (IETR) of Nantes with a possible cofunding by the Direction Générale de l'Armement (DGA).
Direction finding techniques aim to estimate the Direction Of Arrival (DOA) of one or more transmitters using the signals received by an array of sensors, and are used in various domains such as radar, acoustics, astronomy or wireless communications. Phased arrays are used in many radio communication applications, in order to locate RF transmitters and focus radiated energy towards the user for instance, as it is done in 5G ground stations.
On the other hand, Software-Defined Radio deports some signal processing that was historically carried out by dedicated hardware to the digital baseband, where digitized signals are instead processed using programmable instructions. This allows to modify the behavior of an RF transceiver by reprogramming instead of hardware modification or redesign. This flexibility offered by Software-Defined Radio allows updates, including of new communication standards or even modifications to the signal processing by reprogramming, without any physical intervention, with a generic hardware that can be functional over wide frequency ranges (over 7 GHz in the case of the USRP X410 from National Instruments).
Our team is interested in developing a passive direction finding system based on Software-Defined Radio to enable a single system to locate as many types of targets as possible, in the context of instrumented artillery ammunitions. The goal of this study is to develop a numerical simulator and the needed direction finding algorithms, as well as adapt the implemented algorithms to a commercial Software-Defined Radio platform. Finally the performance and limitations of the developed system will be evaluated through several scenarios with various received waveforms, trajectories of the ammunition and the target, etc. The implemented experimental system will be tested in anechoic environments as well as real conditions outdoors for comparison with results from the numerical simulator, in order to provide first conclusions on achievable performance with such a system for artillery ammunitions.

Proposed study

First we will adapt state-of-the-art direction finding techniques while accounting for constraints inherent to the project (required computation power, computation time, angular resolution of the produced estimate, etc.) and will validate our choices through a numerical simulator that will be coded on Matlab for instance. The student will implement the necessary functions to emulate the sampled signals received by the phased array depending on the considered source (waveform), the evolution of the Channel State Information (CSI) such as Doppler effect created by the relative movements of the system and target, possible reflections, etc. Techniques to explore and analyze the electromagnetic spectrum can also be implemented to allow the system to choose the appropriate algorithm in scenarios where the ammunition is fired without prior information on the target.
Then we will implement the direction finding system on a commercial Software-Defined Radio and assess the performance and limitations of the developed system through measurement campaigns that will take place at ISL. Comparison of the results from the simulator and measurements will form a first proof of feasibility of an RF flexible direction finder able to meet the very specific constraints of guided ammunitions, which is not available in scientific literature today.
This study will first take place at the IETR (France – 44), then at ISL (France – 68). Short stays at the associate laboratory will occur during the PhD thesis. Publications in international conferences and peer-reviewed journals will be encouraged to value the work of the student among the scientific community.

Candidate's profile

We are looking for a candidate who will own a Master degree or equivalent in electronics, signal processing, radio communication systems or radar by October 2023. The candidate will need to have knowledge in digital signal processing and programming (Matlab, C++). Knowledge in direction finding and/or Software-Defined Radio would of course be an advantage, but skills can be developed during the PhD.
Only students with a nationality from the EU, the United-Kingdom or Switzerland are eligible.

Informations

Dates: Starting beginning of October 2023, 3-years-long contract
Places: First part of the PhD thesis in IETR laboratories (France – 44), second half on site at ISL (France – 68).
Contact: Send an email with a motivation letter and a detailed resume to the supervising team.

Supervisors

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Laboratories

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