INTERNSHIP OFFER

On the design of shared waveforms for communication and radar functions

Keywords: digital communications, radar, estimation/detection, waveform design, information theory, software defined radio.

Context and expected outcomes

In various vehicular scenarios (*e.g.*, UAV, aircraft, intelligent car), merging communication and radar systems is tempting to save resources (*e.g.*, spectrum, energy, weight, volume). To that end, several waveforms were proposed to **jointly perform data transmission and radar sensing** [CWXZ11, KBJ14]. Particularly, **multicarrier modulations** such as orthogonal frequency-division multiplexing (OFDM) have shown interesting capabilities to fulfill this dual function [FNG06, SZW09].

In previous work, we used an "on-the-shelf" OFDM waveform and focused on the design of low-complexity radar receivers [MRB19, MRB18]. We observed a **trade-off in terms of radar vs communication performance**. For example, while spectral efficiency can be seen as a figure of merit from a communication perspective; it is more a nuisance for the radar scene estimation.

A proper optimization of the transmitted signal should be done to control the aforementioned performance trade-off. Such **co-design techniques** may involve information theoretic performance criteria and parametric waveforms [YB07, BK16].

In this internship, we will specify new radar/communication co-design techniques based-on multicarrier modulations. Different degrees of freedom may be proposed (*e.g.*, constellation design, time-frequency grid adaptation) along with original performance criteria.

A coarse roadmap would include the following steps.

1. Bibliography on the topic; implementation and performance evaluation of separate communication and radar waveforms.
2. In-depth study of a state-of-the-art co-design approach (probably [BK16]).
3. Identification of new co-design techniques, implementation and performance comparison with state-of-the-art algorithms.
4. Assessment of the proposed algorithms with real RF signals, using our software-defined-radio platform.

Host institution and place of work

Located in **Toulouse** (France), **ISAE-SUPAERO** is a public higher education and research institute focused on aerospace applications. The department of electronics, optronics and signal processing (DEOS) has an extensive expertise in electrical engineering applied to aerospace systems. In our team, radar and communication systems are mostly studied with signal processing approach (estimation and detection techniques, time-frequency analysis, information theory...).

Candidate profile and application

Applicants should be master (or engineer) students. A strong background in **signal processing and statistics** is required. Good communication skills in English are necessary (written and oral), as well as good development skills (Matlab, Python...).

⇒ Applications (resume, motivation letter, transcript) and informal inquiries are to be emailed to `stephanie.bidon@isae-supaero.fr`, `meryem.benammar@isae-supaero.fr` and `damien.roque@isae-supaero.fr`.

Useful information...

- **Start of internship in 2020** ; duration from five to six months.
- Accommodation and food service are available in the campus.
- A conference submission is targeted during the internship, depending on the student's outcomes.
- Opportunity to continue on the same topic as a PhD student or as a research engineer (fixed-term contract).

References

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[FNG06] G. E. A. Franken, H. Nikookar, and P. V. Genderen. Doppler tolerance of OFDM-coded radar signals. In *Radar Conference, 2006. EuRAD 2006. 3rd European*, pages 108–111, Sept 2006.

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[MRB19] S. Mercier, D. Roque, and S. Bidon. Study of the target self-interference in a low-complexity OFDM-based radar receiver. *IEEE Trans. Aerospace Engineering Systems*, 55:1200–1212, June 2019. Available at http://oatao.univ-toulouse.fr/21176/.

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