INTERNSHIP + PHD IN SIGNAL PROCESS.:
Faster-than-Nyquist receivers based on Monte Carlo methods

Institut Supérieur de l'Aéronautique et de l'Espace
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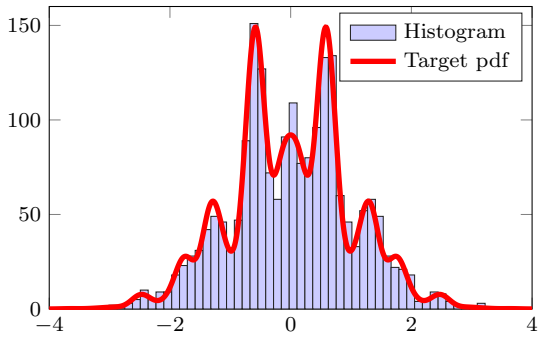
Context and expected outcomes

In the race for spectral efficiency, the idea of a "**faster-than-Nyquist" (FTN)** transmission has been proposed several decades ago [Maz75]. FTN seems particularly suited to *power-constrained channels* (*e.g.*, satellite, optical fiber, mobile) [Col11, PMCA13] while bringing *waveform security* [LMRB19]. Nonetheless, a symbol rate greater than the occupied bandwidth necessarily generates interpulse interference (IPI) and still challenges the symbol detection task. Such an IPI issue has been essentially considered in simple scenarios so far (*e.g.*, perfectly synchronized receivers in presence of AWGN, sometimes with multipath channels) [RA09, BFC09, PA12, MRSS17].

During this internship and/or PhD thesis, we ambition to explore the benefits of FTN in *more realistic channels* (*e.g.*, including residual synchronization offsets and/or partially unknown scatterers). We will rely on **Markov Chain Monte Carlo (MCMC) receivers** [DW05]. In particular, hybrid sampling/factor-graphs techniques could be investigated. Firstly, we will determine asymptotic performance metrics *via* computationally intensive simulations (*e.g.*, information rates) [ML13]. Secondly, we will focus on the design of less complex receivers either with efficient sampling techniques or *via* deterministic approximations (*e.g.*, variational Bayesian techniques) [YWWK16].

(a) Nanosatellites are subject to drastic power constraints and could use FTN purposefully.



(b) Sampling from an arbitrary pdf can achieved *via* several algorithms (here: *slice sampling*).

Host institution and place of work

Located in **Toulouse** (France), **ISAE-SUPAERO** is a public higher education and research institute focused on aerospace applications. Particularly, the department of electronics, optronics and signal processing (DEOS) has an extensive expertise in electrical engineering applied to aerospace systems. The "Communications and Information Theory" (ComIT) research team conducts activities in digital communications, radar, channel access techniques. Applications include space systems, commercial and military aviation, cellular networks and the Internet of things. Our webpage: `http://isae.fr/deos/comit`.

Candidate profile and application procedure

Applicants should be last-year master students or hold a master degree. A strong background in **statistical signal processing** is required. Good communication skills in English are necessary (written and oral). A prior experience in Monte Carlo sampling would be particularly appreciated.

⇒ Applications (resume, motivation letter, transcript, in English or in French) and informal inquiries are to be emailed to

- `damien.roque@isae-supaero.fr`;
- `stephanie.bidon@isae-supaero.fr`.

Application deadline

- For the internship: 05-Dec-2022.
- For the PhD: 13-Mar-2023.

Misc.:

- You may apply either for the internship *and/or* for the PhD thesis.
- The internship should start during the first semester of 2023 (5-6 month), immediately followed by the PhD thesis (36 month fixed-term contract).
- You will be offered various opportunities during the PhD thesis: teaching, international mobility, supervision experience (internships, teaching projects...), relations with defense and aerospace industry.
- EU citizenship is required by the funding agency.

References

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