INTERNSHIP OFFER in digital communications
MCMC receivers for FTN transmission with imperfect synchronization

Research group: ComIT

Location: ISAE-SUPAERO, 10 avenue Édouard Belin, 31400 Toulouse.

Duration: 5-6 months beginning ca. February-April 2022.

Gratification: 3.9 €/hour cf. service-public.fr

1 Context

To face the scarcity of the radio-frequency (RF) spectrum as well as the "hunger" for increased information rate, *faster-than-Nyquist* (FTN) transmission has been proposed [7]. It consists in using non-orthogonal pulses to increase the achievable spectral efficiency, especially in power-constrained channels [2, 8].

2 Problematic and research axes

So far, many studies have been considering FTN symbol detection only in simplified propagation channels with additive noise [6]. Nonetheless, in practice synchronization errors[1] may arise and their impact on FTN receivers have not been thoroughly evaluated. To implement realistic FTN systems it is nonetheless necessary to take them into account (*e.g.,* in satellite communications).

In this internship, we propose to develop FTN receivers taking into account these errors and based on **Monte Carlo Markov Chain** (MCMC) methods [5, 9], including Gibbs sampling moves [4] and/or Metropolis–Hastings moves [1]. Approximated conditional densities may be considered too to decrease the receiver complexity. Impact of the transmission density as well as of the repartition of the pilot symbols will be evaluated.

Organization:

1. Develop an FTN system model in presence of synchronization errors.
2. Implement conventional symbol detectors (e.g.: BCJR, Viterbi) in absence of synchronization errors.
3. Design of MCMC-based symbol detectors in presence of synchronization errors.
   - The first parameter of interest is the time-delay error in scenarios with and without pilot sequence.
   - Synchronization errors in phase and frequency will be then considered.
4. Design of receiver based on approximated factorization of the posterior [10, 11, 3].

If possible, results will be presented in an international conference.

[1] Synchronization parameters include time-delay, phase and frequency shifts.

3 Qualifications

- Final year degree student (Master of Science, Master of Research)
- Fields: statistical signal processing (including estimation batch and/or recursive), digital communications.
- Software: Matlab, LaTeX.
- European citizenship required.
- Preferred candidate profile: after graduation, interested in pursuing this research topic as a PhD student.

4 Application procedure

If this research topic is of interest to you, please send a resume, a letter of motivation and your academic transcript to:

- Damien Roque, <damien.roque@isae-supaero.fr> ;
- Stéphanie Bidon, <stephanie.bidon@isae-supaero.fr>.

References

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