Proposition de recherche doctorale

Studies for mono-carrier systems: application to 4G systems

Mots clés :

- **Directeur de thèse** : OLIVIER RIOUL
- **Co-encadrant(s)** :
- **Unité de recherche** : Laboratoire Traitement et Communication de l'Information
- **Ecole doctorale** : École Doctorale Informatique, Télécommunications, Électronique de Paris
- **Domaine scientifique principal**: Divers

Résumé du projet de recherche (Langue 1)

{{Introduction to the subject and Problem Statement}} Digital communications systems designed in the nineties were not able to face the ever growing demand for higher bit rates and were supplanted by wideband techniques. In particular, the use of OFDM multi-carrier techniques [1] was applied to many present standards such as DAB, DVB, xDSL, Wifi, Wimax, LTE … Nevertheless in spite of many advantages, and in particular its low-complexity, OFDM techniques suffer from various drawbacks. Besides the classical peak-to-average-power-ratio problem, let us cite: the synchronization sensitivity, the heavy redundant signalization to compensate its lack of robustness, the efficiency loss in the time-frequency dimensions because of the OFDM sharp-shape and because of the prefix presence. To compensate those drawbacks, many researchers proposed to get rid of the rectangular shape but then, the OFDM simplicity is then lost. In the meanwhile, mono-carrier studies have gained some interest thanks to several significant breakthroughs. First, the mono-carrier receiver became iterative with the coupling of soft channel decoders's outputs with embedded signal processing techniques [2]. The initialization of various algorithms became less critical, especially in time-varying environments thanks to forward-backward techniques. More recently, some low-complexity smoothing techniques provided several dB gains, when compared to classical synchronization techniques [3][4]. This smoothing technique even allowed to reach the Bayesian Cramer-Rao bound over a wide window of Signal-to-Noise ratios [5] [6]. {{Purpose}} The purpose of this PhD is thus to apply those low-complexity smoothing techniques to other key functions of the receiver: - Channel estimation by channel smoothing techniques, coupling with the channel decoder, bounds derivation, comparison with classical algorithms. Measures of the improvement on MIMO techniques. - Smoothing equalization techniques, coupling with the decoder, associated bounds and comparison with classical techniques. Finally, we want to introduce those techniques in the canvas of 4G LTE uplink mono-carrier receiver and measure the improvement/complexity brought by those techniques. {{Advisors}} Olivier Rioul (PhD, HDR) and Benoît Geller (PhD, HDR) {{Location}} Télécom ParisTech, Paris, France. Olivier Rioul is with the Digital Communications group at the Communications and Electronics Dept. at Télécom ParisTech. Benoît Geller is with UEI Lab at ENSTA ParisTech. {{{Bibliography}}} [1] Ramjee Prasad, "OFDM for wireless communications systems", Artech House, 2004. [2] B. Geller, J.P. Barbot, J.M. Brossier, C. Vanstraceele, "System for compensating turbo-decoder phase shift", International patent pended by the CNRS, PCT Fr2005/01350, January 2006. [3] J. Yang and B. Geller, "Near-optimum Low-Complexity Smoothing Loops for Dynamical Phase Estimation", IEEE Transactions on Signal Processing, vol. 57, no 9, pp. 3704-3711, Sept. 2009. [4] B. Geller, J.P. Barbot, J.M. Brossier, C. Vanstraceele, "Method for estimating the phase and the gain of observation data transmitted over a QAM-modulated transmission channel", International patent pended by the CNRS, PCT Fr2005/002301, WO/2006/032768 30th March 2006. [5] S. Bay, C. Herzet, J.M. Brossier, J.P. Barbot, B. Geller, "Analytic and Asymptotic Analysis of Bayesian Cramér-Rao Bound for Dynamical Phase Offset Estimation", IEEE Transactions on Signal Processing, vol. 56, no 1, pp. 61-70, Jan. 2008. [6] J. Yang, C. Herzet, O. Rioul, B. Geller, "Near-MAP Smoothing Loops for Code-Aided QAM Dynamical Carrier Phase Estimation", IEEE Transactions on Signal Processing, submitted, 2012.

Résumé du projet de recherche (Langue 2)

{{Intellectual Merit}} The central impact of the proposed work stems from its unified treatment of channel estimation and equalization, coupled with channel decoding. No such unified framework or methodology exists at present. This research, by exploring a systematic comparison to Cramér-Rao bounds, is intended to provide the community with an extremely rich toolset, which is expected to impact and benefit similar problems on estimation theory. {{Valorization Potential and Leverage Effects}} The optimal choices to be derived in the research project can be declined in recommendations that could be standardized, at least for the most representative cases.

Informations complémentaires (Langue 1)

{{International Collaboration Perspective}} This theme of research will de?nitely allow us to put coherence in all the work that has already been done so far in the ?eld. We, therefore, intend to unite the whole state-of-the-art. To achieve this goal, we shall interact with the most prominent laboratories that have already contributed some aspects to channel Bayesian estimation. {{Publications}} Dissemination actions will consist in top-ranked publications in the Communication and Signal Processing ?elds. One identi?ed goal is to submit to ICASSP and the IEEE Transactions on Signal Processing. The results of this research will be presented at major national and international professional venues, in the Communication and Signal Processing communities.

Informations complémentaires (Langue 2)

{{Advisors}} Olivier Rioul (PhD, HDR, olivier.rioul@telecom-paristech.fr) and Benoît Geller (PhD HDR, benoit.geller@ensta-paristech.fr) {{PhD Candidate profile}} The PhD candidate should have a strong interest in fundamental research and a solid background in an area related to applied mathematics, statistics, or information theory. For the necessary exploration work to forge the intuition, some background is desired in software development for signal processing and digitial communications (Matlab, C); the advisors can assist the student with those aspects and eventually teach her/him how to handle them.