Projet TAST4
Low complexity turbo-decoding

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Context

Turbo-codes were invented by Berrou et al in 1993 [1]. They revolutionize the field of error-correcting codes by proposing coding schemes that operate very near to the Shannon limit over different channels. The novelty was about concatenating two convolutional codes separated by an interleaver and jointly decoding using an iterative procedure. In this project, we are interested in the trellis-based decoder called the Bahl-Cocke-Jelinek-Raviv -BCJR) Algorithm [2]. It is an algorithm for maximum a posteriori probability (MAP) symbol decoding *i.e.* it maximizes the probability of each symbol given the whole observed sequence.

Today, machine-to-machine (M2M) communications are one of the central use cases in the upcoming new fifth generation (5G) mobile network as they play a major role in the Internet of thing (IOT). When deploying such devices, one faces one main challenge: battery-powered devices should consume as low energy as possible in order to extend their lifetime.

Unfortunately the complexity of the classical BCJR algorithm is not necessarily compatible with the targeted cheap and power-constrained devices. To this aim, low complexity (suboptimal) decoding algorithms [3] are of interest in order to achieve sufficient trade-offs between energy consumption (or computational complexity) and decoding performance (mainly bit-error rates).

Tasks

This project will be performed in two main steps. First we will study the turbo codes system: *i.e.* the procedure of the encoding an the strategy of the BCJR algorithm. Second, and after a deep understanding of the BCJR algorithm and analyzing its principal complexity bottlenecks, we will study state-of-the-art low complexity alternatives and select the best solution regarding our context. This solution is to be analyzed in details and compared to the classical BCJR algorithm using Matlab; as an optional third step, we will implement the transmitter and the receiver in a real radio system using software-defined radio (SDR)

References

[1] Claude Berrou and Alain Glavieux. *Near optimum error correcting coding and decoding: Turbo-codes*. IEEE Trans. Commun, 44(10):1261-1271, 1996.

[2] LR Bahl, J Cocke, F Jelinek and J Raviv. *Optimal decoding of linear codes for minimizing symbol error rate* IEEE Trans. Inf. Theory, 20:284-287, 1974.

[3] H Chen, RG Maunder, L Hanzo. *A survey and tutorial on low-complexity turbo coding techniques and a holistic hybrid ARQ design example* IEEE communications Surveys and Tutorials, 15(4), 1546-1566, 2013.

Présentation et renseignements

Le projet qui s'inscrit dans le Master TAST (Terrestrial and Space Telecommunications) comprend une part de recherche bibliographique, une part expérimentale et la rédaction d'un article scientifique au format IEEE pour présenter les résultats.

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