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Turbo Codes: The Issue of Average Union Upper Bound under Imperfect Channel State Information in Rayleigh Fading Channels

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Abstract: The potential of turbo codes to demonstrate excellent performance in the region of low signal to noise ratio is now a familiar fact. The idea of turbo codes was first introduced by Berrou and was based on the clever utilization of the existing decoding mechanism of BCJR with a change in the encoder by introducing feedback and an interleaver in the overall scheme. Since then, these powerful forward error correcting codes have attained a significant attention and have either replaced or have become a sturdy candidate for many applications in this era of modern communication systems. So far, a lot of work has been published regarding the performance of turbo codes by using both simulation and average upper bounds, but unfortunately, no author has yet obtained a mechanism to resolve the issue of obtaining an average upper bound under imperfect channel state information. In this article we will address the issue of obtaining an average union upper bound for the bit error rate using the transfer function approach. In this work, the bound for coherent BPSK over independent Rayleigh fading channels will be discussed and it will be showed that this way of computing the average union upper bound is a generalized approach for obtaining upper bounds. In order to incorporate imperfect estimation, it is assumed that the estimation errors are Gaussian distributed having a variance equal to a fraction of the variance of normalized Rayleigh distribution. The work also shows that the pairwise error probability expression with no estimation error is a particular instance of an imperfect estimation case.

Key Words: Turbo code, imperfect estimate, channel state information, pairwise error probability, average union upper bound

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