APP based iterations stopping criteria for MNBTC

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***Abstract*—A study of the iterations stopping criteria adapted to multi-non-binary turbo-decoders, based on the evolution of a posteriori probability density (APP) is presented. The performaces bit / frame error rate (B/FER) versus signal to noise ratio (SNR) of multi-non-binary turbo codes (MNBTC) equipped with the iterations stopping mechanism proposed in this study are compared with those obtained using the genie iterations stopping criterion. Details about the redundancy in the number of processed iterations as compared to the ideal criterion are also presented.**

Keywords—communication systems; correcting codes; iterative decoding; a posteriori probability; turbo-codes

I. INTRODUCTION

With the turbo codes (TC) development [1] iterative decoding has become the most used decoding method for correcting codes. It is the most powerful as well. However, the iterative decoding has some drawbacks. One of the drawbacks is the high complexity involved. Another major drawback of TC iterative decoding is the redundancy. The iterative decoding redundancy mainly refers to the iterations performed after the errors have been fully eliminated. Determining the moment when this fact has occurred is the goal of the iterations stopping mechanism. A mechanism that does not perform any iteration after error correction is an idealization and it is not practically feasible. This mechanism called genie [2] implies the knowledge of the original data sequence at the reception. But, the genie mechanism represents a benchmark for evaluating the efficiency of the practically implementable. Somewhat implausible, the genie iterations stopping mechanism is also redundant. It is ideal only for correctable data blocks, which after decoding are "cleaned" of errors. The genie mechanism is totally redundant for uncorrectable blocks. The idea of stopping the iterative decoding also for uncorrectable blocks has been proposed in [3]. However, for the SNR at which the TC is used, the proportion of correctable blocks is very high, so genie remains a reference criterion.

The iterations stopping criteria abound [4]-[8] in the literature in the late 90s and at the beginning of the last decade. These criteria were designed for single binary turbo codes (SBTC). With the development of double binary turbo codes (DBTC) [9]-[10] studies dedicated to iterations stopping criteria for these TC have appeared as well. Basically, they are adjustments to the proposed criteria for SBTC to the particularities of DBTC decoding.

In this paper, we present a study regarding the iterations stopping criteria based on the evolution of APP distributions, computed after each iteration of the iterative decoding process performed in the case of MNBTC. The MNBTC, recently proposed [11], presents very good performances B/FERvsSNR, especially in the error floor region. The MNBTC involves a higher computational volume than the SBTC or the DBTC, for each iteration in the turbo decoding process. On the other hand, they have a higher turbo decoding convergence than the SBTC of the DBTC. These two MNBTC features justify the use of iterations stopping mechanisms. By turbo decoding convergence we mean the average number of iterations required to decode a block processed by the turbo decoder. In other words, it is the average number of iterations performed by a MNBTC equipped with a iterations stopping mechanism based on the genie criterion.

The rest of the paper is structured as follows. Section II brings a brief overview of MNBTC. We will present the structure of a MNBTC, the scheme of a multi-non-binary convolutional encoder (MNBCE), the maximum a posteriori (MAP) decoding algorithms and the maximum logarithmic MAP (Max-Log-MAP). In section III, the proposed stopping mechanism for multi-non-binary turbo decoder is presented. For this purpose, an analysis of the evolution of the APP values distribution that represents the output of the two multi-non-binary convolutional decoder is previously performed. The experimental results are presented in section IV. The performances B/FERvsSNR obtained for MNBTC equipped with iterations stopping mechanisms based on both genie criterion and the proposed criteria based on the so called minAPP criterion are presented. We also presented the the efficiency of minAPP criterion as compared to the genie criterion. The last section is dedicated to conclusions.

II. MULTI-NON-BINARY TURBO CODES

The MNBTC are detailed in [11]. In this section we will make a short presentation on several aspects of the structure and functioning of MNBTC, useful to describe the MNBTC stop iterations mechanisms. In order to use the information presented in [11], we will keep the same notation defined there.

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