EMS Decoding Algorithm that Introduced Shuffled Strategy and Improved Variable Node Update

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***Abstract*—Non-binary LDPC codes have excellent performance, but the decoding algorithm is complex. EMS algorithm reduces the search space of the check equation by truncating the iterative message vector, and exchanges performance for lower complexity. In this paper, we propose an EMS decoding algorithm (Shuffled_VNU_EMS) with a shuffled strategy and improved variable node update. This algorithm updates by column, so that the latest variable node information of the last column can be used. At the same time, to reduce the information oscillation, a weighting factor β is introduced when updating the variable node information,β= 0.9. The simulation results show that when the code length is 512, the code rate is 0.5 and the bit error rate is 10^{-4}, the coding gain of the shuffled VNU EMS algorithm proposed in this paper is 0.18 dB higher than that of the classical EMS algorithm.**

Keywords—LDPC, EMS, decoding algorithm, variable node update, shuffled strategy

I. INTRODUCTION

Low-density parity-check (LDPC) codes were first invented in 1962 [1]. When LDPC coding uses a confidence propagation decoding (BP) algorithm, it can be close to the channel capacity [2]. LDPC is a linear block code defined on the sparse parity-check matrix. It has the advantages of lower decoding complexity and more flexible code speed. It is very suitable for high-order modulation systems.

The belief propagation (BP) decoding algorithm[3-5] is the traditional decoding algorithm of LDPC, but it uses many multiplication operations. Experts put forward some improved methods based on the BP decoding algorithm. Among them, the log-likelihood ratio confidence propagation (LLR-BP) decoding algorithm [6-8] uses the log-likelihood ratio to represent the probability information of nodes. When the log-likelihood ratio confidence propagation (LLR BP) decoding algorithm is applied to LDPC codes, the encoded messages are iteratively exchanged between variables and check nodes, which greatly shortens the running time compared with the BP algorithm. When updating the verification node, the minimum sum algorithm replaces the complex operation with the minimum value approximation, but the amount of other calculations is still equivalent to the Log-BP algorithm. The EMS algorithm is the extended minimum sum algorithm (EMS algorithm) [9] proposed by D. Declercq in 2007. By truncating the length of the message vector transmitted between the variable node and the verification node, it can greatly reduce the decoding complexity of multivariate LDPC codes.

In order to reduce the amount of computation, the EMS algorithm stores the original first nm largest elements in descending order by preprocessing the information vector. This direct truncation method will bring some performance loss. In addition, this paper analyzes the role of shuffling strategy in the BP decoding algorithm [10] and proposes an improved extended minimum sum algorithm for variable node update based on shuffled, Shuffled_VNU_EMS. The improved algorithm uses the shuffling strategy. In each iteration, the latest variable node information of the updated column is used to update the information of the later sequence verification node, and the variable node information is weighted $\boldsymbol{\beta}$ The modified information [11] makes the external information value of the last iteration also participate in the updating process of the variable node of the current iteration, so as to reduce the oscillation of external information. The decoding speed of the node is faster and the decoding quality can be improved.

The rest of this paper is arranged as follows: In the second section, we describe the main steps of EMS algorithm