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A REVIEW OF RESEARCH ON THE CONSTRUCTION AND DECODING OF MULTIPLE LDPC CODES

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Annotation. With the continuous progress of communication technology, LDPC codes have become one of the key technologies in channel coding with their superior error correction performance and efficient decoding algorithms. Among them, multivariate LDPC codes perform better in high-order modulation and burst error channels, especially in short to medium code length conditions, but there are also shortcomings [3]. In order to better reconcile band utilization with BER and reduce decoding complexity, this paper discusses the construction and decoding of multivariate LDPC codes, focusing on their development history and research status.

Keywords. Channel coding, LDPC codes, multiple LDPC codes, construction, decoding

Around the 1960s, Gallagher started to construct multivariate LDPC codes using finite fields while proposing binary LDPC codes, but only from the idea of multivariate codes. It was not until 1998 that Mackay and Davey successfully demonstrated that LDPC codes constructed randomly based on finite fields outperformed binary LDPC codes, with good iterative decoding performance in both Gaussian white noise (AWGN) channels and binary erasure channels (BEC).

In fact, the construction methods of multivariate LDPC codes can be divided into two categories, namely randomized construction methods and structured construction methods. The PEG [1] algorithm is one of the commonly used randomized construction methods, where the connection between the check node and the variable node can be established step by step under a known degree distribution, and is used to build Tanner graphs of multivariate LDPC codes with large ring lengths. The approximate extra-ring message degree (ACE) algorithm is also one of the well-known computer-based stochastic construction algorithms, which increases the influence of overlapping rings on the decoding code by considering the rings as a way to improve the flow of extra messages during decoding iterations. The above random construction method requires a large number of computer search operations, and the constructed code words are irregular. Although the randomly constructed LDPC codes have good performance, the coding complexity is high.

Using algebraic theory, knowledge of finite geometry and the theory of matrix operations as the main structured construction method can be used to construct a class of multiplexed LDPC codes with regular structure of the check matrix. The structured construction method can be used to construct a class of multiple LDPC codes whose check matrices have a regular structure. By using sets of special structures, such as perfect difference sets, prime sets and good codes, a class of LDPC codes with regular structure can be constructed, which This effectively improves the performance of the waterfall region and brings some performance gains. Constructing multivariate LDPC codes can be combined with "good" codes to bring structural optimization, including generalized RS codes (GRS) [2] and Irregular Repeated Accumulation (IRA) codes. By combining other code The optimization of the checksum matrix of multivariate LDPC codes, in combination with other code features, allows for efficient encoding and easy to implement in hardware and further increase encoder throughput. Finite geometric knowledge is one of the most important ways to construct LDPC codes is to use the relationship between points and lines at the earliest. It is possible to obtain code word structures with a minimum distance and a better trap set, with a very low error leveling. The mask technique is used more often in matrix operation theory, and the mask technique is mainly The mask technique is mainly used by multiplying a check matrix of known structure with a certain mask matrix to change the original matrix structure, reducing the number of short loops while making the degree distribution better and the sparsity The mask technique is mainly used to change the structure of the original matrix by multiplying the known structure with a certain mask matrix, reducing the number of short loops while making the degree distribution better and sparser.

In addition, there are many measures of code word merit, including ring distribution, minimum distance, trap set, etc. Several of the structured construction methods mentioned above also start from these measures. One of them is for the existence of rings, especially short rings, which tend to bring about correlation between variable nodes, making the outer information return to its own node after only a few passes, which is not conducive to accurate decoding, such as the PEG algorithm which focuses on designing code words with larger ring lengths. The greater the minimum distance, the less it is affected by noise and the easier it is to decode, which is also one of the key factors affecting the decoding threshold and performance curve waterfall area. As multivariate LDPC codes are defined over a finite domain, their check matrix consists of elements within the domain, so optimization of measures such as the ring can be achieved from the perspective of optimizing the set of coefficients.

In summary, for the problem of constructing multivariate LDPC codes, the core objectives are optimize the metrics that measure the structure of the code word so as to quickly and accurately construct a structured checksum matrix, which facilitates accurate decoding at the receiver. For the decoding of multivariate LDPC codes the core objective is to optimize the metrics for measuring the code word structure so that a well-structured check matrix can be constructed quickly and accurately to facilitate accurate decoding at the receiver. The decoding problem of multi-dimensional LDPC codes requires an analysis of the decoding rules of the two types of nodes to reduce the algorithm of the two types of nodes can be reduced without degrading the error correction performance.

List of used sources:

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