RECENT RESULTS ON CONSTRUCTION OF STRUCTURED LDPC CODES

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Abstract:

Low Density Parity Check Codes (LDPC) were introduced by Gallager [1] around 40 years ago, rediscovered in 1996 [2]. LDPC codes can be decoded with simple soft decision iterative decoding with a complexity that grows linearly with code length, and yet achieve error performance very close to the theoretical limits set by Shannon. However, being defined as the null space of a sparse random parity check matrix, it is difficult to implement encoding block in practical applications especially in cases of long codes. We propose structured sparse matrices that permit very low complexity encoders even in the case of long codes. Algebraic methods and combinatorial mathematics are used to build cyclic and quasi-cyclic LDPC matrices. The encoder of cyclic and quasi-cyclic LDPC codes can be implemented using shift registers where the complexity of encoding would be linearly proportional to the code length. Short cycles especially of length four in the Tanner graph deteriorate the performance of the decoding algorithm. Structured LDPC constructions based on the methods we describe, guarantee the absence of these cycles of length four. This presentation is organised as follows: we go briefly through the properties of LDPC codes and discuss two methods for constructing structured LDPC matrices. The first method is based on a branch of combinatorial mathematics called Balanced Incomplete Block Design (BIBD) [3]. We go through the definition of BIBD and introduce the general methods of constructing BIBD LDPC codes. Then we shall explain one particular method referred to as symmetrically repeated differences SRD and provide several designs based on this method. The second part of the presentation introduces a simple method to construct quasi-cyclic LDPC codes based on Vandermonde matrix design, which is also referred to as array LDPC codes [4]. This method offers a flexible construction, easy to implement and its Tanner graph is free of cycle four [5]. Furthermore we present comparisons between random Mackay codes, LDPC codes based on BIBD design and Vandermone construction. Simulation results show that by negligible performance loss structured LDPC codes provide much better performance/complexity trade-off, which makes them practical to implement.