Performance Comparison of LDPC and Distributed LDPC Coding schemes

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Introduction

We present a comparison of the performance of LDPC and distributed LDPC coding system for a relay channel . Low-density parity check codes a class of block code with parity check matrices. These codes perform well with iterative probabilistic algorithm. We have used Sum-Product Algorithm (SPA) and it propagates soft probabilities of the bits between bit nodes and check nodes through the Tanner graph.

LDPC Coding

An LDPC code is an (*n, k*) linear block code whose parity-check matrix *H* contains only a few 1's in comparison to 0's. Two parameters are defined for a parity-check matrix. Here, *J* is number of nonzero elements in a column and *K* is the number of non zero elements in a row. LDPC code is a regular LDPC if *J* is constant for every column and *K* is also constant for every row. The code may be referred to as irregular on the other hand, if *H* is low in density but *J* and *K* are not constants [1]. Every parity check matrix can be represented by a factor graph. As an example, for parity check matrix *H*, its corresponding factor graph is shown in Figure1 and Figure 2, where the variable nodes v_i, i= 0,1,2,3,4,5 are represented by circles and the check nodes c_j, j= 0,1, 2,3 are represented by squares.

$$H = \begin{pmatrix} 1&1&1&0&0&0 \\ 0&1&1&1&0&0 \\ 1&0&0&0&1&1 \\ 0&0&0&1&1&1 \end{pmatrix}$$

Figure 1: An example for parity check matrix

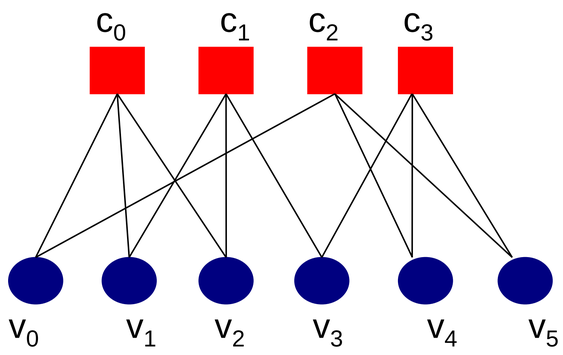

Figure 2: Factor graph for the parity check matrix

Distributed LDPC coding scheme

A conventional single user LDPC code is designed and operates efficiently at a certain channel parameter for the point to point transmission from the source to the destination. Using a relay located at a destination using the decoded-and-forward strategy. The overall code should be designed jointly for the source-relay link and the source-destination link considering the presence of a relay. This will need the designed constituent LDPC code should operate at two different channel parameters. The overall LDPC should be designed jointly for the source relay link and the source destination link considering the presence of relay.

A system with one relay R is considered, which is on the direct line between a source and a destination D, as shown in fig. 3. Following equations [2] are hold in the simulation, path loss exponent and the d is 0.5 and AWGN channel assume for all the links.

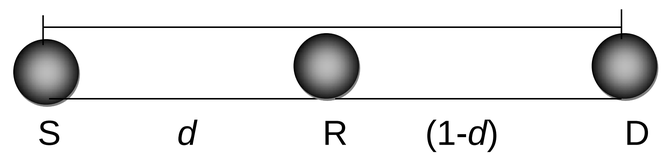

Figure 3: A relay system with relay R on the direct line between sources S and destination D

$$\frac{\sigma_{SR}^2}{\sigma_{SD}^2} = d^{\alpha} \;, \frac{\sigma_{RD}^2}{\sigma_{SD}^2} = (1-d)^{\alpha}$$

Alternatively SNR in different links are given by

$$SNR_{SD} = \frac{1}{\sigma_{SD}^2}$$

$$SNR_{SR} = \frac{1}{\sigma_{SR}^2} = SNR_{SD}.\frac{1}{d^{\alpha}}$$

$$SNR_{RD} = \frac{1}{\sigma_{RD}^2} = SNR_{SD}.\frac{1}{(1-d)^{\alpha}}$$

Results

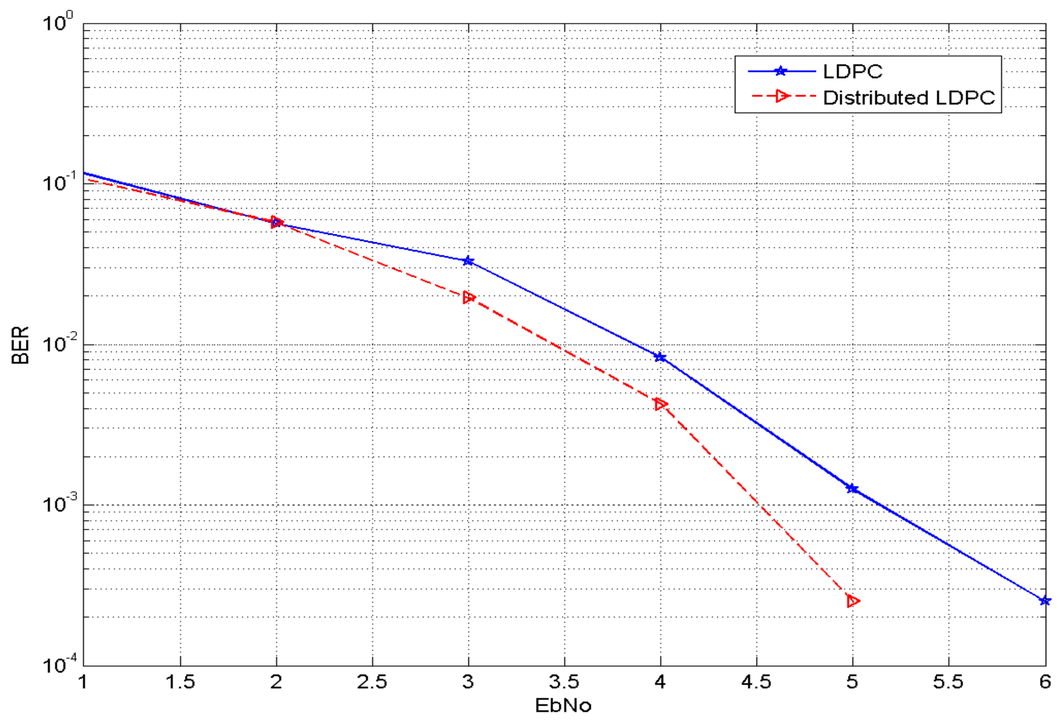

Figure 3: Comparison of LDPC and Distributed LDPC coding schemes over AWGN channel

Result shown here is the initial phase of the project and the further research is being continued to find the optimal decoding technique.

Conclusion

We presented link level BER performances of LDPC coded and distributed LDPC. It has shown in the simulation distributed LDPC coding system having higher BER performance compared to the LDPC system. Moreover the fluctuation in the error floor of LDPC further smoothed by increasing number of iterations in the Monte Carlo simulations.

References

[1] R. G. Gallager, " Low Density Parity check codes, *Transactions of the IRE Professional Group on Information Theory*, Vol. IT-8, pp. 2l-28, January 1962.

[2] M. Wu, P. Weitkemperer D. Wübben, K.-D. Kammeyer," Comparison of Distributed LDPC Coding Schemes for Decode-and-Forward Relay Channels, "proceedings of International ITG Workshop on Smart Antennas WSA, ", pp 127-134, 2010.