Noisy Gradient Descent Bit-Flip Decoding for LDPC Codes

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Abstract

Document Sections

I. Introduction

II. Related Work

III. Proposed Noisy GDBF Algorithm

IV. Simulation Results

V. Architecture Considerations

Show Full Outline

Authors

Figures

References

Citations

Keywords

Metrics

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Footnotes

Abstract:
A modified Gradient Descent Bit Flipping (GDBF) algorithm is proposed for decoding Low Density Parity Check (LDPC) codes on the binary-input additive white Gaussian noise channel. The new algorithm, called Noisy GDBF (NGDBF), introduces a random perturbation into each symbol metric at each iteration. The noise perturbation allows the algorithm to escape from undesirable local maxima, resulting in improved performance. A combination of heuristic improvements to the algorithm are proposed and evaluated. When the proposed heuristics are applied, NGDBF performs better than any previously reported GDBF variant, and comes within 0.5 dB of the belief propagation algorithm for several tested codes. Unlike other previous GDBF algorithms that provide an escape from local maxima, the proposed algorithm uses only local, fully parallelizable operations and does not require computing a global objective function or a sort over symbol metrics, making it highly efficient in comparison. The proposed NGDBF algorithm requires channel state information which must be obtained from a signal to noise ratio (SNR) estimator. Architectural details are presented for implementing the NGDBF algorithm. Complexity analysis and optimizations are also discussed.

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