

Synopsis

We investigate into the limitations of the sum-product algorithm for binary low density parity check (LDPC) codes having isolated short cycles. Independence assumption among messages passed, assumed reasonable in all configurations of graphs, fails the most in graphical structures with short cycles. This research work is a step forward towards understanding the effect of short cycles on error floors of the sum-product algorithm.

We propose a modified sum-product algorithm by considering the statistical dependency of the messages passed in a cycle of length 4. We also formulate a modified algorithm in the log domain which eliminates the numerical instability and precision issues associated with the probability domain. Simulation results show a signal to noise ratio (SNR) improvement for the modified sum-product algorithm compared to the original algorithm. This suggests that dependency among messages improves the decisions and successfully mitigates the effects of length-4 cycles in the Tanner graph. The improvement is significant at high SNR region, suggesting a possible cause to the error floor effects on such graphs. Using density evolution techniques, we analysed the modified decoding algorithm. The threshold computed for the modified algorithm is higher than the threshold computed for the sum-product algorithm, validating the observed simulation results. We also prove that the conditional entropy of a codeword given the estimate obtained using the modified algorithm is lower compared to using the original sum-product algorithm.