LDPC Codes via Bent/Near-Bent Functions: Properties and Applications to NASA Deep Space

Jose W. Velazquez*, Heeralal Janwa, University of Puerto Rico at Rio Piedras

Efficient and reliable error correction is important for NASA's deep-space missions. For the Mariner spacecraft, Reed-Solomon codes were used for error correction and later, Turbo codes for NASA missions. Recently, linear time decodable Low-Density-Parity-Check (LDPC) codes and protograph-based LDPC codes have been proposed for future NASA deep-space missions in various proposals by the Jet propulsion laboratory's (JPL) information processing group. These copy and permute the edges and nodes of a small graph. We propose a new construction and compare it to current NASA standards.

Our work optimizes decoding and error-correction efficiency through belief propagation analysis of new LDPC codes based on bent and near-bent functions. These functions are related to Almost-Perfect-Nonlinear (APN) functions. APN power functions were investigated by Janwa and Wilson (1991), and Janwa, Wilson, and McGuire (1995), and later by scores of other researchers. The conditions for constructing these functions are directly related to the construction of good error-correcting codes and bent/near-bent functions. We have recently generalized results by Dillon, Dobbertin (2003), and Carlet to obtain new Bent functions. We construct our LDPC codes from these new functions. We compare the performance of our codes to previous NASA standards.

Keywords: LDPC Codes, NASA Deep-Space, Error-Correction