Paper ID: 52751
student

IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Advanced Technologies for Space Communications (1)

Author: Mr. Naveed Naimipour
National Aeronautics and Space Administration (NASA), United States

Dr. Haleh Safavi
NASA, United States
Dr. Harry Shaw
NASA GSFC, United States

POLAR CODING FOR FORWARD ERROR CORRECTION IN SPACE COMMUNICATIONS WITH LDPC COMPARISONS

Abstract

With the surging development of optical telecommunications for space applications, the importance of error correction has become more apparent than ever. Specifically, the exploration of forward error correction code (FEC) methodologies will be instrumental in developing the standards for optical communications in space. In this paper, we report on our ongoing investigations into the viability of polar codes for optical communications and compare them with their conventional LDPC counterparts. Polar codes have immense promise of assisting space communications error correction due to their ability to bypass the error floors that plague LDPC codes.

We have evaluated extremely promising techniques including new cyclic redundancy checks (CRC), successive cancellation (SC), and successive cancellation lists (SCL) that assist polar coding in achieving the Shannon limit in a timely manner. The fixed block correction style of CRC codes has shown it can assist polar coding in detecting errors with burst noise particularly well. Furthermore, SC codes eliminate redundancies by cutting the polar codes into smaller pieces for processing and works well for longer block lengths. SC typically performs poorly with smaller block lengths, but SCL attempts to remedy this issue by adding a memorized portion of bits to aid the error correction. These methodologies have the unique potential to overtake current LDPC standards.

Results of Matlab simulations to test the ability of each polar coding methodology to handle a variety of variables are reported. In addition, simulations conducted with AWGN and burst noise to test each technique's ability to handle different types of noise are reported. The different types of noise will test each technique's ability to account for noise typically encountered in space and each technique's ability to correct unexpected errors. Results of simulations for different rates and message lengths are also reported to determine each technique's ability to handle large data volume and fix errors. Similar simulations will be conducted via MATLAB and C for LDPC codes with additional tests for convolutional and no interleavers.

Finally, a discussion regarding the future ability of polar codes to satisfy current missions in the place of, or in conjunction with, LDPC codes along with the merits of each FEC technique's ability to process data efficiently and handle data while maintaining adequate performance will be provided. Preliminary recommendations will be made for each technique's effectiveness for GEO related missions along with discussions regarding each technique's ability to fit within the CCSDS standards for optical communications.