ADVANCED TECHNOLOGIES FROM ISRO

Interest Exploration Note TT / 11 / 01 / HQ

LDPC Convolutional Code (LDPCCC)

The Indian Space Research Organisation (ISRO) has developed a MATLAB and C++ model of the Low Density Parity Check (LDPC) and LDPC Convolutional Code (LDPCCC) for use in Global Navigation Satellite System (GNSS) respectively.

Global Navigation Satellite System (GNSS) are under planning / being implemented by the US, Russia, Europe, China, Japan, India, Nigeria and many other countries in the frequency bands 1559-1610 MHz (L1 band), 1215-1300 MHz (L2 band) and 1164-1215 MHz (L5 signal).The signal and data structure for each of these systems is different. Data rates ranging from 25 bits/sec to 500 bits/sec and Forward Error Correction (FEC) techniques from rate = ½, k = 7 convolutional code to Low Density Parity Check (LDPC) codes have been proposed for various signals.

A. Application of LDPC / LDPCCC

These models can be used for developing FPGA netlist or IP Core RTL product for LDPC or LDPCCC as applicable to GNSS. For telecom and other applications the software can be modified to suit a given application.FEC technology using Advanced Coding Techniques is useful in deep space missions, fibre communication, computer to computer communication links etc.

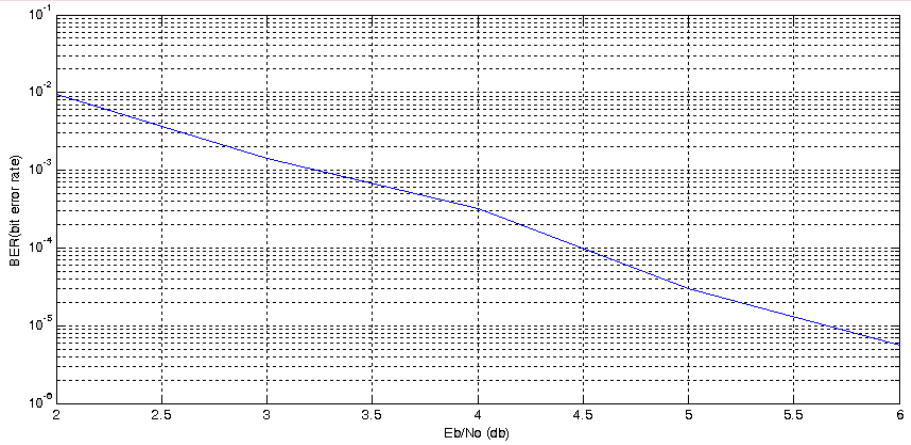
B. Advantages of LDPC Block codes

1) These are suited for implementations that make heavy use of parallelism. Consequently, error-correcting codes with very long code lengths are feasible.
2) The quasi-cyclic LDPC codes presented show a comparable decoding performance to the randomly constructed LDPC codes with the advantage of a significantly reduced encoding complexity.

3) QC-LDPC codes have encoding advantage over conventional LDPC codes and their encoding can be carried out by shift register with complexity linearly proportional to the number of parity bits of the code.

4) No tail bits are required for block coding providing additional bits for data transmission.

LDPC Block Code Algorithm



BER v/s Eb/No for 35 iterations

C. Advantages of LDPCCC

1) LDPCCC are simple to encode, since the original code construction method yields to a shift register based systematic encoding.

2) LDPC convolutional codes are suitable for transmission of continuous data as well as block transmissions in frames of arbitrary size where LDPC can transmit block of fixed length only.

3) For a given complexity LDPC convolutional codes have better performance than LDPC block codes.

4) LDPCCC has excellent BER performance under AWGN.

5) LDPCCC is extremely useful for large values of data bits N. However, they can be used with good BER performance for shorter number of data symbols such as in GNSS navigation data.

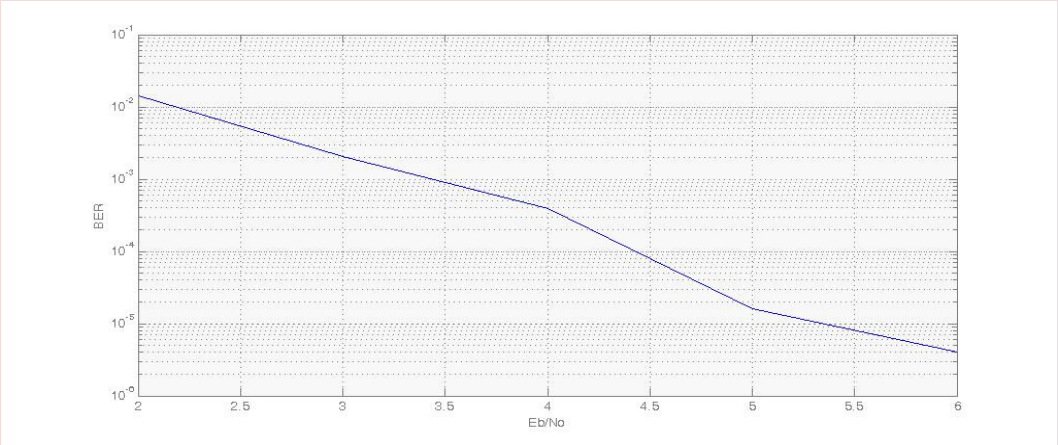
6) LDPCCC architecture is more amenable to pipelining because of feed forward architecture. Hence, it may achieve higher clock speeds and continuous decoding.

7) VLSI implementation of LDPCCC is based on replicating identical units called processors. A complete decoder can be constructed by concatenating a number of these processors together. The convolutional structure of the Tanner graph aids VLSI implementation.

8) For comparable BER performance, the size of an LDPCCC processor could be an order of magnitude less than that for LDPC block code. Hence the routing complexity within a processor is also an order of magnitude less than that for a block code.

LDPC CC Algorithm

Use of LDPC Convolutional Codes (LDPCCC) for navigational data structure in a conventional medium earth orbit or geostationary orbit satellite navigation system is yet to be proposed. For finite block lengths, a systematic comparison of these codes is not proposed in the literature so far.



AWGN performance of LDPCCC

The LDPC and LDPCCC algorithms have been subjected to Failure Mode effect analysis (FMEA) testing.

TECHNOLOGY TRANSFER FROM ISRO

ISRO is willing to offer the know–how of this technology to entrepreneurs / capable parties / IP Core developers etc engaged in use of Advanced Coding Technology for a variety of applications. Parties interested in acquiring this know-how may write with details of their present activities, requirements, plans for commercialization, infrastructure and technical expertise available with them and their own market assessment to the address given below.

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