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"IMPLEMENTATION OF NON BINARY LDPC DECODER WITH IMPROVED PERFORMANCE"

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***ABSRACT-** Low density parity-check (LDPC) code is a linear error correcting code, a method of transmitting a message over a noisy transmission channel. An LDPC is constructed using a sparse bipartite graph. LDPC codes are capacity-approaching codes, which means that practical constructions exist that allow the noise threshold to be set very close (or even arbitrarily close on the BEC) to the theoretical maximum for a symmetric memory less channel. The noise threshold defines an upper bound for the channel noise, up to which the probability of lost information can be made as small as desired. Here implementation of the Non-Binary LDPC encoding and decoding is done using symbol flipping algorithm on MATLAB.*

***Keywords:** LDPC codes, noise threshold, sparse bipartite graph, bit flipping algorithm*

I. INTRODUCTION

In wireless communication systems noise comes into picture in the channel between the transmitter and receiver. Due to this errors are introduced hence received signal is different from transmitted signal. To overcome this problem error control codes are used. Error detection and correction or error control are techniques that enable reliable delivery of digital data over unreliable communication channels. As we can see from Fig 1 the source encoder converts symbols into digital form. The digital output of a source encoder is fed to the channel encoder in which additional bits or redundant bit are added depending on the error correcting technique used. After modulation the information is transmitted on the noisy channel. After modulation the information is transmitted on the noisy channel. The sources of noise can be various defined by statistical characteristics using transfer functions to model their behaviour. Many communication channels are subject to channel noise, and thus errors may be introduced during transmission from the source to a receiver. Error detection techniques allow detecting such errors, while error correction enables reconstruction of the original data in many cases. The general idea for achieving error detection and correction is to add some redundancy (i.e., some extra data) to a message, which receivers can use to check consistency of the delivered message, and to recover data determined to be corrupted.

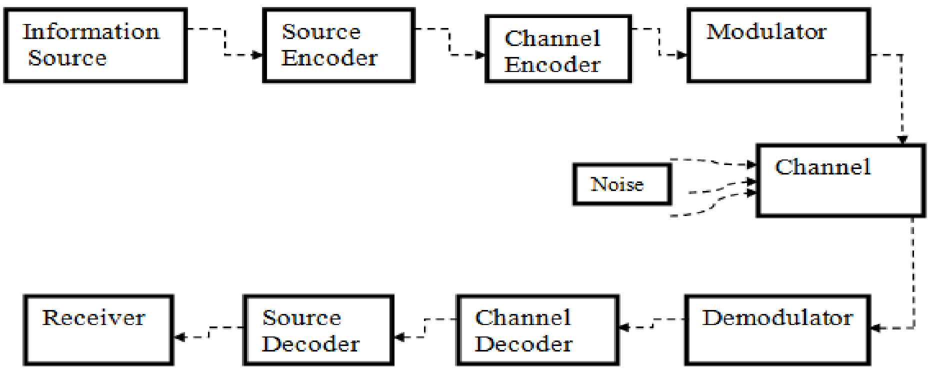

Fig 1: The Block Diagram of Digital Communication System

The error control performance of these codes is evaluated in terms of Bit Error Rate (BER) by transmitting randomly generated data.On the surface, BER is a simple concept— its definition is simply:

$$BER = Errors/Total\ Number\ of\ Bits$$

LDPC codes are block codes with parity-check matrices that contain only a very small number of non-zero entries. It is the sparseness of H which guarantees both a decoding complexity which increases only linearly with the code length and a minimum distance which also increases linearly with the code length.

The biggest difference between LDPC codes and classical block codes is how they are decoded. Classical block codes are generally decoded with ML like decoding algorithms and so are usually short and designed algebraically to make this task less complex. LDPC codes however are decoded iteratively using a graphical representation of their parity-check matrix and so are designed with the properties of H as a focus.

LDPC codes can be classified as: 1) Regular LDPC Codes
2) Irregular LDPC Codes

And it can also be classified as: 1) Binary LDPC Codes
2) Non Binary LDPC Codes

Non-binary LDPC (NB-LDPC) codes show superior correction performance in the error floor region compared to their binary counterparts, when codes with high rates and small to moderate code words lengths are used . This performance improvement comes at the cost of a larger decoding complexity in the non-binary case than in the binary case.

II. PROPOSED SYSTEM

The proposed system can be explained in a simple way as a coding technique used in the digital communication system using one of the most powerful class of codes that is LDPC Codes. Non binary counterparts of these codes show a better performance and consistency in case of transmission and reception of information signals. Here one of the algorithm called the symbol flipping algorithm is used which shows a better performance measures. The whole system is divided into steps from encoding of the LDPC codes, syndrome generation and the recompilation of the syndrome using symbol flipping algorithms.

The steps are:

1] Syndrome bit generation.
2] Calculation of non zero values.
3] Picking up the message bits and finding the summation En.
4] Recompilation of the syndrome using flipping algorithms.

IMPORTANCE OF FLIPPING ALGORITHM

Decoding algorithms are iterative, meaning they require a large number of repeated calculations. In practice, we can trade between performance and complexity by operating with less iteration. So-called Weighted Bit-Flipping (WBF) algorithms have extremely low complexity, but with a large penalty in performance. Numerous bit-flipping algorithms have been devised to improve performance. Gradient Descent Bit-Flipping (GDBF) algorithms provide a good balance between performance and complexity. Some bit-flipping algorithms perform close to MS, but require a big increase in complexity. Bit-flipping decoders associate a reliability score to each symbol. For a given symbol xi, the reliability score, Ei , represents the sum of all locally available information, including the channel sample magnitude and adjacent parity-check results. Faster decoding is possible by flipping multiple bits in each iteration.

The Symbol Flipping Decoding algorithm of the non-binary ldpc decoder is as shown in fig4. Here designing of symbol-flipping decoding (SFD) algorithm is done which combines a technique of error estimation and a method of multiple voting levels from each unsatisfied check-sum to the corresponding variable nodes.

Decoding operation of LDPC is start by initialization at the variable node with $u_{m,n}(\alpha) = \delta_n(\alpha)$. Then go through several iterations at two nodes (variable node and check node) and finally error computation will be done to correct the errors.

III. METHODOLOGY

In general decoding with EMS and Min-Max algorithm involves a higher degree of complexity in their updating of check nodes rules. These techniques cost much during the implementation. In order to come back with these drawbacks two solutions can be used,

1) Number of iterations in both these algorithms is reduced. Or
2) Complex rules of check node updating are reduced.

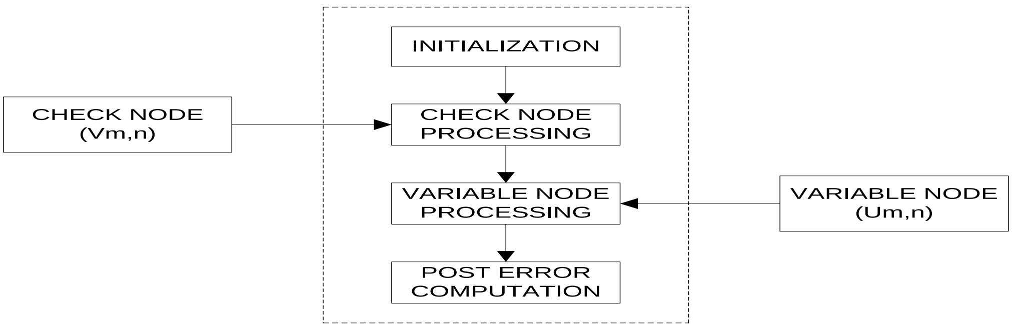

Fig 2: General Architecture for LDPC decoding.

IV. RESULTS

RESULTS OF DIFFERENT DECODING TECHNIQUES

BER is the parameter for measuring the decoder performance. And it is a function of signal to noise ratio at the receiver.

Log-domain approach:

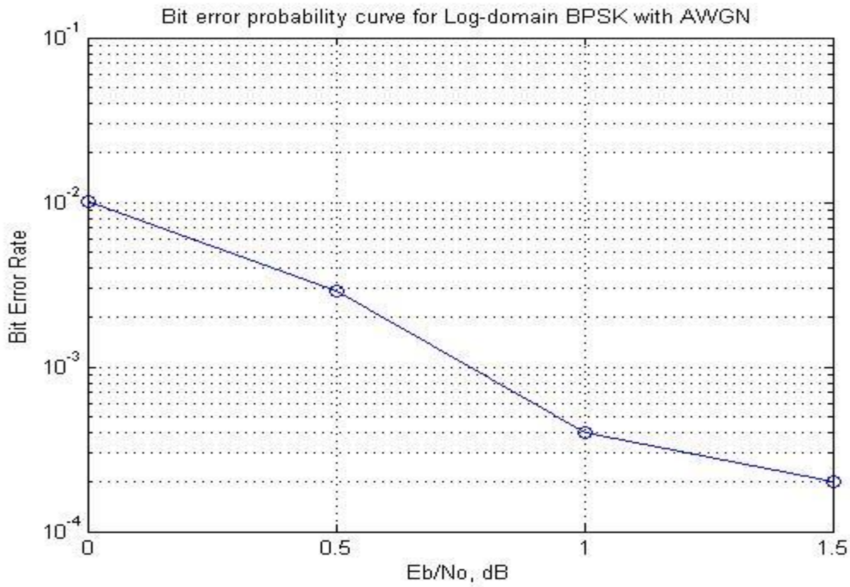

Fig 3 : Bit error probability curve for Log-domain BPSK with AWGN.

Simplified log-domain approach:

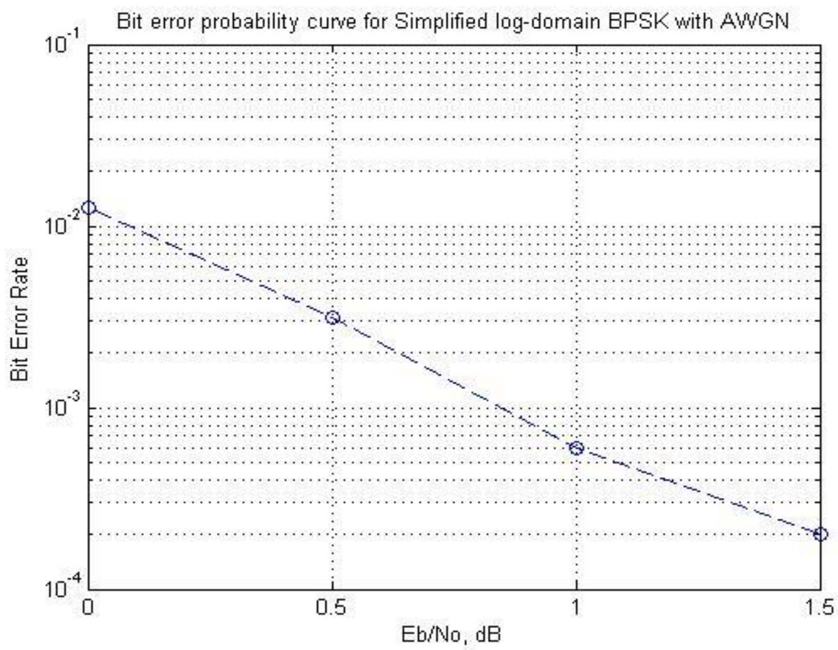

Fig 4 : Bit error probability curve for Simplified Log-domain BPSK with AWGN.

Hard decision /bit flipping approach:

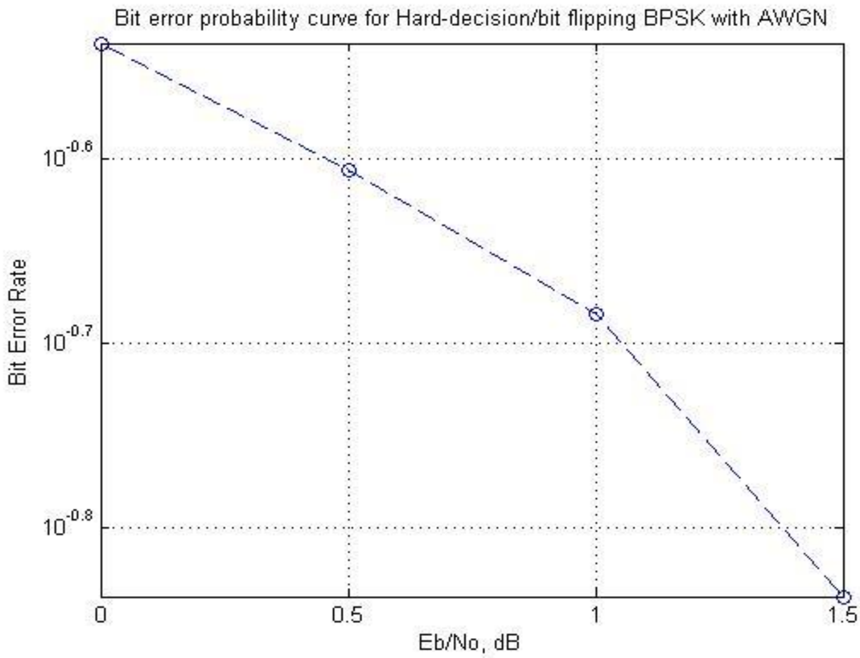

Fig 5 : Bit error probability curve for hard decision/Bit-flipping BPSK with AWGN.

RESULTS COMPARED WITH ALL THE DECODING TECHNIQUES

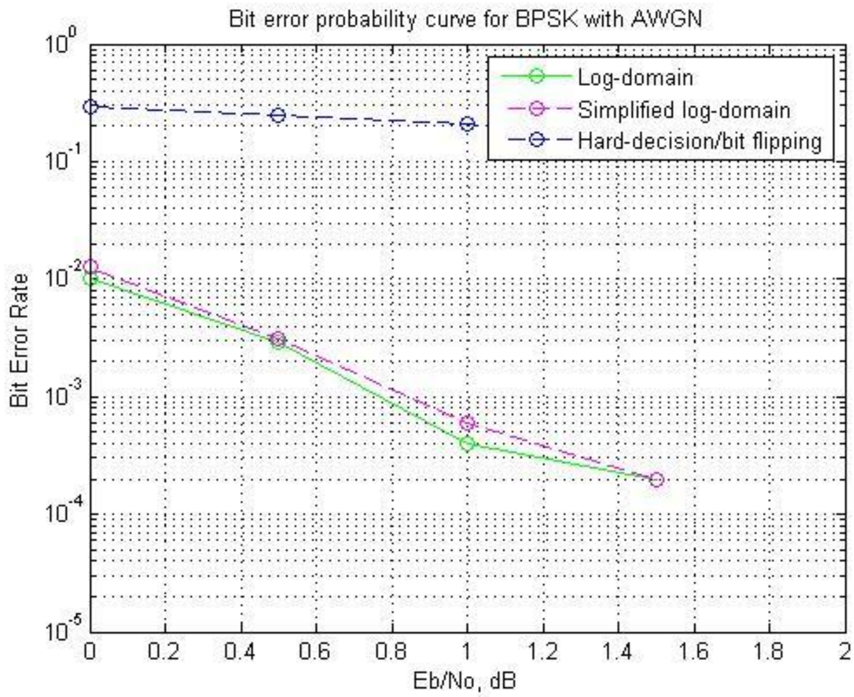

Fig 6: Bit error probability curve for all 3 decoding BPSK with AWGN.

RESULTS WITH DIFFERENT CHANNEL NOISES

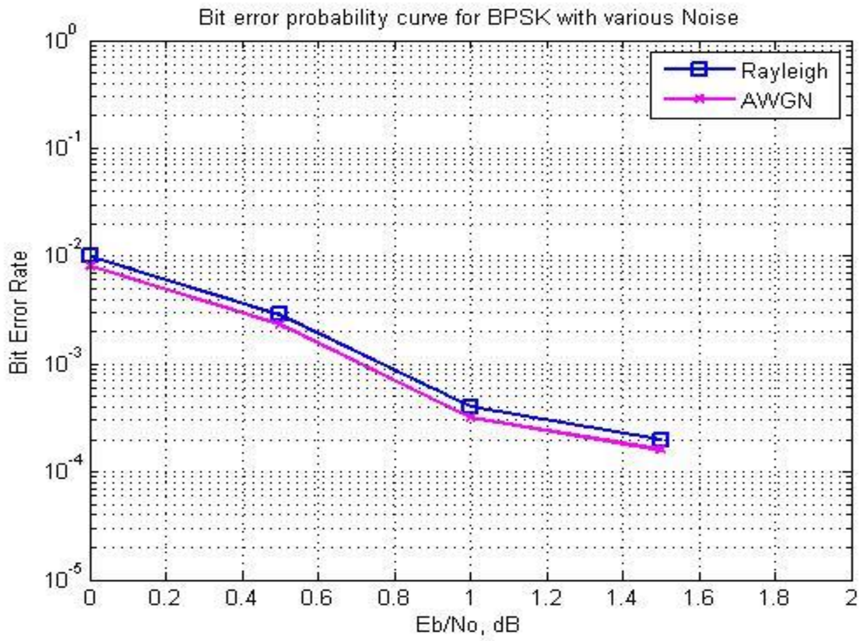

Fig 7: Bit error probability curve for various noise.

RESULTS WITH DIFFERENT MODULATION TECHNIQUES

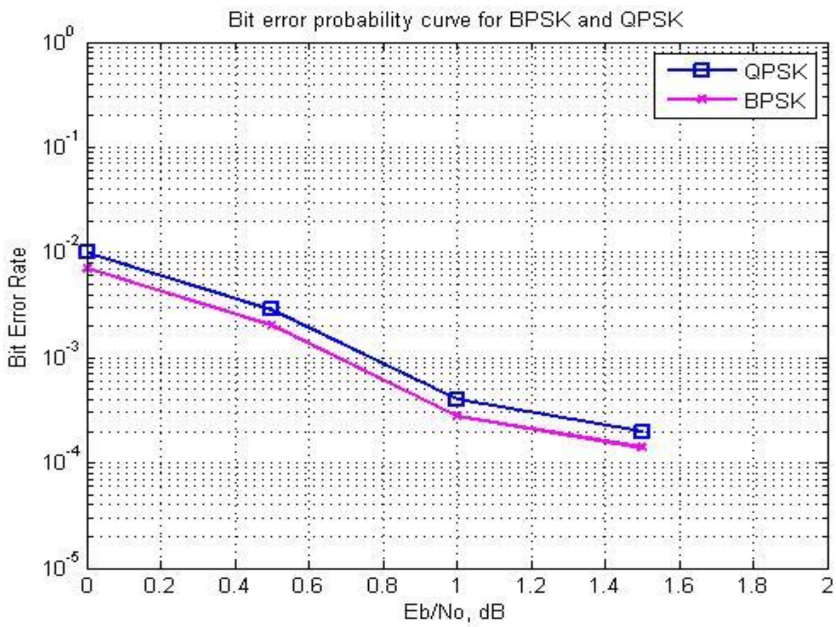

Fig 8: Bit error probability curve for different modulation techniques BPSK and QPSK.

CONCLUSION

The symbol flipping algorithm performs better than classical generalised decoding algorithms for LDPC codes which has larger length code words. Log domain, simplified log domain and with the flipping algorithm are 3 decoding processes used for comparison. AWGN and Rayleigh channel noise are 2 different noises used for comparison. Analysis of results has been with BPSK and QPSK modulation techniques. It may conclude that BER for this method is best choice. It has applications in various digital fields.

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