

Implementation of Soft Computing Techniques for Low Density Parity Check Codes Decoders

B.Rajasekar¹, T Vijayendra Gowtham Reddy², Syed Imam³, Nandhitha. N.M⁴

¹Associate Professor, ^{2,3} UG Scholar, ⁴Professor, ^{1,2,3,4}ECE Department.

^{1,2,3,4} Sathyabama Institute of Science and Technology, Chennai, India.
mail: rajasekar.ece@sathyabama.ac.in⁴

Article Info

Volume 82

Page Number: 15813 - 15815

Publication Issue:

January-February 2020

Article History

Article Received: 18 May 2019

Revised: 14 July 2019

Accepted: 22 December 2019

Publication: 28 February 2020

Abstract

Ever since Gallager came out with Low Density Parity Check Codes, it is extensively used as correcting codes. At the transmitter's end, data is encoded using LDPC. When the signal is transmitted in channel, Additive White Gaussian Noise (AWGN), Rayleigh and Rician fading results in signal distortion. At the receiver's end, signal is decoded to correct the errors. The most commonly used decoding techniques are Sum of Product and Maximum Likelihood algorithms. As both these techniques are dependent on probability of bits, accuracy of decoding is affected. Hence it is necessary to develop efficient encoder/decoder. Instead of developing two different units, one for encoder and the other for decoder, it will be efficient if a simple system is used as both encoder and decoder. Hence, the proposed work aims at developing a LDPC encoder and decoder with soft computing techniques. LDPC being a non-linear code, justifies the use of soft computing technique. Back Propagation Network (BPN) is the most widely used network for non-linear applications. In this work, BPN based decoder is developed

Keywords: Back Propagation, hidden layers, learning parameter, momentum parameter

I. INTRODUCTION

Low density Parity Check Codes were first used by Gallager in the year 1960s at Massachusetts Institute of Technology [1]. Until the rediscovery of these codes in 1996 Turbo codes were used extensively [2]. Though, min-max algorithm and sum-product algorithms are used for message detection, probability of detection is yet to be improved. Considerable research is carried out in this area. In that parity check matrix, the rows represent the equations and the columns represent the bits in the code word [3]. Decoding complexity is less for LDPC, when compared to other codes. In recent years, soft computing techniques are well accepted as prediction techniques especially for non-linear data [4]. In this work, BPN based LDPC decoder is developed and heuristic analysis is performed to determine the optimized architecture with specified number of hidden layers and neurons in each layer.

In this paper, feasibility of BPN as decoder is dealt in section 2. An overview of BPN is provided in section 3. Results are discussed in Section 4 and conclusion is provided in Section 5.

II. BACKPROPAGATION ALGORITHM AS DECODING TECHNIQUE

The source produces a stream of bits as input to the channel, since the channel accompanies with various noises such as Additive White Gaussian noise etc. The output produced at the receiver may have some errors due to the added noise. The proposed work aims at removing the errors produced due to the noise and produce the output which may be approximately equal to the input bit stream.

In order to reduce the computational complexity, both encoding and decoding parts in the system are performed simultaneously. The encoding part is done at the input side of the system and decoding part is applied at the output of the

system. At input the bit stream is divided into certain blocks containing several bits. These input bits are encoded with the parity bits and form as a codewords. These codewords are sent as input to the channel for transmission. Here the parity codes are obtained from the parity check matrix containing Low Density Parity Check codes. Now it's time for decoding part, the receiver recognizes the presence of input bit stream combined with parity codes as usual. Here there are many decoding techniques available such as max-min algorithm, Sum of product and so many, but the effective algorithm is back propagation algorithm as it trains the neural network several times to reduce the errors at the receiver. The following contains the detail information regarding back propagation algorithm.

III. REVIEW OF BACKPROPAGATION ALGORITHM

In artificial neural networks, there are many algorithms to calculate the output. In this work BPN is used to calculate the errors at the receiver at output layer. In BPN algorithm, there are mainly three layers. These three layers are input layer, hidden layer and output layer. At input layer, the input values are given and at output layer the output is obtained. Input bit stream (codeword) propagates into the channel consisting of noises like White Gaussian noise, some bits in the input bit stream may disappear or inputs may get flipped as zero's to one's and one's to zero's or may some extra bits (due to noise) may get added to the input bit stream (codeword). If the input bit stream is introduced directly into the channel, errors due to the noise are found at the receiver end which can be calculated at the output layer. In order to overcome this problem, bits with Low Density Parity Check codes are encoded to obtain codeword which can be propagated into the channel.

In BPN algorithm, initially weights are initialized in the network. The values of the weights varying between the range 0 and 1. The neural network trains as per learning parameter and momentum parameter. Number of neurons in the neural network is according to the complexity of the input bit stream. i.e to decode simple bit streams, minimum neurons are used in the network. Similarly, large number of bits in the bit stream

necessitates large number of neurons in the neural network.

There are two paths involved in decoding at receiver's end using back propagation network, the first path is feed forward path and the other path is backward path. Neural network for the first time allows the input bitstream propagated into the network.

Updating of weights is done in backward path. After all the weights get updated, the training of the neural network starts again this process continues until the obtained output is approximately equal to the target value. This is called back propagation neural network which is widely used in military applications, tele communication etc.

Using Back Propagation Network, a model is constructed which simultaneously works as both encoder and decoder. This can be achieved even by using the concept probabilistic neural network, but the main disadvantage of probabilistic neural network is it can detect only values other than zero.

IV. RESULTS AND DISCUSSION

The following are the simulation results obtained when back propagation algorithm is used for training the neural network to produce the approximate values as output. Minimum Performance Gradient is a value that is set when training is to be stopped.

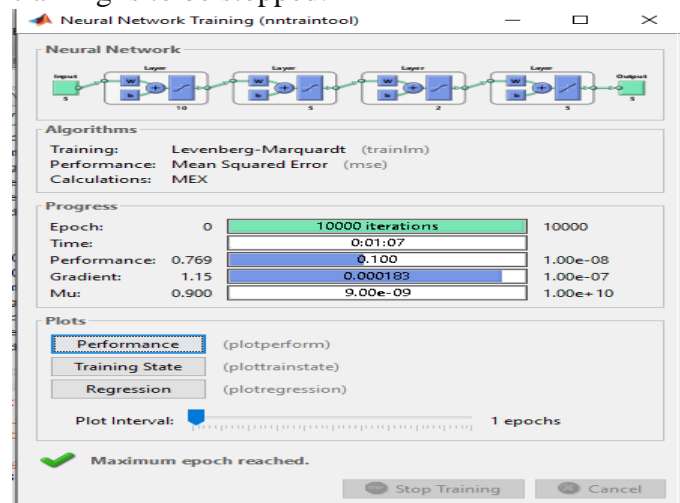


Fig. 1. Training of neural network

From, Fig. 1, it is found that the training has stopped at 10000th iteration. After which the network is tested with a new set of data and is then saved for further implementation.

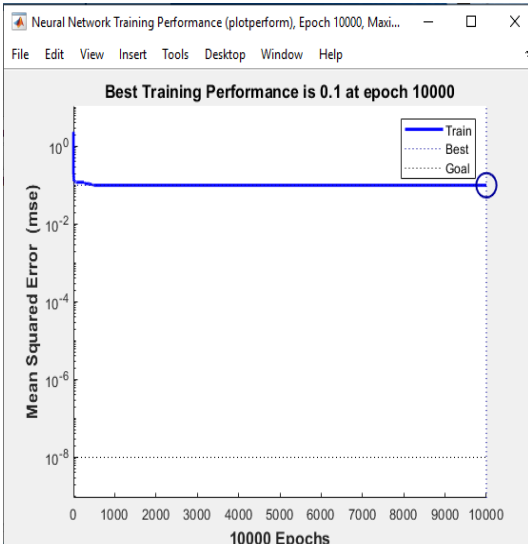


Fig. 2. Performance of the neural network

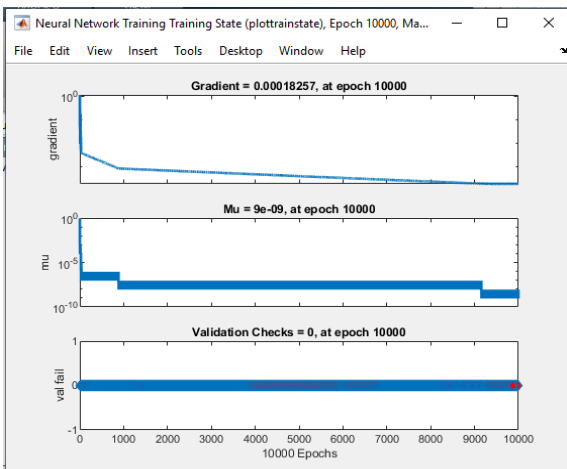


Fig. 3. Training state of neural network

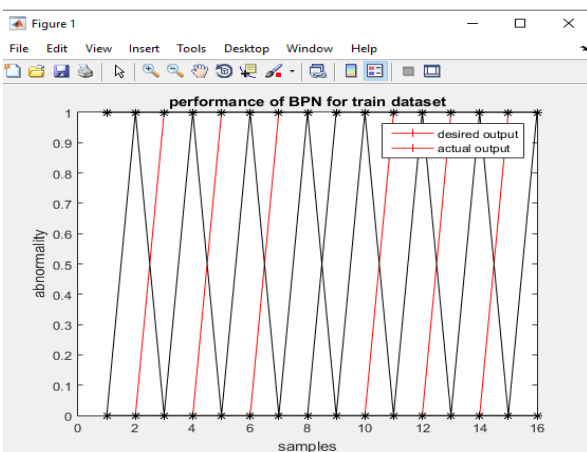


Fig. 4. Performance of BPN for train data set.

In this work, BPN, a feedforward architecture is used for detecting the message bits from the noisy channel. Of the various architectures of BPN, for this particular application, four hidden layers with 10, 5, 2 and 5 neurons provide the best results. Though the network works well for trained dataset, performance is 89% for the test dataset. In order to improve the performance for the test dataset, Convolutional Neural Network (CNN) can be used instead of conventional feedforward networks.

IV. REFERENCES

- [1] Rajasekar, B. and Logashanmugam, E.(2014), "Development of GCD based High Girth Quasi-Cyclic LDPC Codes for Enhanced Decoder Design", Sylwan Vol.158, No.8, pp.586-592, ISSN-0039-7660.
- [2] Rajasekar, B. and Logashanmugam, E. (2014), "Euclidean Geometry LDPC Codes for Error Correction in Memory Devices", IJAER, Vol.9, No.21, pp.9447-9454, ISSN 0973-4562.
- [3] Rajasekar, B. and Logashanmugam, E. (2014), "Design and Development of an Improved Split Row Decoding Algorithm with Reduced BER", Research Journal of Applied Sciences, Engineering and Technology, Vol.8, No.11, pp.1326-1330, ISSN NO- 2040-7459.
- [4] Nandhitha, N. M. "Artificial Neural Network Based Prediction Techniques for Torch Current Deviation to Produce Defect-Free Welds in GTAW Using IR Thermography", Proceedings of 3rd International Conference on Advanced Computing, Networking And Informatics (ICACNI 2015), Vol 1, Volume 43 Page 137-142, 2016

V. CONCLUSION