Review of Deep Neural Network Detectors in SM-MIMO System

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ABSTRACT

A deep neural network detector for SM-MIMO has been proposed. Its detection principle is deep learning. For this a neural network must be trained first, and then used for detection purpose. It doesn't need any channel model and instantaneous channel state information (CSI). It can provide better bit error performance compared with conventional viterbi detector (VD) and also it can detect any length of sequences. For a MIMO system, the channel estimation complexity can be avoided. It can detect in real time as arrives the receiver. The main benefit is it can be used where the channel model is difficult to design and also the channel is continuously varying with time.

KEYWORDS: Spatial Modulation, Deep Learning, Neural Network, Channel State Information, Viterbi Detector

INTRODUCTION

Multiple input multiple output (MIMO) system is technology to increase better channel capacity by using multiple antennas at both transmitter side and receiver side [1]. SM-MIMO is the most modern communication system. It can provide time and frequency resources, multiple users, multiple antennas and other resources [2]. The aim of this paper is to apply deep learning in the SM- MIMO detection problem and understand its benefits.

One of the vital modules in reliable recovery of data sent over a communication system is detector. A detector is estimates the transmitted signal from a noisy and corrupted signal at the receiver. The design and analysis of detector depends on mathematical models that describe the transmission process, signal propagation, receiver noise, and any different parameters in communication system [3].

For the communication system, where the channel model maybe unknown and channel is intractable. Otherwise, underlying channel model are known but, channel is changing with time (instantaneous CSI). So, in this case estimation can be achieved by transmitting and receiving predesigned pilot sequence, which known by receiver. It results in data transmission rate decrease. To overcome this problem, this paper use deep learning [4]-[6].this algorithm is enough to perform detection under unknown channel model and imperfect CSI

DEEP LEARNING BASED DETECTION ALGORITHM

Computer software that imitates the function of neural network of human brain is called deep learning. It uses deep neural network for learning. It consists of three layer, input layer, hidden layers and output layer. The hidden layer is made up of fully connected neurons, it receive input from first layer and perform some mathematical operations [7]. Detection using deep learning is process of estimating transmitted symbols from noisy received symbols. For this, NN detectors have two phases, training phase and detection phase. NN can be used trained by training dataset, which is achieved by continuously transmitting and receiving known sequences. Then used for detection [8] and [9]. Iterate these two phases until a tolerable level of accuracy is obtained.

TYPES OF NEURAL NETWORK DETECTOR
A. Convolutional neural networks (CNN) detector

CNN is simplest neural network architecture which are specially designed for complex signal. It act as set filter to extract most relevant feature. This type neural network uses a mathematical operation called convolution. Convolution is a special kind of linear operation. This network receives fixed size inputs and provides fixed size outputs. CNN is a type of feed forward artificial neural network with minimal amounts of preprocessing. By using this type of network, only the symbol detection is possible. It cannot use for sequence detection.

B. Feed forward neural networks detector

The simple type of artificial neural network detector. In this, information flows in forward direction. It receives noisy input at the input layer, and then gives to hidden layers for processing. The output layer gives the estimated output. It

does not have any feedback. Information ends at the output layers. For each new symbol arrives at the receiver, then whole blocks need to be re-estimated for further detection. This is the main drawback of feed forward neural network.

C. Recurrent neural network (RNN) detector

Recurrent neural network is a type of deep learning oriented algorithm with feedback. It's algorithm follow a sequential format [10]. The RNN can handle any length of input and outputs. RNN have the memory element, information from previous symbol is stored as state of RNN [11]. The standard use of RNN is processing of series time data or sequences. A new technology is called sliding bidirectional recurrent neural network (SBRNN) has added to conventional recurrent neural network for better performance [12]. The main goal of this technology is that it can detect any arbitrary length data without any need of re-estimation.

CONCLUSION

We have presented deep neural network (DNN) detector for MIMO system. It can detect the sequence of symbols in MIMO system without having perfect channel model and instantaneous channel state information. It performs detection in a real time at the receiver. The bit error rate performance of proposed neural network high compared to other conventional detectors. It can detect any arbitrary length of sequence.

REFERENCE

[1] N. Samuel, T. Diskin, and A. Wiesel, "Deep MIMO detection," in Proc. IEEE 18th Int. Workshop Signal Process. Adv. Wireless Commun., Sapporo, 2017.

[2] P. Yang, Y. Xiao and M. Xiao, "Adaptive spatial modulation MIMO based on machine learning" in J. IEEE. Sel. communication. 2019.

[3] S. Dorner, S. Cammerer, J. Hoydis, and S. T. Brink, "Deep learning based communication over the air," IEEE J. Sel. Topics Signal Process., vol. 12, no. 1, pp. 132–143, Feb. 2018.

[4] Y. LeCun, Y. Bengio, and G. Hinton, "Deep learning," Nature, vol. 521, no. 7553, pp. 436–444, May 2015.

[5] I. Goodfellow, Y. Bengio, and A. Courville, "Deep Learning". Cambridge, MA, USA: MIT Press, Nov. 2016.

[6] M. Ibnkahla, "Applications of neural networks to digital communications: A survey," Signal Process., vol. 80, no. 7, pp. 1185–1215, 2000.

[7] U. Mitra and H. V. Poor, "Neural network techniques for adaptive multiuser demodulation," IEEE J. Sel. Areas Commun., vol. 12, no. 9, pp. 1460–1470, Dec. 1994.

[8] S. Dorner, S. Cammerer, J. Hoydis, and S. T. Brink, "Deep learning based communication over the air," IEEE J. Sel. Topics Signal Process, vol. 12, no. 1, pp. 132–143, Feb. 2018.

[9] Y. Isk and N. Taṣ pınar, "Multiuser detection with neural network and pic in CDMA systems for AWGN and rayleigh fading asynchronous channels," Wireless Personal Commun., vol. 43, no. 4, pp. 1185–1194, 2007.

[10] K. Cho et al., "Learning phrase representations using RNN encoder and decoder for statistical machine translation," in Proc. Conf. Emp. Methods Natural Lang. Process., 2014, pp. 1724–1734.

[11] M. Schuster and K. K. Paliwal, "Bidirectional recurrent neural networks," IEEE Trans. Signal Process., vol. 45, no. 11, pp. 2673–2681, Nov. 1997.

[12] N. Farsad and A. Goldsmith, "Neural network detection of data sequences in communication system" IEEE transaction on signal processing. .vol.66, no.21, nov2018.