# A Brief Review on Deep Learning in Application of Channel Estimation

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| **ABSTRACT**  In this review paper, some deep learning applications for channel estimation in digital communications are investigated. Deep learning can be used for joint channel estimation and symbol detection in OFDM wireless communication systems [1]. Training is made in an offline manner using simulation data. Then the trained model is used in the online deployment stage to correct data bits in the receiver side. In this approach, simulation results show that deep learning based approach gives better BER results compared to LS and MMSE for scenarios of cyclic prefix removal, a small number of pilot bits and nonlinear clipping noise. In another study, authors propose a deep learning based channel estimation scheme to overcome the fast time-varying and non-stationary characteristics of vehicle-to-everything communications [2]. Their approach is to improve the data pilot-aided (DPA) channel estimation method widely studied for the IEEE 802.11p systems. As a different study, interpretation of deep learning in channel estimation is studied [3]. Authors focus on the black box characteristics of deep learning models and they try to interpret deep learning approaches in channel estimation. They compare traditional channel estimation methods to deep learning methods. In Ref. [4] a new architecture called STA-DNN is proposed for successful channel estimation in highly fast changing channel scenarios. They make a coarse estimation using STA method and then a fine estimation applying DNN. Their focus is IEEE 802.11p standard and so they study the OFDM scheme. In another study, time varying Rayleigh fading channel is studied and a deep learning based channel estimator is proposed [5]. Authors get better results compared to traditional channel estimation methods and some DL based architectures in terms of mean square error (MSE). They called their method the Sliding Bidirectional Gated Recurrent Unit (SBGRU). In this method, initial knowledge about channel is not needed. In Ref. [6] a channel estimation method based on deep learning is proposed for fast time-varying and non-stationary characteristics in the high-speed mobile scenarios. The method is called ChanEstNet. A large amount of high speed channel data is used to train the model in an offline manner. Convolutional Neural Network (CNN) and Recurrent Neural Network (RNN) are utilized in the proposed method. They get better results in high-speed mobile scenarios and less computational complexity compared to traditional channel estimation methods.  **References:**  [1] H. Ye, G. Y. Li and B. -H. Juang, "Power of Deep Learning for Channel Estimation and Signal Detection in OFDM Systems," in *IEEE Wireless Communications Letters*, vol. 7, no. 1, pp. 114-117, Feb. 2018.  [2] J. Pan, H. Shan, R. Li, Y. Wu, W. Wu and T. Q. S. Quek, "Channel Estimation Based on Deep Learning in Vehicle-to-Everything Environments," in *IEEE Communications Letters*, vol. 25, no. 6, pp. 1891-1895, June 2021.  [3] Q. Hu, F. Gao, H. Zhang, S. Jin and G. Y. Li, "Deep Learning for Channel Estimation: Interpretation, Performance, and Comparison," in IEEE Transactions on Wireless Communications, vol. 20, no. 4, pp. 2398-2412, April 2021.  [4] A. K. Gizzini, M. Chafii, A. Nimr and G. Fettweis, "Deep Learning Based Channel Estimation Schemes for IEEE 802.11p Standard," in *IEEE Access*, vol. 8, pp. 113751-113765, 2020.  [5] Q. Bai, J. Wang, Y. Zhang and J. Song, "Deep Learning-Based Channel Estimation Algorithm Over Time Selective Fading Channels," in *IEEE Transactions on Cognitive Communications and Networking*, vol. 6, no. 1, pp. 125-134, March 2020.  [6] Y. Liao, Y. Hua, X. Dai, H. Yao and X. Yang, "ChanEstNet: A Deep Learning Based Channel Estimation for High-Speed Scenarios," *ICC 2019 - 2019 IEEE International Conference on Communications (ICC)*, Shanghai, China, 2019, pp. 1-6. |
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