Statistical Channel Modeling for Indoor Environments Using Generative Adversarial Networks

Shihao Ju and William Xia
NYU Tandon School of Engineering, NYU WIRELESS, Brooklyn, NY, 11201
{shao, william.xia}@nyu.edu

I. Introduction and Motivation

The vast amounts of bandwidth (over tens of GHz) offered by the Millimeter-wave (mmWave) and Terahertz (THz) spectrum [1] have the potential to support rapidly increasing mobile traffic demand throughout the world, which is expected to reach 77 exabytes per month by 2022 [2]. Advancements in technologies that operate in these frequencies (e.g. massive multiple input output (MIMO)) aims to support such stringent demands, but introduce more difficulties and challenges. Conventional channel modeling approaches may not accurately characterize the wireless channel given the increased number of complex modeling components.

Thus, deep learning is considered to be a potential solution to this problem from a data-driven perspective. This project aims to employ a generative adversarial network (GAN) to predict statistical channel information, with simulated channels generated from a ray tracer. We hope that this work can shed light on latent correlations between different channel parameters, which could be leveraged for future wireless systems design.

II. Background and Prior Works

There are a few attempts to apply generative neural networks to create wireless channels in various settings. A GAN-based wireless channel modeling framework was proposed, where a vanilla GAN was used to generate additive Gaussian white noise (AWGN) channel without any domain-specific knowledge or technical expertise [3]. An experienced deep reinforcement learning (deep-RL) framework based on GANs was proposed to provide model-free resource allocation for ultra reliable low latency communication [4]. A variational GAN was trained to approximate wireless channel responses to more accurately reflect the probability distribution functions (PDFs) of stochastic channel behaviors [5]. In addition, conditional variational autoencoder was used as an alternative generative model to generate pathloss and angular information of multipath components (MPCs) [6].

III. Problem Statement

Here, we train a GAN to generate multipath channel impulse responses with power, delay, and angle information based on the simulated channel data from the ray tracing tool Remcom Wireless Insite [7], and compare it to the conventional modeling approach to evaluate the performance of the proposed GAN. It would be interesting to understand how the generator and the discriminator would evaluate the wireless channels, and investigate if the networks learned similar strategies as conventional modeling approaches. We select indoor office and indoor factory as target simulation environments at mmWave frequencies such as 28 GHz and 60 GHz. We expect that the vanilla GAN may fall short, and some innovation on the network structure or some types of domain knowledge fusion may be needed. This project will be used as a base application and will be generalized to arbitrary channel measurements and simulations with different types of modeling components in 5G and beyond.

References

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