Role of AI/ML in PA Linearization for Next G Wireless

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ABSTRACT

Considering the environmental impact of radio access technologies alongside traditional performance metrics that have driven the evolution of 4G and 5G systems, it's essential to recognize that wireless infrastructure consumes a significant portion of energy used by communication service providers [1-2]. Several techniques, including resource optimization at the network level, traffic-driven power supply modulations, and various energy saving modes in the radio unit (RU) have shown to play a crucial role in reducing the energy consumption of a radio access network for different traffic loads. However, when the transmitter is pushed to operate at near maximum power ratings to enhance higher wireless channel capacity, machine learning (ML) based digital pre-distortion (DPD) techniques in conjunction with high-efficiency power amplifiers (PAs) become the cornerstone to the successful deployment of energy-efficient basestation remote radio heads (RRHs) and RUs.

In this presentation, we will explore an underlying technology, namely integrated and adaptive DPD, from its early inception derived from the Volterra series to modern advanced PA linearization techniques. As artificial intelligence (AI) permeates all layers of wireless communications, we will illustrate how AI/ML techniques can be effectively incorporated into the design methodology of PA linearization by analyzing different modeling approaches. Highlights of the presentation include sequential cascading of Volterra-based models, which is inspired by AI/ML techniques to address non-convex optimization problems, generative adversarial network-based ML optimization, and novel DPD architectures, where artificial neural networks are co-designed with the conventional Volterra-based models. A new DPD architecture, Neural***Volterra***^{TM}, will be introduced during the presentation. We hope the study's findings will illuminate the modeling capabilities of the state-of-the-art research and provide insights into future directions from the industrial perspective.

[1] K. Chuang et al., "Radio challenges, architectures, and design considerations for wireless infrastructure: Creating the core technologies that connect people around the world," *IEEE Microw. Mag.*, vol. 23, no. 12, pp. 42–59, Dec. 2022, doi: 10.1109/MMM.2022.3203925.

[2] K. Chuang et al., "Towards sustainable networks: Attacking energy consumption in wireless infrastructure with novel technologies," *IEEE Microw. Mag.*, vol. 24, no. 12, pp. 44-59, Dec. 2023, doi: 10.1109/MMM.2023.3314319.