Research Project Description

The project seeks to explore deep learning-based techniques for improving signal processing in machine-type communications (MTC), with a particular emphasis on short-packet communications. The goal is to investigate the potential of innovative neural network architectures (e.g., recurrent and convolutional ones) in enhancing the accuracy and efficiency of tasks critical to MTC, including active user detection, channel estimation, and channel coding/decoding. Additionally, this project will evaluate advanced techniques for supporting massive multiple access and analyze their advantages and limitations compared to current signal processing methods.

Activity Plan

The project will begin with a thorough review of recent scientific literature on deep learning applications in machine-to-machine communications. Selected works will be critically analyzed for their innovative approaches, highlighting their performance, computational complexity, latency, and feasibility for real-time implementation in MTC scenarios. Building on the literature, the next step involves designing and testing neural network architectures—such as LSTM networks and potentially other recurrent and convolutional architectures—to enhance signal processing tasks specific to MTC. This might include, e.g., improving performance in active user detection and channel estimation under the constraints of short-packet, low-latency requirements. The project will also examine the application of AI tools to optimize existing channel coding and decoding methods, especially for short codes. This may involve reducing latency or improving energy efficiency without compromising reliability. Additionally, part of the activity will be devoted to investigating the potential for developing new short codes and their associated decoding algorithms through AI-driven methods.

Another focal point of the activity is to investigate AI-enhanced signal processing techniques that support massive multiple access, a key requirement in many MTC applications. This includes exploring how AI can assist in optimizing resource allocation and managing interference in highly congested wireless networks.

The project will include an extensive software implementation and a comprehensive numerical performance analysis via software simulation. The analysis will focus on performance metrics relevant to MTC, such as low error rates, latency, and energy efficiency, providing a benchmark comparison against traditional non-AI methods.