Karlsruher Institut für Technologie

Communications Engineering Lab (CEL)
Prof. Dr.-Ing. Laurent Schmalen

Implementation of a differentiable channel model for E2E constellation optimization in long-haul optical fiber communication

Master's Thesis

Project

The optical waveform channel in long-haul optical fibers can be modeled using the nonlinear Schrödinger equation, which can be numerically approximated using the split step Fourier method (SSFM). With the SSFM, the effect of the channel in a non-linear optical fiber is calculated in small steps and integrated along the fiber to approximate the effect of the full fiber. From the transmitter to the receiver, many of calculations are chained and the calculation of a gradient for end-to-end optimization becomes prohibitively complex and suffers from problems like vanishing gradients. Therefore other approaches to model non-linear optical fiber channels in a differentiable manner have been proposed.

Tasks

In this project, your tasks will be investigation into proposed numerical approximations of the non-linear optical fiber channel, selection and implementation of promising candidates, preferably in Python and PyTorch to extend existing tools at CEL. During and after implementation, performance evaluations with existing channel models, based on the SSFM, are performed to characterize and highlight differences of the channel model. To take advantage of the differentiable nature of the implemented channel model, you apply your model in an existing machine learning framework to optimize modulation of an optical communication system from end-to-end.

Requirements

- ✓ Interest in Machine Learning
- ✓ Communication Engineering I & II
- ✓ Machine Learning and Optimization in Communication Engineering (MLOC)
- ✓ Interest in optical communications
- ✓ Having fun implementing algorithms in Python

Institute

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