Master Thesis / Internship:

Optic-Electronic-Optic Interferometers for Advanced Coherent Signal Processing

Karlsruhe Institute of Technology

In contrast to conventional interferometers, where an optical signal is split, processed along fixed optical paths, and recombined to produce interference (Fig. 1(a)), an optic–electronic–optic (OEO) interferometer first converts the signal to the electrical domain via coherent detection. This enables advanced and reconfigurable digital signal processing (DSP) before remodulation and optical recombination, greatly increasing system flexibility while preserving coherent interference (Fig. 1(b)). Previous work has demonstrated coherent add–drop multiplexing in dense WDM systems using QPSK modulation. In this project, the system will be extended to higher-order modulation formats (e.g., 16-QAM), and the impact of finite local oscillator (LO) laser linewidth (e.g., ~100 kHz) on coherence and interference contrast will be systematically studied. Further extensions may include spectrally overlapping subcarriers and the implementation of a full coherent DSP chain, including timing and carrier recovery.

Tasks may include:

- Develop and simulate DSP algorithms using MATLAB/Python.
- Implement DSP algorithms in VHDL, focusing on fixed-point and real-time operation.
- Experimental characterization on FPGA.

For more information contact:

Dr.-Ing. Salek Mahmud
md.mahmud@kit.edu

Prof. Dr. Sebastian Randel
sebastian.randel@kit.edu

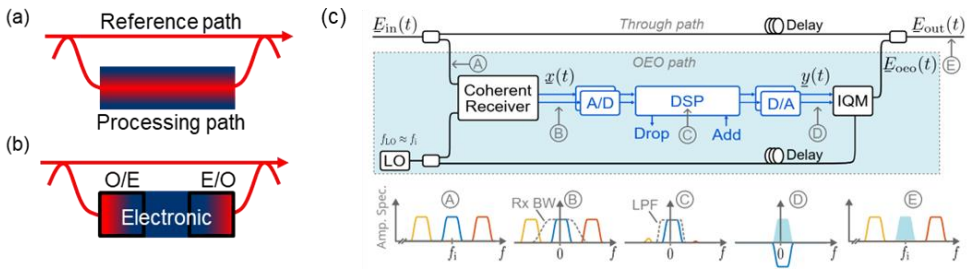

Fig. 1. (a) Conventional interferometer with an optical processing path. (b) OEO interferometer with opto-electronic and subsequent electro-optic conversion. (c) Basic building blocks of an OEO interferometer.

Reference: Mahmud, *et. al.*, Optic-electronic-optic interferometer enabling coherent optical add-drop multiplexing," Opt. Express 33, (2025).