Karlsruhe Institute of Technology

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

Integrated Sensing and Communications in the Short-Blocklength Regime

Bachelor's Thesis/Master's Thesis

Project

Next-generation 6G wireless systems are expected to integrate radar-like sensing capabilities, enabling applications such as environmental mapping, localization, and object detection. This concept, known as integrated sensing and communications (ISAC), reuses the same waveform and hardware resources for both tasks, improving spectral and hardware efficiency.

Much of the existing theoretical research on ISAC considers the infinite- or asymptotic-blocklength regime, in which arbitrarily long codewords and idealized performance limits are assumed. Practical communication systems, however, transmit data in finite-length packets, particularly in applications with strict latency and reliability requirements. In this regime, the achievable communication rates and sensing performance can differ significantly from their asymptotic counterparts.

This thesis will investigate integrated sensing and communications in the finite-blocklength regime. The objective is to characterize the fundamental trade-offs between communication and sensing performance and to develop novel strategies for optimizing these trade-offs under finite-blocklength constraints.

Tasks

1. Familiarize yourself with the fundamental sensing-communication trade-off and finite-blocklength forward error correction
2. Compare finite- and infinite-blocklength performance and analyze the trade-offs between communication performance, sensing performance, and blocklength
3. Ideally, propose novel schemes to improve finite-blocklength performance

Requirements

✔ There are no strict requirements for this thesis. Much more important is the motivation to independently familiarize yourself with complex topics

✔ Helpful is prior knowledge of programming, (Python, PyTorch), as well as communications engineering, radar, information theory, and signal processing

Institute

Communications Engineering Lab

Hertzstr. 16
Gebäude 06.45
76187 Karlsruhe
www.cel.kit.edu

Contact

M.Sc.
Benedikt Geiger

Room 109
benedikt.geiger@kit.edu

M.Sc.
Jonathan Mandelbaum

Room 204
jonathan.mandelbaum@kit.edu