**Institut für Industrielle Informationstechnik**
Hertzstraße 16, Geb. 06.35
76187 Karlsruhe
www.iiit.kit.edu

# Masterarbeit

# Semantic Segmentation at the Shot-Noise Limit

## Description

Explore how convolutional networks can exploit sub Poisson photon statistics from squeezed light to improve edge detection and segmentation in photon limited microscopy. You will implement a photon counting forward model that includes detector quantum efficiency, dark counts and readout noise, and generate diverse synthetic microscopy scenes across photon budgets. The goal is to identify architectural and loss function adaptations that yield measurable gains over classical filters and standard deep models, and to provide a high quality, reproducible dataset for the community.

## Tasks:

1. Implement a photon counting simulator that produces sub Poisson statistics and models detector nonidealities.
2. Create annotated synthetic microscopy datasets with varying photon budgets and imaging conditions.
3. Adapt and train segmentation/edge models (U Net, ResNet backbones) with edge aware loss functions.
4. Benchmark against classical methods (Canny, Sobel) and standard DL baselines; run robustness tests and ablations.

The work can be done in German or English.

## Prior knowledge

- Deep Learning (CNNs, U-Net, ResNet)
- Image Processing and Computer Vision
- Understanding of noise statistics (Poisson/Sub-Poisson)
- Basics of Quantum Optics (advantageous)

## Research area

- Computational Photography/Low-Light Visi
- Quantum Imaging (Squeezed Light statistic
- Semantic Segmentation & Edge Detection
- Noise-aware Deep Learning
- Synthetic Microscopy Data Generation

## Studiengang

- [x] Elektro- und Informationstechnik
- [x] Informatik
- [x] Mathematik
- [x] Physik

## Alignment

- [x] Research
- [x] Implementation
- [x] Analysis and evaluation
- [x] Method development
- [x] Simulation

## Start

At any time

## Links

Mitarbeiterseite

## Ansprechpartner

Dr. Hamza Gardi
Westhochschule, Hertzstr. 16
Geb. 06.35, Zimmer 115
hamza.gardi@kit.edu
Tel.: (0721) 608 - 4451759