Lehrstuhl Steuerung,
Regelung und Systemdynamik

Master Thesis

programming

POD-based optimization of denoising algorithms used in safety-critical applications

Keywords: denoising algorithms, machine learning, probability of detection, performance evaluation, optimization

Conditions:

Duration:	6 months
Requirements:	Programming skills in Python or MATLAB, Familiarity with probability and statistics
Language:	English
Target group:	Master students

Contents:

In safety-critical domains such as aerospace, civil infrastructure, autonomous systems, and healthcare, the reliability of data-driven decision making heavily depends on the quality of the collected data. Measurement noise caused by environmental variability, sensor degradation, or operational disturbances can mask subtle features essential for accurate system assessment and safe operation. To address this challenge, machine learning (ML)-based denoising algorithms, such as autoencoders, are widely used to restore clean and meaningful signals from noisy measurements.
The performance of denoising algorithms is typically evaluated using metrics such as reconstruction error or signal similarity measures. The probability of detection (POD) approach provides a reliability-oriented framework to assess the denoising capability of models as a function of noise level or other influencing factors. The POD methodology can be employed to evaluate denoising algorithms under different signal-to-noise ratios (SNRs) and temperature variations. Integrating the POD-based performance evaluation within an optimization framework, has the potential to enhance the reliability and robustness of ML-based denoising algorithms, particularly under low SNRs and varying temperature conditions. This approach is expected to yield a more systematic optimization strategy for denoising models used in safety-critical systems.

The goals of this work are:

- Developing ML models for denoising data used in safety-critical domains considering temperature effects
- Evaluating model performance and reliability using the POD approach
- Optimizing denoising performance for robust operation under low SNR and varying temperature conditions
- Comparing non-optimized, traditionally optimized, and POD-based optimized models
- Complete and detailed documentation/presentation of the research results

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