# Deep Learning Approaches for Spatial and Temporal Classification Using High-Resolution Sensor Data

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Abstract

This dissertation explores deep learning techniques for classifying data obtained from high-resolution sensors across spatial and temporal domains. The study addresses challenges such as noise, resolution variability, and inconsistent imaging conditions, providing robust solutions for real-world applications.

For the temporal domain, high-resolution Single-Photon Avalanche Diode (SPAD) sensors are utilized to capture transient histograms, encoding picosecond-level photon arrival times as temporal fingerprints. A one-dimensional convolutional neural network (1D CNN) framework is employed for accurate pixel-wise material segmentation. This approach leverages the SPAD sensor's high temporal resolution to overcome limitations in conventional imaging systems.

For the spatial domain, high-resolution microscopic imaging data are analyzed for detecting and classifying parasitic eggs using the YOLO object detection algorithm. Techniques such as deep latent space image restoration and GrabCut-based data augmentation are integrated to enhance image quality and robustness. This enables YOLO to accurately identify and classify egg types even under challenging imaging conditions.

This work introduces effective deep learning frameworks for high-resolution sensor data classification in both spatial and temporal domains. It highlights the use of 1D CNNs for SPAD-based transient signal analysis and an enhanced YOLO pipeline for microscopic object detection, demonstrating the adaptability and precision of deep learning approaches in leveraging high-resolution sensor data for diverse applications.