Robust Hardware & Software Systems

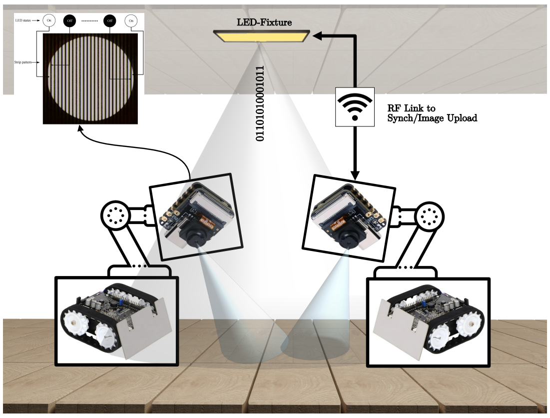
Technische Universität Braunschweig

Master Thesis Idea

Title: In-Situ Supervised Learning for Rolling-Shutter Signal Decoding in Camera-Based VLC Systems

Camera-based visible light communication (VLC) systems leveraging the rolling shutter effect enable simultaneous data transmission and spatial localization, making them attractive for indoor positioning of resource-constrained robots. However, their performance is highly sensitive to deployment-specific factors, including camera characteristics, exposure settings, motion, ambient lighting, and geometric conditions. As a result, models trained offline often fail to generalize reliably in real environments, and obtaining large amounts of accurately labeled training data is challenging due to the difficulty of synchronizing transmitted signals with captured rolling-shutter images.

This thesis proposes an infrastructure-assisted in-situ training framework in which a central lighting node transmits known modulation patterns while robots capture corresponding image data during operation. The robots periodically upload selected frames to the central node, which performs synchronized labeling based on the known transmission schedule and signal structure. This enables the generation of deployment-specific labeled datasets without manual annotation, allowing continuous refinement of convolutional neural network (CNN) models for robust rolling-shutter signal decoding under real operating conditions.



Goals:

- Design the in-situ data acquisition and synchronized labeling pipeline, including transmission scheduling at the lighting node and frame selection/upload from robots.
- Develop and train a CNN-based rolling-shutter decoder with incremental fine-tuning using the in-situ labeled dataset, including data quality and selection criteria.
- Evaluate robustness across deployment conditions by comparing offline-trained and in-situ-trained models using metrics such as decoding accuracy and Bit Error Rate (BER).

Contact:

- Juan Felipe Gutiérrez Gómez (juan-felipe.gutierrez-gomez@tu-braunschweig.de)