University of Basel

Department of
Biomedical Engineering

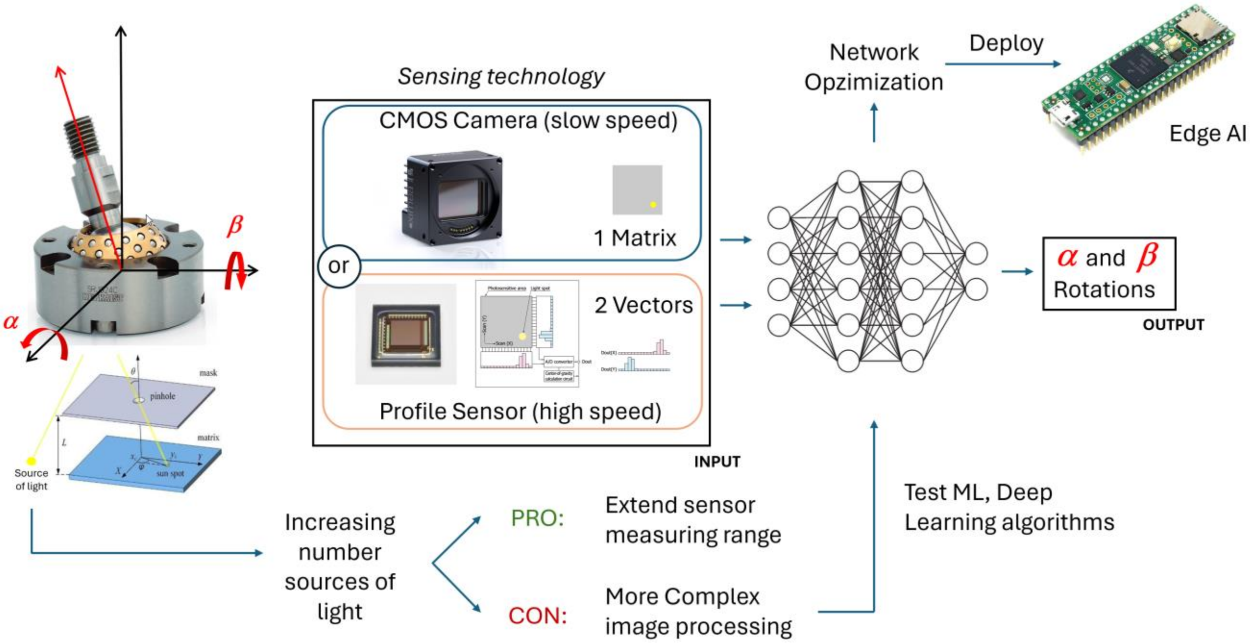
University of Basel, Department of Biomedical Engineering, Hegenheimermattweg 167c, 4123 Allschwil

Master of Science – Biomedical Engineering
Thesis Proposal

Deep learning-based calibration for spherical joint encoder.

Spherical joints, pivotal in mechanical devices including medical robotics, currently lack robust sensor technologies for accurate orientation estimation. In response, we propose a novel rotary encoder concept tailored for the MIRACLE endoscope, capable of measuring dual rotations akin to sun sensors employed in satellite orientation systems.

With initial experiments, utilizing a single light source, we were able to employ a mathematical model to predict the angular rotations. However, with the goal to extend the measurement range, we propose employing multiple light sources. Nonetheless, this strategy would inevitably introduce complexity in image/signal analysis. As a result, leveraging machine/deep learning techniques emerges as an intriguing approach to address this challenge. By exploring various network architectures and optimizing for accuracy, we aim to develop an efficient calibration model.



The primary objectives of this thesis entail acquiring/generating datasets paired with their ground truth and experimenting with different light source configurations to improve the system performance. In addition, there is the option to test the proposed setup using both a profile sensor (which enables faster data acquisition but with less detail) and a CMOS sensor (which offers slower but higher-resolution data). This provides the opportunity for a comprehensive comparison of accuracy and speed between the two sensor types. A significant portion of the project will focus on employing machine learning and deep learning methodologies to identify the most suitable

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model to optimize the sensor and its calibration. Additionally, we aim to investigate methods to reduce the neural network size to enable "real-time" measurement on microcontrollers (Edge AI).

Optionally, we can also propose exploring how to modify the setup to extend the measuring range from two to three rotations, thereby broadening the applicability of the system.

Nature of the Thesis
Experimental: 20%
Programming: 60%
Documentation: 20%

Specific Requirements
Programming skills in Python
Previous experience with microcontrollers (Optional)

Group Leader / Supervisor

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