

Master-Thesis/Bachelor-Thesis

Intelligent Image Processing for Combustion Analysis of Turbulent Hydrogen Flames

Motivation & Background

Hydrogen-based fuels are a key enabler for carbon-free energy conversion in advanced gas turbines. Despite their potential, significant technical challenges remain, particularly in achieving stable and efficient combustion while minimizing NO_x emissions. Addressing these challenges requires a deeper fundamental understanding of hydrogen flame behavior under turbulent conditions. Experimental investigations using in-situ optical diagnostics provide valuable insight into flame dynamics. However, the extraction of reliable and quantitative information from large volumes of combustion image data remains one of the most challenging steps. This project focuses on improving and extending existing image processing approaches for optical diagnostics of turbulent hydrogen combustion. In particular, it explores intelligent image segmentation techniques and the potential of machine learning to enhance accuracy, efficiency, and the accessible experimental parameter space.

Main Objectives (Bachelor Thesis): Apply and evaluate established image processing methods to analyze optical images of turbulent hydrogen jet flames. The focus is on extracting meaningful flame features and quantifying flame behavior using existing computational tools.

Main Objectives (Master Thesis): Develop, extend, and critically assess advanced image segmentation approaches for hydrogen combustion analysis. In addition to conventional methods, the project emphasizes machine-learning-based techniques and their ability to improve robustness, accuracy, and scalability of combustion image analysis.

Tasks

Common Tasks (Bachelor & Master)

- Familiarization with hydrogen combustion physics, optical diagnostics, and experimental image data
- Implementation and application of existing image processing routines (MATLAB or Python) for flame segmentation
- Quantitative evaluation of flame behavior, including flame burning speed

Additional Master Thesis Task

- Development and comparison of machine-learning-based image segmentation methods with conventional approaches

Focus areas

Experiment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Construction	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Modeling	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
Data analysis	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>

Date

16.02.2026

Start from

Flexible

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