Project Summary

This project aims to expand and validate an existing machine-learning framework for the quantitative analysis of hydrogen bubble dynamics during electrochemical water splitting. The current algorithm can detect and analyze bubbles from high-speed imaging data; however, additional experimental datasets are required to improve its accuracy, robustness, and applicability to different electrode surfaces.

The student will conduct electrochemical experiments combined with high-speed imaging to generate bubble-evolution videos under controlled operating conditions. These datasets will be processed using the existing machine-learning model and used to further train, validate, and optimize its performance.

The main project objectives are to:

1. Perform electrochemical and high-speed imaging experiments on various electrode materials and surface-engineered samples.
2. Generate and annotate additional datasets for machine-learning training and validation.
3. Improve bubble detection, segmentation, and tracking performance under different imaging and experimental conditions.
4. Extract quantitative bubble characteristics, including bubble size distribution, growth rate, number density, surface coverage, coalescence events, detachment diameter, and detachment frequency.
5. Develop a standardized framework for comparing bubble behaviour and gas-removal performance across different electrode surfaces.

The final outcome will be a robust and reproducible experimental and data-processing workflow that automatically analyzes high-speed videos and provides statistically meaningful metrics for evaluating electrode performance in hydrogen production.