

Faculty of Engineering

ASPIRE Summer Research Program 2026-2027

Project Title: **How Bacteria Swim in Droplets: AI-Assisted Single-Cell Motility Phenotyping**

Supervisor(s): **Prof. Adrian Neild, Dr. Mohammad Reza Raveshi**

Department: **Department of Mechanical and Aerospace Engineering**

Email: Adrian.Neild@monash.edu, Mahraz.Raveshi@monash.edu

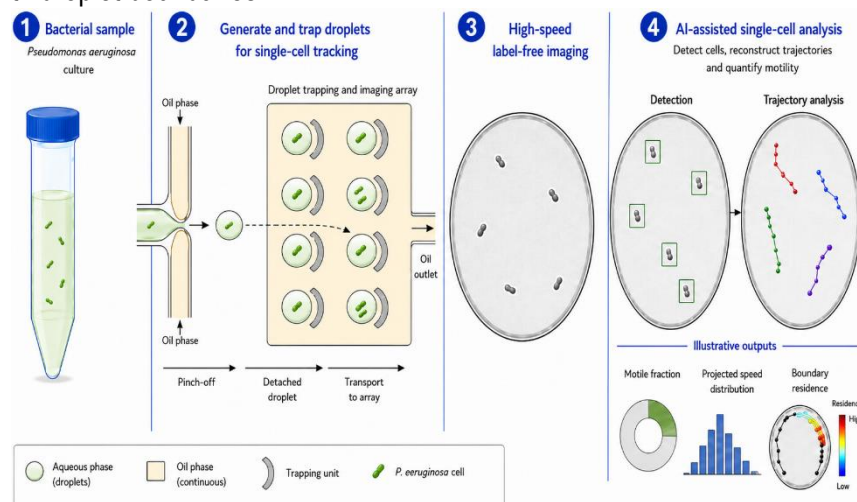
Website profile of project supervisor: <https://www.monash.edu/engineering/adrianneild>

Objective

To develop and validate a droplet microfluidic platform that uses AI-assisted image analysis to track individual *Pseudomonas aeruginosa* cells, quantify their swimming speeds, and characterise their trajectories and interactions with droplet boundaries.

Project Details

Pseudomonas aeruginosa is a clinically important opportunistic pathogen whose flagellar motility enables cells to explore environments and encounter interfaces. However, population-level assays can obscure cell-to-cell variation. This project will address the engineering challenge of reliably imaging and tracking swimming bacteria within microdroplets.



microdroplets. Using a droplet microfluidic platform, you will culture bacteria, optimise platform operation, acquire high-speed microscopy videos and build a curated image dataset. You will develop and validate an AI-assisted image-analysis workflow combining machine-learning-based bacterial detection with trajectory reconstruction using Fiji/TrackMate and MATLAB or Python.

The workflow will distinguish motile from non-motile cells, quantify swimming-speed distributions and characterise behaviour near droplet boundaries. Automated measurements will be benchmarked against manual annotations and tested for reproducibility across droplets, devices and days.

The project will deliver a validated microfluidic platform, an automated analysis workflow, a benchmark motility dataset and a standard operating procedure. You will gain experience in microfluidics, high-speed imaging, computer vision, programming and quantitative bioengineering.

Prerequisites

An interest in coding, image analysis or microfluidics is desirable. Experience with MATLAB, Python or ImageJ/Fiji is helpful but not essential; training will be provided.

Additional Information

Applicants may be required to attend an interview.