MONASH
ENGINEERING

MONASH University

Faculty of Engineering

Summer Research Program 2023-2024

Project Title: **Using Artificial Intelligence (AI) via Physics-informed Neural Networks to measure 3D turbulent shear flows**

Supervisor(s): **Professor Julio Soria**

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Objective

The objective of this summer research project is to: (1) develop the formulation to enhance laser- and linage-based velocimetry using Artificial Intelligence (AI) via Physics-informed Neural Networks (PINN), (2) implement, test, and verify the methodology using existing data from direct numerical simulations of turbulent shear flows and (3) apply AI enhanced PINN methodology to experimental 3D particle image velocimetry measurements of turbulent shear flows.

Project Details

Historically, the majority of turbulent shear flow (TSF) research has focused on data collection with early analysis techniques sometimes as simple as linear regressions. Today modern solutions are often highly sophisticated combinations of mathematics, statistics, computer science, and a host of other disciplines. Still, as the complexity of the analysis process has grown, it remains largely driven by human expectations and hypotheses. However, this paradigm is rapidly being stretched to its limits due to the dramatic growth in scientific data: e.g. terabytes of experimental data from TSF experiments. It has been recognised for some time that no single researcher or even a large team can directly and carefully examine such enormous amounts of data. To address this challenge, TSF research like many other areas of engineering science is moving toward more data-driven techniques that ultimately aim to augment the need for prior assumptions and meticulously tailored hypotheses with its massive data collections. Central to this task is scientific machine learning (SciML), which allows computers to accomplish tasks once feasible only by humans, but which are not well suited to the human brain. The aim of this project is to develop, implement and evaluate a method that uses high-spatial resolution velocimetry data and employs SciML, e.g. physics-informed neural network (PINN) that treats the governing equations as a parameterised constraint, to recover the missing flow dynamics that cannot be measured due to current technological experimental limitations.

Prerequisites

Third-year Mechanical or Aerospace Engineering student who will continue this project into a FYP in 2024. HD in either MAE 3401 or MEC 3451 (essential), HD/D average in Mathematics (preferable).

Additional Information

If shortlisted, you will be required to attend an interview.