Proposal for Master thesis:
Machine learning for heat transfer analysis in turbulent flows

Heat transfer analysis in wall-bounded flows by data-driven approaches

The study of boundary layers is a key point for the prediction of viscous stresses and thermal fluxes at fluid-solid interfaces. The surface roughness, which may be artificially obtained and properly tuned using additive manufacturing techniques, significantly influences the local properties of the boundary layer and thus the heat transfer rate. In case of turbulent flows, several closure models are available to consider the effects of roughness, by defining ad-hoc boundary conditions. In this work, machine-learning techniques will be used to obtain proper information from experimental data to allow tuning and calibration of turbulent closure models based on different artificial roughness patterns. The tuned model will be then assessed in terms of accuracy of the representation with respect to more classical solutions. The phenomena investigated in this work have a significant impact in many fields related to thermal transfer optimization, including aerospace applications, energy devices and electronics [2].

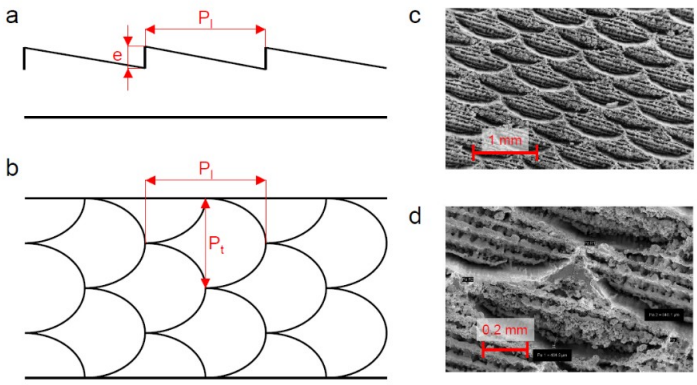

Figure 1: Sample schematics and SEM images of shark-skin like superficial patterns [1]

References

[1] L. Ventola et al, Convective Heat Transfer Enhancement through Laser-Etched Heat Sinks: Elliptic Scale-Roughened and Cones Patterns. Energies 2020, 13, 1360.
[2] B. Aupoix et al, Extensions of the Spalart–Allmaras turbulence model to account for wall roughness, International Journal of Heat and Fluid Flow 2003, 24:(4) 452-462

Keywords
Computational fluid dynamics; Heat transfer; Turbulence modelling; Machine learning; Additive manufacturing

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Requirements
Strong interest in computational fluid dynamics and attitude to coding is required.
Friendliness with MATLAB and (at least) basic knowledge of Linux operating systems are required.
Interest in additive manufacturing techniques or on emerging Machine Learning approaches.