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Multi-Fidelity Surrogate Models for Aerodynamic Applications

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Multi-fidelity methods [1] aim to supplement accurate high-fidelity results at sparse locations in parameter space, with less expensive low-fidelity results that cover the parameter space with higher resolution. The current work looks at developing the use of multi-fidelity surrogate models to aerodynamic applications by using data collected from a series of Reynolds averaged Navier Stokes (RANS) and large eddy simulation (LES) calculations of the flow (shown in Figure 1) around tandem wall mounted cubes [2] at varying yaw angles. In this instance, the fine grid LES data is taken as the high-fidelity data points and eddy viscosity RANS calculations have been used to construct a low-fidelity model. A mapping is then constructed between the low and high fidelity data, bridging the fidelities to form a multi-fidelity surrogate model. A multi-fidelity multi-layer perceptron (MLP) was used to model the force coefficients on the second cube varying with the inlet yaw angle, with results in Figure 1 showing a significant improvement over single fidelity modelling. Ongoing work includes testing the multi-fidelity surrogate method on local flow parameters in order to build up fuller descriptions of the flow at angles that were not included in the training data for the model.

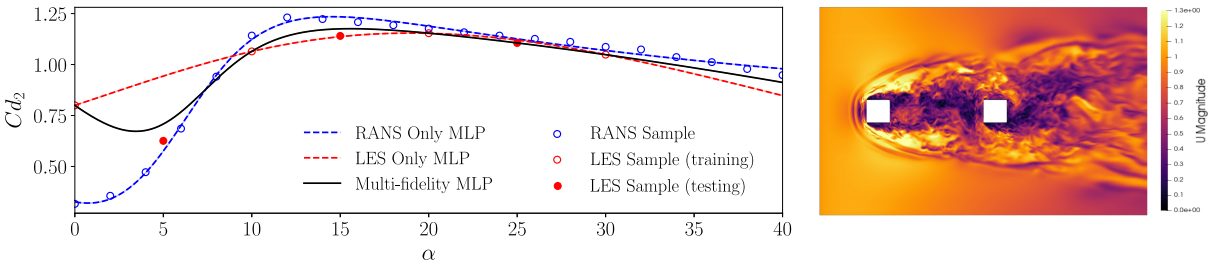

Figure 1: *Left:* Plot of drag coefficient of the downstream cube against angle of attack with raw data and single fidelity MLP models for both RANS and LES data and a multi-fidelity MLP model. *Right:* Slice of the LES instantaneous velocity field.

REFERENCES

[1] P Perdikaris et al. Nonlinear information fusion algorithms for data-efficient multi-fidelity modelling. *Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 2017.

[2] R Martinuzzi and B Havel. Vortex shedding from two surface-mounted cubes in tandem. *Int. J. Heat and Fluid Flow*, 2004.