Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Learning Full Flow Fields from Sparse Wind Tunnel Data[1] PABLO HERMOSO MORENO, EMILE OSHIMA, Caltech, SHENGZE CAI, Brown University, MORTEZA GHARIB, Caltech — Surface tufts and pressure taps are commonly employed in wind tunnel tests to diagnose flow around aerodynamic models. These are relatively simple to implement but can only provide spatially sparse information. On the other hand, techniques that give full flow fields such as pressure sensitive paint or particle image velocimetry are costly and limited in spatial domain. To bridge this gap, we employ deep learning methods to obtain full flow fields from simple and sparse data. In particular, data provided to the learning algorithm is limited to flow direction and pressure which can be obtained from tufts and taps, respectively. To demonstrate concept feasibility, we developed a physics-informed neural network (PINN) which takes points in space as input and outputs flow variables at those points. The algorithm minimizes a loss function that represents the deviation of the learned flow field from provided data and the governing flow physics. The PINN is first validated with 2D flow over a NACA0012 airfoil. Sensitivity to experimentally relevant factors such as data point distribution and noise are investigated. Finally, the work is extended to 3D flows that are representative of wind tunnel testing and the ability to predict wall shear stress is explored.

[1]The authors would like to acknowledge the Caltech Center for Autonomous Systems and Technologies, and Prof Jonathan Morrison from Imperial College London.

Emile Oshima
Caltech

Date submitted: 03 Aug 2020 Electronic form version 1.4