JOHNS HOPKINS
Center for Environmental
& Applied Fluid Mechanics

FALL 2021 CEAFM VIRTUAL SEMINAR SERIES

"A Model for External Aerodynamics Based on Building-Block Flows"

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Hosted by Dennice Gayme (MechE)

A wall model for large-eddy simulation is proposed by devising the flow as a collection of building blocks, whose information enables the prediction of the stress as the wall. The core assumption of the model is that simple canonical flows (such as turbulent channel flows, boundary layers, pipes, ducts, speed bumps, etc.) contain the essential flow physics to devise accurate models. Three types of building block units are used to train the model, namely, turbulent channel flows, turbulent ducts, and turbulent boundary layers with separation. The approach is implemented using two interconnected artificial neural networks: a classifier, which identifies the contribution of each building block in the flow; and a predictor, which estimates the wall stress via non-linear combinations of building-block units. The output of the model is accompanied by the confidence in the prediction. The latter aids the detection of areas where the model underperforms, such as flow regions that are not representative of the building blocks used to train the model. The model is validated in a realistic aircraft geometry from NASA Juncture Flow Experiment, which is representative of external aerodynamic applications with trailing-edge separation.

Adrian Lozano-Duran is the Draper Assistant Professor at MIT AeroAstro. He received his Ph.D. in Aerospace Engineering from the Technical University of Madrid in 2015. From 2016 to 2020, he was a Postdoctoral Research Fellow at the Center for Turbulence Research at Stanford University. His research is focused on Computational Fluid Mechanics and physics of Wall Turbulence. His work includes turbulence theory & models by artificial intelligence and large-eddy simulation, high-speed flows, and multiphase flows, among others.

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