IST 597 PIML Project

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Project Idea

Physics Informed Reduced Order Models (For Optimization):

Research Question

How can we develop generalizable (across flow conditions and design parameters), accurate, and computationally efficient reduced-order models for complex fluid dynamics problems?

General Outline

- Start with a low-fidelity, first-order physics-based model (that accounts for design parameters for optimization).
- Correct the physics-based model with a data-driven differential model, a Neural ODE, which accounts for the missing dynamics.

Application

- Highly flexible or flapping wings.
- Rotorcraft blades.
- Wind turbine blades.

The neural ODE learns wake dynamics and (or) the structural non-linearities.

Sources of Data

- High or mid-fidelity simulations (CFD and (or) FEM).
- Wind tunnel experimental data (if publicly available).

Possible Algorithms

- Neural ODEs.

References

1. Vargas Venegas, C., & Huang, D. (2023). Physics-Infused Reduced-Order Modeling of Aerothermal Loads for Hypersonic Aerothermoelastic Analysis. AIAA journal, 61(3), 1002-1020.