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Improving aerodynamic simulation accuracy of a NASCAR body with machine learning augmented turbulence models KYLE MOONEY, Geminus.AI, COLBY MAZZUCA, Richard Childress Racing, RACHEET MATAI, ANAND PRATAP SINGH, Geminus.AI, ERIC WARREN, Richard Childress Racing, KARTHIK DURAISAMY, Geminus.AI — Aerodynamic loads on a NASCAR vehicle at race speeds significantly influence its on-track performance. Due in part to complex boundary layer separation and interacting turbulent structures, the accuracy of these loads obtained in CFD simulation environments can be limited by the capabilities of the underlying turbulence model. In this work, we demonstrate how experimental data combined with machine learning (ML) methods can be used to augment a turbulence model and improve simulation accuracy on a NASCAR body. Two similar yet distinct model augmentation methods are shown, both of which use experimental wind tunnel data to drive model augmentation. One method uses flow feature based cell clustering and optimization routines to perform localized calibration of turbulence model parameters. The second method utilizes a combination of adjoint-based field-inversion and machine learning to generate field-based corrections to predicted turbulent quantities. Validation and portability of the model augmentation is demonstrated by applying trained augmentations on unseen vehicle bodies and compared to experimental wind-tunnel measurements. Simulation results show significantly improved agreement with experimentally measured aerodynamic loads compared to baseline k-Omega-BSL results.

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