School of Engineering

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Mechanical Engineering

Insight into the Aerodynamics of NASCAR Racers

Aerodynamics plays a pivotal role in motorsports racecar performance enhancement endeavors. To aero advantage while adhering to resource limitations set by race sanctioning bodies, we present the development of a Reynolds-Averaged Navier Stokes (RANS) CFD framework for NASCAR Cup stock-racecars using a Scale Averaged (SAS) approach. We will present an assesses of the impacts of solver parameters, closure coefficients, and boundary conditions on prediction accuracy, validated against wind tunnel data representing various on-track conditions. Our CFD framework achieved a ~98% correlation with wind tunnel measurements. Recognizing the unique aerodynamics of stock-racecars, we also investigated the effectiveness of the Improved Delayed DES (IDDES) approach, slated to reveal finer vortical structures unaccounted for by the RANS solvers. Furthermore, spectral analyses of aerodynamic forces and moments illustrate the roles of racecar geometry components in dominant energy modes. To comprehensively explore this, we found that a more sophisticated tool, such as the Dynamic Mode Decomposition (DMD), is essential. Due to limited flow-field data for training a DMD algorithm on NASCAR racecars, we developed the process using a simplified road vehicle, the Ahmed body. However, applying the existing DMD algorithm to high Reynolds number flows around the Ahmed body led to nonphysical dampening of medium-to-high frequency modes. To address this, we introduced a modified DMD algorithm featuring a mode filtration process, which was observed to be highly effective in both flow-field reconstruction and predicting future states..

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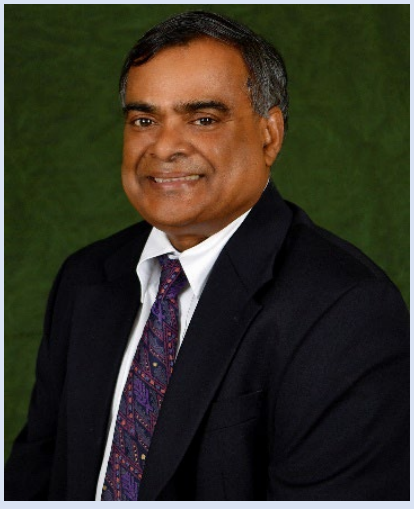

Biography: Mesbah Uddin is a Professor of Mechanical Engineering at the University of North Carolina at Charlotte and leads the "Digital Design and Optimization (DDO)" research initiative, which focuses on enhancing Charlotte's connections with defense and security-related companies. From 2012 to 2022, he directed the North Carolina Motorsports and Automotive Research Center, elevating it to a prominent research and graduate training institution. He was a member of the North Carolina Governor's Motorsports Advisory Council from 2012 to 2017. He earned his BS and MS degrees in Mechanical Engineering from Bangladesh University of Engineering & Technology, and a PhD from the University of Melbourne, Australia. Between 2005-2008, he served as a senior Aerothermal CFD analyst at Chrysler, and prior to held positions at Queen's University in Canada, and Bangladesh University of Engineering & Technology. Dr. Uddin's research interests center around computational and experimental fluid dynamics, with significant accomplishments in motorsports and automotive research. His research group at Charlotte played a leading role in optimizing the aerodynamics of the SRT Viper GTS-R racecar, resulting in championship victories. He maintains active involvement in professional societies.

Friday, September 22, 2023 – 10:30 am – COB 110

Fall 2023 Seminar Series