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Research Recap

Platooning for Improved Safety and Efficiency of Semi-Trucks (PISES) II

Purpose: The project team worked gain a better understanding of semi-truck platoon operations including aerodynamics, diesel efficiency, and safety-logistics. Platooning of semi-trucks can offer a cost-effective method for reducing energy consumption across a fleet of vehicles. Vehicles traveling together can exploit close following distances enabled by vehicle-to-vehicle communication to reduce aerodynamic drag and, in turn, overall power requirements. Driving within a leading vehicle's wake affords aerodynamic savings to both the trailing, and to a lesser extent the leading vehicles. A general trend of increasing savings with decreasing following distance is observed in experimental and computational work, but the precise behavior of the drag is governed by the highly complex dynamics of fluid flow and thus extremely sensitive to minor changes in geometry, such as side mirrors or platoon configuration, and other flow parameters. In this project report, the team outlines an approach to learning the dynamics of turbulent flow and demonstrates the capabilities of a high-fidelity turbulence dataset.

Approach: Inspired by the underlying physics, the team investigated the use of Neural ODEs (NODEs) to model spatiotemporal dynamics. While smaller NODEs have been used successfully before, the researchers explored modeling whole field dynamics with this framework by developing a data-driven, reduced-order model to forecast three-dimensional turbulence.

Key Findings: The researchers' approach captures important details of the flow, namely the large-scale dynamics, and produces stationary sequences in line with the physics of the problem. They also found the convolutional network details, both the encoder-decoder and the dynamics estimator, have a significant impact on the results, informing future developments in this field.

Conclusion: The research team proposed a novel methodology for forecasting complex nonlinear spatiotemporal dynamics through purely data-driven methods. They found that the largest scales of the flow, which are relevant to engineering applications, are well-approximated, and some dynamic characteristics of interest are maintained. In follow-on work, they aim to scale up this program with realistic vehicle simulations.

Photo by Caleb Ruiter on Unsplash

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Project Record:

- https://ppms.cit.cmu.edu/projects/detail/285

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