Visualization of Car Fluid Flow

Table of Contents

Basic Info

Team Names:
Jacob Haydel, u1137077 (u1137077@utah.edu)
Pranav Rajan, u1136324 (u1136324@utah.edu)
Jack Wilburn, u0999308 (u0999308@utah.edu)

Project title: Car Fluid Flow Simulation and Visualization

Background and Motivation

Give an overview of the project.
For our project, we're planning to visualize how air flows around cars and to show how that flow affects the drag that a car might experience. We hope to compare several different cars against each other to show how many types of car body change the performance characteristics of the vehicle. Ultimately, we'll visualize this data to show our viewers which cars have better design, what design choices led to less drag, and which vehicles to avoid, if handling and gas mileage are a top priority.

We chose to visualize car aerodynamics data because air flow is important in car design. Poor decisions about airflow can lead to safety and performance issues, thus this kind of simulation/visualization could help designers find and mitigate issues before the car is constructed. Additionally, manufacturers often want to optimize their airflow for a number of reasons, including better gas mileage, better handling characteristics, and a quieter ride.

Why is this project important and/or interesting?
Our team is interested in the aerodynamic characteristics of cars. We would like to compare and contrast aerodynamic characteristics across various types of cars to determine how they differ in their use of aerodynamics. For example we would like to determine what features on these cars produce the most drag (turbulent flow).

Although we chose cars in this example, this kind of fluid flow simulation and visualization has many applications in our world. For example, in aviation it's important to know lift and drag characteristics of aircraft, and in architecture it's important to know how the air will flow around the buildings and whether that creates any force that

might impact the structure. Knowing how to generate these kinds of data and how to visualize them effectively is a key skill for modern designers and engineers.

Project Objectives

What are the objectives of the project? What are the questions you want to answer?
We have several objectives for this project, related to both the generation of scientific data and its visualization. First, we're going to take some CAD models of cars and learn to simulate simple fluid flows with OpenFOAM. Secondly, we're going to take that data that we've generated and visualize it using paraview. A third, stretch goal, is to animate the fluid flow data in paraview, so that viewers of our visualization can see how the cars are generating vortices, etc. This is a stretch goal, since it should be clear where the areas that cause drag are from a still frame.

What would you like to learn by completing this project?
We would like to learn more about the techniques and processes involved in visualizing fluid flow. We would also like to explore the aerodynamic characteristics of different car types/models. For example visualizing the widely debated aerodynamics of modern F1 cars and comparing them to older F1 cars would be interesting.

What data will you be using for your project?
The data that we will be using will be simulated data that we will generate using the OpenFoam software and car .stl files that we find online.

Hardware/Software

If you are doing a programming project, list the hardware and software you will be using.

Software:

- OpenFoam - for generating simulation data
- Linux - Generating OpenFOAM data
- Paraview - for visualizing simulation data
- Car STL - CAD car models. We will be using open source/free stl files that we find online
- Windows - for visualizing the simulation data with Paraview

Hardware:

- We will not be using any special hardware for this project
- If the project becomes tricky to run on our individual machines, we may try to leverage some of the SOC/SCI infrastructure.

Project Schedule

What is your project schedule? What have you done thus far and what will you have to do to complete this project? Be as specific as possible.

March 21: Figure out how to simulate data using OpenFOAM and STL, generate some data (maybe not from care models) so that we can start learning how to visualize the OpenFOAM data
March 28: Figure out how to visualize fluid flow simulation with paraview
March 31: Progress Report Submission
April 5: Make fluid flow simulations of multiple cars and visualize the results
April 12: Animate fluid flow submissions (if time available)
April 21: Final Project Submission

When the project is completed, how specifically can we evaluate how successful it is?
The success of the project will be contingent on our ability to produce useful fluid flow visualizations for various cars.

Deliverables:
Generated simulation data for 4-5 cars
Fluid flow visualization of those cars
Presentation/report that shows the outputs of our work
(optional) Animated fluid flow visualizations

Any other useful information? N/A