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Optimizing Powertrain Simulation Models

Two Sentence Elevator Pitch:

Students on the Isuzu project will develop and optimize a Powertrain simulation model to improve the efficiency and effectiveness of Powertrain design.

Abstract:

The student team will support engine model based development with a combination of data driven models, 1D powertrain models, and supervised machine learning based optimization methodologies. Utilizing existing algorithm libraries, students will develop and perform statistical analysis and build data driven emission models and engine performance models to optimize both steady-state and transient operation conditions. Previous feasibility studies suggest that a supervised machine learning approach could be effective. Results will support steps towards a fully virtual vehicle simulation and development environment.

Impact:

The results of this project will be implemented into current Isuzu model-based powertrain/full vehicle development workflow. The project focuses on data driven models along with exploration of different optimization strategies. This methodology can be utilized to improve model robustness and significantly reduce the powertrain development cost.

Scope:

Minimum Viable Product Deliverable (Minimum level of success)

- Develop data-driven emission and engine performance models from current simulation data, including model development, performing sensitivity analysis and error uncertainty quantification. Identify “key parameters” driving model performance.
- Use existing or generate new engine testing and simulation results (1D/CFD) to develop emission and performance models based on “key parameters”.
- Understand the underlying physical meanings and implement the machine learning (ML) algorithm to develop fast-running surrogate reduced order models and use ML-based optimization to find and develop optimum and robust calibration.

Expected Final Deliverable (Expected level of success)

- Surrogate emission/combustion model integrated with existing 1D, CFD models.
- Optimization workflow to develop robust powertrain calibration in model-based development process.

Stretch Goal Opportunities: one or more of the following

- Hardware implementation and integration.
- Virtual vehicle model development.

Student Skills:

MDP Sponsored Projects are both a professional and academic learning experience for students. By participating in this program, students are actively preparing for graduate school and a professional career. As part of the experience, MDP expects professional behavior. To best prepare you for future professional opportunities, your experiences on this MDP team will be very broad. In addition to key technical skills that you will bring to the team, you will engage deeply in the self-directed learning of new and important concepts, demonstrate flexibility, collaboration, and cooperation, and develop strong professional communication skills. This also means that you will need to be able to work outside of your traditional area of study in the true multidisciplinary nature of our projects. You won't always be able to anticipate how your skills and expertise will be used, so the MDP Sponsored Project will challenge you to grow and develop as a professional.

Project Area	Specific Skills	Likely Majors
General Programming (2 – 3 Students)	General interest and skills in programming. Strong Interest and motivation to develop new skills. EECS 281 Completed Key skills: Python / C	CS (All)
Model and Simulation Development (2 students)	Model development, Optimization and simulation techniques (supervised machine learning, virtual modeling, Monte Carlo testing, data analysis and visualization) General programming skills (R preferred)	DATA (BS/BSE) IOE STATS (BS) MIDAS CS (All) with minor in STATS, MATH, and/or DATA.
Combustion/Emission/Engine Performance (2 Students)	Basic understanding of engine combustion and emission formation. General simulation and model development experience. Ideally ME 458 Combustion Engines or equivalent	MECHENG ChE ISD-AUTO ISD-GAME

Additional Desired Skills/Knowledge/Experience

Any of the following skills, knowledge, experience, interests or outlooks, would be valuable to the 2020 team. We don't expect students to be familiar all or even most of the technical items, but strong candidates will have familiarity or experience with some of them and a positive attitude to learn

what is necessary as the project gets underway. Please highlight your experience with any of the items on this list in your personal statement on the application.

- Interest in virtual engine/powertrain/vehicle development
- Successful team based project experience and/or professional experience in engineering
- Experience/Skills in
 - Model optimization
 - Any practical development of 1D / CFD model development
 - Combustion research / engine development
 - C / Python/ R/ Matlab
 - Experimental Design / Statistical modeling
- Completed or co-registered in MECHENG/AUTO 458 Combustion Engines

Location:

Most project work will take place on campus during the semesters. There will be frequent trips to the Isuzu technical park in nearby Plymouth, MI for collaborative work with Isuzu Engineers. Transportation to Isuzu Technical Park in Plymouth provided by MDP.

Sponsor Mentor:



Yong Sun,
Supervisor, Model based development

Yong is a 2012 University of Michigan Master of Science in Aerospace Engineering graduate. He has worked at Isuzu for 3 years with focusing on autonomous driving, electrification, and model based approach development.

Yifan Wei, Engineer I, Model Based Development.
Lakshmidhar Uppalapati, Engineer II, Model Based Development
Saurabh Sharma, Engineer II, Model Based Development

Faculty Mentor



ROBERT MIDDLETON
Assistant Research Scientist, Mechanical Engineering
College of Engineering, University of Michigan

Rob's research interests include combustion, focusing primarily on automotive engines.

Legal Requirements:

Citizenship Requirements.

- This project is open to all students on campus.

Intellectual Property Agreements / Non-Disclosure Agreement Requirements (please select one)

- Students will sign standard University of Michigan IP/NDA documents.

Summer Project Activities

- Students will be guaranteed an interview for a 2020 internships. The interviews will take place in March of 2020.
- Positions in various research and development directions are open, not confined in MDP area.

Company Information:

Isuzu is the global leader in commercial vehicles and diesel engines. We consistently focus on "creation without compromise" in the process of building and maintaining a world-class organization. By expanding our operations across the globe, Isuzu products benefit people in over 100 countries. To ensure the most advanced performance and superb service, we are moving forward in product development, quality, manufacturing systems and customer support, which will become the new global standards of excellence. We hold an uncompromising commitment to improvement for better products and a better partnership with the world.