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Master Thesis: Machine Learning Strategies to Enhance Performance Contact Simulation

About Us: Within the Department of Applied Mathematics and Engineering for Future Components at Robert Bosch Corporate Research we have the competencies in Fluid Dynamics and Reliability. Our team develops advanced simulation methods for the design of tribological components. These methods are utilized across various Bosch business units to enhance the development of gears, bearings, valves, guidances and more in applications such as e-bike drive units, braking components and power tools.

Project Overview: in the project I lead, we have developed a software solution for simulating contact dynamics under Elastohydrodynamic Lubrication (EHL) conditions. This software has been validated through experiments and has demonstrated superior efficiency compared to state-of-the-art Computational Fluid Dynamics (CFD) and Finite Element Method (FEM) based software. Achieving further time efficiency will enable Bosch developers to virtually evaluate and validate numerous prototypes, including all possible micro-modifications such as surface roughness, flank corrections, tolerances and variations in lubricants and material characteristics.

Thesis Objective: advance the current state of simulation methods by leveraging machine learning techniques to develop highly efficient models for 3D contact simulations. Building on the success of simplified 2D models, this research aims to identify and implement the most promising machine learning methods that can deliver accurate and rapid simulations in three-dimensional contexts. The specific goals of this thesis include:

- Identifying Optimal Machine Learning Methods: Conduct a thorough investigation to pinpoint the most effective machine learning approaches for 3D contact simulations.
- Generating Training Data: Utilize available in-house software to produce a comprehensive dataset that will be used to train the machine learning models.
- Evaluating Efficiency and Quality Trade-offs: Analyze the balance between computational speed and the accuracy of the simulation results to ensure optimal performance.
- Implementing and Validating Models: Develop, implement, and rigorously test the selected machine learning methods to confirm their validity and reliability in 3D simulations.
- Addressing Complexity in Simulations: Tackle the challenges associated with transitioning from 2D to 3D simulations, ensuring that the models can handle increased complexity effectively.

The outcome of this thesis will be directly integrated into our simulation workflow, significantly benefiting our internal customers.

If you have any questions or need further information, please do not hesitate to contact me.

Thank you for considering this request.

Yours sincerely,

Dr. Cesar Pastor