HEXAGON

Case study

Method for efficient combined avoidance maneuver and crash analysis using active human body modeling

Autoliv – Sweden

ODYSSEE CAE enables a comprehensive crash model to be run on a laptop with a run-time reduction of >95% compared to a research cluster.

Autoliv is the world's largest supplier of automotive safety equipment with 42% of the market share. Autoliv can trace its history in the automotive safety industry to 1953 with the founding company Auto Service AB.

Autoliv is the largest tier 1 automotive safety supplier and produces airbags, seatbelts, steering wheels, and additional safety features. These safety features combined are expected to save 30,000 lives and prevent 300,000 severe accidents per year. Autoliv is positioned to become the global leader in mobile safety by transforming the industry by setting new safety trends.

Autoliv operates in 27 countries with the head office in Stockholm, Sweden.

> **ODYSSEE CAE allows inferring unknown response surfaces within seconds. It's extremely rapid. There is no need for high performance computing."**

Bengt Pipkorn,
Director of simulation
and active structures

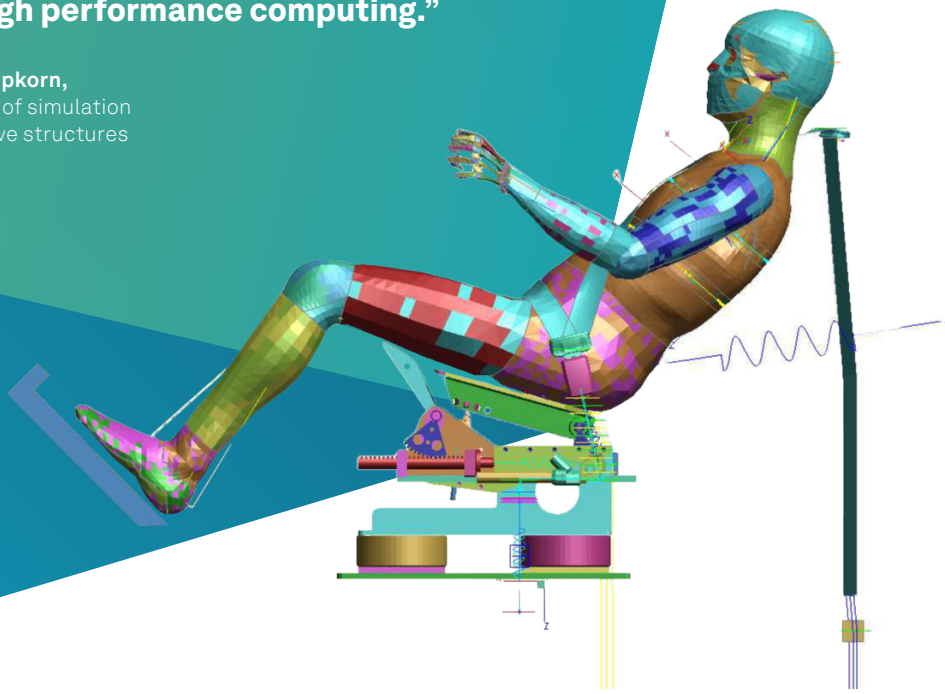

Fig 1: Simple body model in a crash simulation restrained by a three-point seatbelt and semi-rigid seat

Challenge

Current real-world analyses on crashes indicate that conventional crash modeling is insufficient for accurately predicting injuries. The conventional crash modeling uses a rigid human body being subjected to the crash conditions. The current cars have autonomous features to swerve or brake to attempt to prevent an accident. These lower acceleration maneuvers and the occupant's tensed muscles affect the position and posture of the occupant, which influences the injuries sustained. These are unrepresented in current digital crash modeling or in physical crash dummy testing. Autoliv is creating an innovative approach that addresses all the inadequacies of conventional modeling. The approach would model the precrash dynamics, an active human body, and the crash. This approach is very computationally heavy where a single simulation would take multiple days. This timescale for a single simulation limits the ability to perform parameter optimisation. Autoliv is interested in using machine learning techniques to enhance its model and reduce the time needed.

Solution

Using ODYSSEE CAE, Autoliv can make the model more accessible with reduced computational time and power. The new simulation model uses FEA to replicate the pre-crash dynamics (swerving or braking), a human body with muscles tensing, and the crash scenario with the modified occupant's position. The human model reacting to the pre-crash dynamics with muscles tensing was developed with human volunteers.

The testing of ML techniques with ODYSSEE CAE was done in two configurations. The first configuration was a control test to determine injuries sustained by a simple body model in a semi-rigid seat with only a seatbelt. ODYSSEE CAE was given 5 crash scenarios lasting 160ms to create a reduced order model (ROM) to create the animation and predict the forces and injuries. The second configuration was testing the capabilities of ROM techniques by modeling the crash scenario with precrash dynamics, an active human body, and the newest occupant safety features. The ROM was trained on 6 scenarios lasting 1700ms to recreate the animation and to predict the forces and injuries.

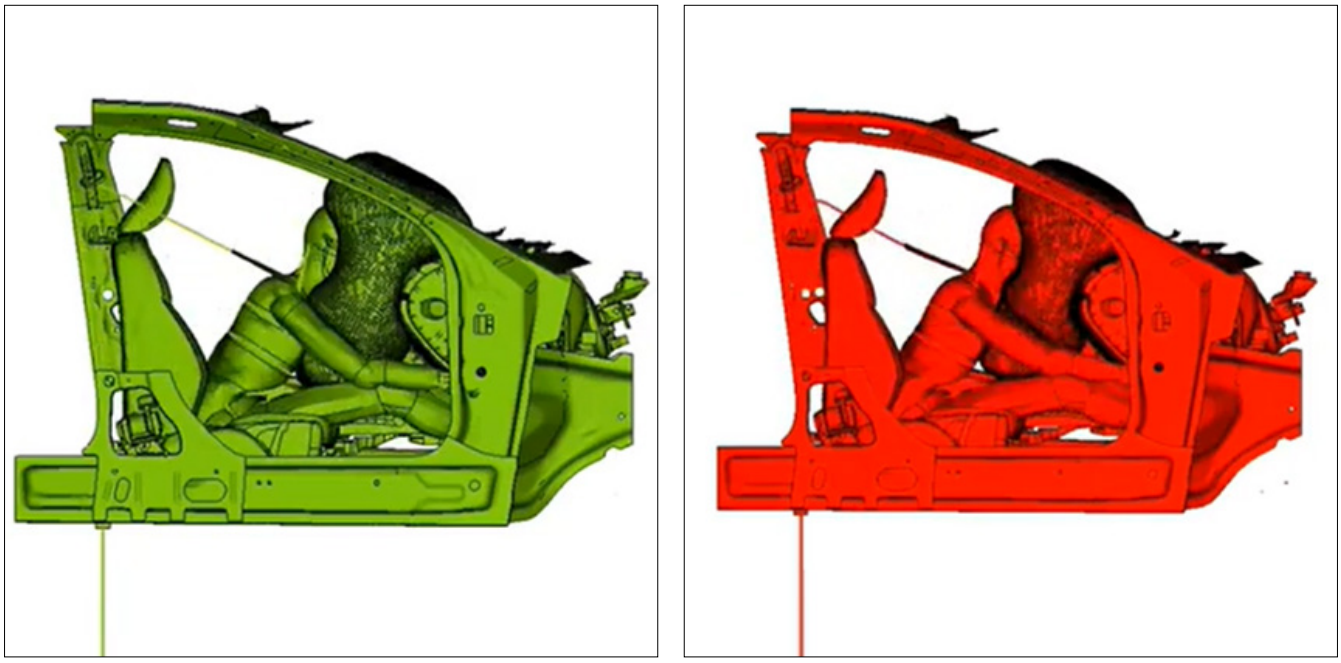

Fig 2: Simulation of an active human body model inside a car with airbag and seatbelt safety features.
Red is ODYSSEE CAE prediction, Green is FEA model simulation.

Results

The results obtained by ODYSSEE CAE were completed in a fraction of the time of FEA. The ROMs were run on a laptop with 4 cores while the FEA simulations were run on a 16 and 32-core computation cluster. The first configuration time was reduced from 4h36m on a research cluster of 16 cores to 1h10m with ODYSSEE CAE (74.6% computation decrease). The forces and accelerations were accurate within 5% error. Using ODYSSEE CAE, the second configuration with the precrash kinematics and safety features decreased the running time from 47h35m on a research cluster of 32 cores to 1h32m on a 4-core laptop (96.77% computation decrease). The ROM predictions showed close kinematic agreement with FEA simulations. The computation cluster remains available for the other simulation needs while ODYSSEE CAE uses a small company laptop to predict the new Autoliv model. The reduced time and power needed, allow parametric optimisation for the realistic crash simulation to improve safety and to set new trends in safety analysis.

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Key highlights
Product: ODYSSEE CAE
Industry: Automotive
Benefits: • ODYSSEE CAE enables a comprehensive crash model to be run on a laptop with a run-time reduction of >95% compared to a research cluster

Hexagon is a global leader in digital reality solutions, combining sensor, software and autonomous technologies. We are putting data to work to boost efficiency, productivity, quality and safety across industrial, manufacturing, infrastructure, public sector, and mobility applications.

Our technologies are shaping production and people-related ecosystems to become increasingly connected and autonomous – ensuring a scalable, sustainable future.

Hexagon's Manufacturing Intelligence division provides solutions that use data from design and engineering, production and metrology to make manufacturing smarter. For more information, visit hexagonmi.com.

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