ARC Collaborative Research Seminar Series
Fall 2008

September 24th, Wednesday (9:30-11:00am)
University of Michigan, Lurie Engineering Center, Level 4, GM Room

Thrust Area 4
Advanced and Hybrid Powertrains
Presents:

Simulation-based Assessment of Various Dual-Stage Boosting Systems
Byungchan Lee, The University of Michigan
(no abstract available)

Effect of Fuel Properties on Premixed Diesel Combustion
Andrew Ickes, The University of Michigan
(no abstract available)

Estimation of the Instantaneous Engine Components Frictional Losses
Nabil Chalhoub and Giscar Kfoury, Wayne State University
(no abstract available)

October 15th, Wednesday (9:30-11:00am)
University of Michigan, Lurie Engineering Center, Level 4, GM Room

Thrust Area 5 Presents:

Towards Confidence Extrapolation of Validated Simulations
Yogita Pai, The University of Michigan

Abstract: Given the validation of a simulation for a certain application domain, the questions becomes whether and how we can extrapolate our confidence to unknown application domains. This talk outlines possible approaches that may be useful in developing confidence extrapolation techniques.

Representing and Accounting for Geometry in Optimal System Design
Kwang Jae Lee, The University of Michigan

Abstract: Component geometry is an important aspect of optimal system design that is largely neglected. In this talk, we discuss research efforts in representing geometric instantiations and accounting for component geometry in optimal system design and configuration. A new computation environment and preliminary results will be presented.

Reduced Representations of Vector-valued Coupling Variables in Decomposition-based Optimization
Michael Alexander , The University of Michigan

Abstract: Decomposition-based optimization strategies introduce consistency constraints that link subproblems together through coupling variables. When these coupling variables are vector-valued subproblems become very large and do not permit efficient optimization. This research aims at identifying ways to reduce the size of these vector-valued coupling variables to improve optimization

efficiency while maintaining a sufficient level of accuracy.

October 29th, Wednesday (9:30-11:00am)
University of Michigan, Lurie Engineering Center, Level 4, GM Room

Thrust Area 2 Presenting:

Effect of Posture and Movement of Vehicle Operators on Vibration Transmissibility

Heon-Jeong Kim, Bernard Martin, The University of Michigan

Abstract: Vibration transmissibility to the human body is a function of both vehicle vibration characteristics and postures associated with the performance of movements. An experiment was designed to investigate variation in vibration transmissibility to upper body segments when performing dynamic reach movements in the direction of targets distributed in the right hemisphere of a vehicle operator. The data are used to build a database necessary to the development of an active biodynamic human model. Transmissibility will be assessed for pre-determined hand locations and the corresponding upper body posture along the hand trajectory. This sampling technique, providing snapshots of whole-body transmissibility at selected intervals, will be used to estimate and reconstitute dynamic behaviors.

Convoy Driving with a Secondary In-Vehicle Task: Modeling and Experimentation

Helen Fuller, Omer Tsimhoni, Matthew Reed, The University of Michigan

Abstract: The goal of this project is to integrate a physical human model (HUMOSIM Framework) with a computational cognitive model (QN-MHP) to create a tool to study complex human-machine interactions. A description of the QN-MHP will be presented, and the model's abilities and limitations will be discussed. A driving simulator experiment was conducted to generate data that will be used to calibrate the integrated model. Subjects of four statures entered information on a touch-screen display located in one of four positions while driving in a convoy, following a lead vehicle that changed speed continuously. Subjects drove a normal-weight vehicle and a heavy-weight vehicle. Driving performance and secondary task performance were analyzed as a function of display location, subject stature, and vehicle weight. Driving behavior and secondary task performance results will be presented, along with a model of the in-vehicle task.

November 5th, Wednesday (10:30-12:00am)
University of Michigan, Lurie Engineering Center, Level 4, GM Room

Thrust Area 3
High Performance Structures and Materials
Presents:

RBDO for Ground Vehicle Durability with an Associated Confidence Level under Input Model Uncertainty

Kyung K. Choi, Yoojeong Noh, and Ikjin Lee, The University of Iowa
David Gorsich and David Lamb, U.S Army RDECOM-TARDEC

Abstract: When carrying out RBDO, it is often assumed that uncertain input variables are independent. However, certain input variables, such as the fatigue material properties, are correlated. Thus, the reliability analysis results and RBDO results are invalid if the input correlations are not properly modeled. For the RBDO problem with the correlated input variables, a joint CDF of the input variables should be modeled. However, in practical applications such as Army ground vehicles, only limited paired sampled material property data can be acquired since experimental testing is expensive. In this presentation, a copula is used to model the joint CDF by linking marginal CDFs. To model the joint CDF, it is necessary to identify the correct copula using the marginal CDFs and paired samples. A Bayesian method is proposed to identify the correct copula and marginal CDF types. When the input variables are correlated, the performance functions become highly nonlinear in the normalized independent variable space, which makes the FORM-based inverse reliability analysis result inaccurate. In this presentation, the most probable point (MPP)-based dimension reduction method (DRM) is used for the inverse reliability analysis for

accurate probability of failure calculation without requiring the second order sensitivity analysis. Finally, to account the input model uncertainty, a method is proposed to assess the confidence level of the reliability analysis and RBDO results. As an example of correlated input variables, an RBDO study of an M1A1 Abrams road arm model is carried out. The data shows that there are very strong correlations between the material properties such as the fatigue strength coefficient and fatigue strength exponent; as well as between the fatigue ductility coefficient and fatigue ductility exponent. For this problem, we have obtained an RBDO result with an associated confidence level.

Multi-scale Simulations for Developing Light Weight Vehicles with Increased Survivability to Loads from Explosions and High Velocity Projectiles

Nick Vlahopoulos, The University of Michigan

Abstract: The U.S. Armed forces face the need for rapid deployment from the United States in order to engage regional threats decisively on a global basis. Size and weight are paramount factors for Army vehicles supporting this force projection structure. Lighter weight vehicles is an enabling factor for faster transport, higher mobility, fuel conservation, and a reduced ground footprint of supporting forces. At the same time high levels of protection must be offered by the vehicle to its occupants against combined loads from explosions and high velocity fragments and projectiles. Weight reduction and high levels of survivability are mutually competing objectives. Composite materials provide some of the most viable options for manufacturing such lightweight vehicles provided that they can offer the desirable level of protection. Multi-scale simulations can be engaged for designing such materials and for evaluating the overall vehicle survivability. NASA Glenn has developed the ImMAC suite codes which enable coupled multi-scale analysis of advanced composite structures. In this project the ImMAC simulation capability is combined with a readily available code for simulating the response of a target structure subjected to loads from explosion/fragmentations in order to develop a new multi-scale simulation method suitable for Army vehicle analysis. The work completed up-to-date demonstrates the feasibility of designing light weight vehicles with high resistance characteristics to loads from explosive threats.

December 10th, Wednesday (9:30-11:00am)
University of Michigan, Lurie Engineering Center, Level 3, Johnson Rooms

Thrust Area 1 Presents:

Internet-Distributed Hardware-in-the-Loop Simulation for Cyber-Enabled Concurrent Automotive Systems Engineering: A TARDEC/UM Case Study

This talk will present key steps towards an observer-free approach to Internet-distributed hardware-in-the-loop (HIL) simulation of automotive systems. Such Internet-distributed HIL simulation can be a key enabler for cyberinfrastructure-based concurrent systems engineering. The talk will begin by exploring the relevant literature on Internet-distributed simulation and control, with particular emphasis on the fundamental tradeoffs between transparency and stability and how Internet delay and jitter affect these tradeoffs. The talk will then present both simulation-based and experimental studies of transparency and stability in Internet-distributed HIL simulation. The studies build on earlier work at both the ARC and TARDEC on engine-in-the-loop simulation, reduced-order vehicle and engine system simulation, as well as model-based Internet-distributed HIL simulation. These studies underscore the potential for Internet-distributed HIL simulation to become a key tool for army truck system integration.

High-Fidelity Lithium-Ion Battery Health Degradation Modeling for Condition-Based Maintenance and Health-Conscious Hybrid Power Management: Preliminary Results

Tulga Ersal, Hosam K. Fathy, and Jeffrey L. Stein, The University of Michigan

This talk will present recent research in the area of high-fidelity, electrochemistry-based Lithium-ion battery health degradation modeling. Such modeling of health degradation is critical for both condition-based maintenance and battery health-conscious hybrid power management. The talk will begin by describing the fundamental electrochemical processes governing Lithium-ion battery behavior. The talk will then explore the literature on Lithium-ion battery modeling, and use this literature to develop a high-fidelity electrochemistry-based model of battery health degradation. Steps towards the manipulation of this model into a differential algebraic equation-based form conducive for control system design will be explained in depth. Furthermore, the model will be used to highlight some potentially important facts regarding the impact of battery power management on battery health and lifetime costs.