ARC Collaborative Research Seminar Series
Fall 2007

2007 October 10th, Wednesday (9:30-11:00am)
University of Michigan, Lurie Engineering Center, Level 4, GM Room

Presenting:
Thrust Area 1 – Dynamics and Control of Vehicles

Novel Modeling, Design, and Estimation Techniques for HMMWV Rollover Analyses
Burit Kittirungsi, Tulga Ersal, Hosam K. Fathy, and Jeffrey L. Stein, The University of Michigan

2007 October 24th, Wednesday (9:30-11:00am)
University of Michigan, Lurie Engineering Center, Level 4, GM Room

Presenting:
Thrust Area 3 – High Performance Structures and Materials
Modeling and Design for Improved Vehicle Mobility, Safety, and Survivability

Tire-Soft Terrain Traction
Jonah H. Lee University of Alaska Fairbanks
Hongyan Yuan Ohio State University

In order to better design vehicles traversing over soft terrains such as soils and snow, traction and motion resistance need to be understood and predicted. In this talk, we first give an overview of our progress in the modeling of tire, terrain, tire-snow interaction and vehicle dynamics. Most of the current studies of tire-snow interaction involve only smooth tires without tread patterns that are ubiquitous in most tires. We then discuss the effects of simple tread pattern for a 2-D rigid tire and compare the results of interfacial forces and sinkage with those for a smooth tire. The distributions of the interfacial forces due to parts of the tirethe tread block, the void and the flankare then presented such that the relative contributions of the parts of the tire can be understood and related to the overall interfacial forces. Our recent extensive studies on tire-snow interaction have revealed the shortcomings of the current constitutive model of snow, which are attributed largely to a lack of understanding of the micromechanical behavior of snow that determines the macroscopic behavior of the deformation and failure of snow. The second part of this talk then discusses our effort in obtaining three-dimensional snow microstructure using microtomography as well as the stochastic reconstruction of the scanned microstructure such that robust snow constitutive equations based on micromechanical behavior of snow as well as direct simulation of tire tread block on real and simulated microstructure can be obtained in the near future.

An Innovative Reactive Gunner Restraint System for Improved Gunner Safety in Military Vehicles
Chang Qi, Guang Dong, Zheng-Dong Ma, and Noboru Kikuchi University of Michigan

According to an Army newsletter, there were 107 M1114 rollovers in FY 2005 and 2006, and 56% of the resulting fatalities were gunners. A proper gunner restraint system (GRS) is therefore essential for improving gunner safety and survivability in military vehicles. In addition to safety, the gunner's comfort and ability to operate effectively are two important measures of the GRS design, because these are directly related to the fighting ability of the soldier. The objective of this new research initiative is to develop an innovative gunner restraint system for improved gunner safety and performance under various extreme vehicle events and battlefield scenarios, including: rollovers, braking incidents, crashes, high-speed maneuvers, rough terrain crossings, and ballistic/blast attacks. The focus is to develop a new and advanced design concept with associated

enabling technologies that support the Army's future ground vehicle programs. The design space will include passive, active, and reactive technologies for searching for an innovative and optimum structural and material system within a broad spectrum. The technology developed in this research can also be used to improve current restraint systems or to develop future restraint systems for commercial vehicles. Three new technologies being developed at the University of Michigan will be presented: FOMD (function-oriented material design), MQ (magic cube approach for survivability design), and RS (reactive structure concept).

An Innovative I-Bumper Concept for Improved Crashworthiness of Military and Commercial Vehicles

Dong Wook Lee, Zheng-Dong Ma, and Noboru Kikuchi University of Michigan

One of the greatest challenges facing the automotive industry is to provide safer vehicles with high fuel efficiency at minimum cost. Current automotive vehicle structures have one fundamental handicap: a short crumple zone for crash energy absorption. This leaves limited room for further safety improvement, especially for high-speed crashes. Therefore, breakthrough technologies are needed to meet this challenge. One potential breakthrough is to use active safety devices instead of conventional passive devices. An innovative inflatable bumper concept, called the "I-bumper," is being developed for improved crashworthiness and safety of military and commercial vehicles. The proposed I-bumper has several active structural components, including a morphing mechanism, a movable bumper, two explosive airbags, and a morphing lattice structure with a locking mechanism that provides desired rigidity and energy absorption capability during a vehicular crash. It has additional innovative means for improving crashworthiness, which is to use tubes filled with a granular material to absorb crash energy. In addition to this innovative concept, an analytical design model is being developed in this research for the optimal design of the I-bumper system, with a focus on the up-front design. Major design variables include those for the explosive airbag, morphing lattice structure, and granular material for maximizing energy absorption in the crash process. The new design methodology has been implemented in Matlab, and validation will be conducted at the full vehicle level using LS-DYNA in order to demonstrate the effectiveness of the I-bumper for improved survivability in high-speed crashes.

2007 November 7th, Wednesday (9:30-11:00am)
University of Michigan, Lurie Engineering Center, Level 4, GM Room

Presenting:
Thrust Area 4 – Advanced and Hybrid Powertrains

Overview of Thrust Area 4
N. Henein, Wayne State University Projects
D. Assanis, University of Michigan Projects

Fundamental Impact of Alternative Fuels on Diesel Engine Operation
N. Henein, Wayne State University
Z. Filipi, University of Michigan

2007 December 5th, Wednesday (9:30-11:00am)
University of Michigan, Lurie Engineering Center, Level 3, Johnson Rooms

Thrust Area 5
Vehicle System Integration, Optimization, and Robustness

Presents:

"Simulation-based Design Validation and E-Certification"
Harshit Sarin, Michael Kokkolaras, Greg Hulbert, and Panos Papalambros
The University of Michigan

2007 December 19th, Wednesday (9:30-11:00am)
University of Michigan, Lurie Engineering Center, Level 4, GM Room

Thrust Area 2

Human Centered Modeling and Simulation

Presents:

Integrating Cognitive Simulation with Human Movement Models in the Virtual Driver: Effects of In-Vehicle Display Location on Driving and Secondary Task Performance in Convoy Driving

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

Transmissibility of Upper Body Segments Affecting Reaching Tasks under Vehicle Vibration Exposure

Bernard Martin, The University of Michigan

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