ARC Collaborative Research Seminar Series
Winter 2004

January 8, Thursday (1:30-3:00pm)
University of Michigan, Lurie Engineering Center, Level 4, GM Conference Room

Case Study Plans for ARC 10th Annual Conference
abstracts

February 5, Thursday
University of Michigan, Lurie Engineering Center, Level 4, GM Conference Room

Optimal System Design under Uncertainty
presented by Thrust Area 5
abstract

February 19, Thursday
University of Michigan, Lurie Engineering Center, Level 4, GM Conference Room

NVH Analysis for Higher Frequency Ranges and Structures With Uncertainties
presented by Thrust Area 3
abstract

March 18, Thursday
University of Michigan, Lurie Engineering Center, Level 4, GM Conference Room

By Thrust Area 1:

Using the Milliken Moment Method and Dynamic Simulation to Evaluate Vehicle Handling
Presenter: Robert Hoffman (Graduate Student Research Assistant) U. of Michigan

Vehicle-Terrain Interaction Effects System Identification for Mobile Robot Planning and Control
Presenter: Dr. Gary Witus (Turing Associates, Inc.)

A Demonstration of Cooperative Mobility
Presenters: Professor John Luntz, Ashish Deshpande (Graduate Student Research Assistant), U. of Michigan

abstracts

April 1, Thursday
University of Michigan, Lurie Engineering Center, Level 4, GM Conference Room

By Thrust Area 2:

**Vehicle Interior Design for Accommodation and Safety:
Past, Present, and Future**

Matthew P. Reed, University of Michigan, Transportation Research Institute

Haptic Interface for Improving Driver-Vehicle Performance: Rejecting and Injecting Disturbances
Prof. Brent Gillespie, University of Michigan, Mechanical Engineering

abstracts

April 22 , Thursday
University of Michigan, Lurie Engineering Center, Level 4, GM Conference Room

Topics from Thrust Area 4

Injection System Controls for Prompt Cold Starting and Low White Smoke Emissions
Prof. Naeim A.Henein, Wayne State University

A New Robust Observer for the Accurate Computation of the Instantaneous Total Engine Friction
Prof. Nabil Chalhoub, Wayne State University

Bearing loading and lubrication in high power density diesel engines
Prof. Dinu Taraza, Wayne State University

Experimental insight in to Heavy Duty Diesel Engine Performance-Emissions Trade-Offs with EGR
Wesley Williamson, Dr. Zoran Filipi, The University of Michigan

Investigation of Advanced Injection Strategies for Low Emissions and High Power Density
Christos Chryssakis, Jonathan Hagena, Dr. Zoran Filipi, The University of Michigan

Advanced Components and Architectures for High Power Density Diesel Systems
Byungchan Lee, Andreas Malikopoulos, Dr. Zoran Filipi, The University of Michigan

No abstracts available.

April 29, Thursday
University of Michigan, Lurie Engineering Center, Level 4, GM Conference Room

Internal meeting for 10th ARC Conference preparations.

ARC Collaborative Research Seminar Series
Winter 2004

January 8, Thursday

Case Study Plans for ARC 10th Annual Conference

Each thrust area will give a brief presentation of case study ideas being considered for the 10th ARC Conference. These will be followed by discussion to assess potential connections and opportunites for integration.

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February 5, Thursday

Optimal System Design under Uncertainty
presented by Thrust Area 5

Design optimization is a decision-making process under the premise that complete information about the problem is available, and that the decisions can be implemented. These assumptions imply that optimization results are as good (and therefore useful) as the design and analysis models used to obtain them, and that they are meaningful only if they can be realized exactly. In reality, these assumptions do not hold. We are rarely in a position to represent a physical system without using approximations, have complete knowledge on all of its parameters, or control the design variables with high accuracy. It is therefore necessary to treat all quantities associated with uncertainty as stochastic. Fortunately, we are often able to postulate reasonable probability distributions and estimate statistical properties of these quantities. This enables us to formulate probabilistic optimization problems and use appropriate methods to solve them. In this talk, we will discuss some theoretical issues of design optimization under uncertainty as they arise when contrasted to deterministic optimization formulations, we will compare several methods for solving single-level probabilistic- (or chance-) constrained programming problems, and we will present a methodology for multi-level system design that utilizes different techniques for propagating uncertainties. We will also demonstrate the application of these methodologies on examples, and discuss interesting and helpful analogies to similar approaches in other disciplines such as manufacturing.

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February 19, Thursday

NVH Analysis for Higher Frequency Ranges and Structures With Uncertainties
presented by Thrust Area 3

In the low-frequency range, the analysis of noise, vibration, and harshness (NVH) for automotive structures is typically handled by finite element analysis (FEA). However, as the frequency range of interest increases, vibration wavelength decreases and modal density increases rapidly, which poses tremendous computational challenges. Furthermore, small parameter uncertainties, such as manufacturing tolerances, have a significant effect on the response of a structure at higher frequencies. Starting in what is often called the mid-frequency range, a deterministic finite element model represents—at best—one member in a population of structures with the same nominal design. Therefore, alternative and probabilistic methods are needed to handle the higher-frequency response of structures subject to parameter uncertainties. In this seminar, the state of the art of mid-frequency NVH analysis will be briefly reviewed, with an emphasis on key contributions that have been made by ARC researchers. Recent progress in substructure-based methods will be highlighted. Then, advances in uncertainty analysis of vibration response will be presented. In addition, the application of energy-based and hybrid FEA techniques to the simulation of automotive NVH across a broad frequency range will be demonstrated.

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March 18, Thursday

By Thrust Area 1:

Using the Milliken Moment Method and Dynamic Simulation to Evaluate Vehicle Handling
Presenter: Robert Hoffman (Graduate Student Research Assistant) U. of Michigan

For over 50 years, automotive engineers have struggled to define and quantify vehicle handling. In this presentation, a new metric will be presented to explicitly measure the stability and controllability of a vehicle using the Milliken Moment Method and dynamic simulation.
Vehicle handling metrics can be separated into two categories: those for closed-loop driving maneuvers, and vehicle level or open loop analysis. A new metric is described that combines open and closed loop methods using the Milliken Moment Method (MMM) and closed loop dynamic simulation. The MMM is a quasi-steady state test, typically done in computer simulation, which measures the reaction forces of a vehicle in a variety of states. Using a dynamic simulation of a lane change, a trajectory of the maneuver is mapped on the yaw moment – lateral force (CN-AY) diagram from the MMM for the entire time history. Using the MMM's capability to determine lateral force saturation for both the front and the rear tires, the amount of both stability (rear tire capability) and controllability (front tire capability) can be determined.
A design case study will be shown to illustrate the advantages and disadvantages of the proposed methodology. Also, an exploration of the relation of the MMM to conventional phase plane stability analysis will be discussed. Finally, the potential impact of this method on some of the Army's needs will be discussed.

Vehicle-Terrain Interaction Effects System Identification for Mobile Robot Planning and Control
Presenter: Dr. Gary Witus (Turing Associates, Inc.)

Military and security operations often require that agents move as quickly as possible, while avoiding collisions and rollover. People judge how fast they can drive, how sharply they can turn and how hard they can brake, based on a subjective sense of responsiveness to driving commands, ride quality, and prior experience in similar conditions. Vehicle handling is a product of the vehicle dynamics and the vehicle-terrain interaction. Off-road terrain is, in general, non uniform with significant local variation in elevation, friction, and resistance. The objectives are to develop real-time models and "on the fly" system identification methods for unmanned ground vehicles to assess driving on the current terrain in order to plan and execute extreme off-road maneuvers.

This effort is a Small Business Innovation Research (SBIR) project sponsored by TARDEC. It is not funded through the ARC, nor is it formally a part of the ARC. However the project is being coordinated with Thrust Area 1. The coordination objectives are to pose modeling and simulation issues from the perspective of applied research and development, and to initiate bi-directional technology exchange. Related Thrust Area 1 projects include off-road handling, control and stability limit modeling, terrain characterization and fusion of digital image and inertial measurement data. Other potentially related ARC projects include real-time tire-soil modeling (Thrust Area 3) and lightweight vehicle mobility (Thrust Area 5).

A Demonstration of Cooperative Mobility
Presenters: Professor John Luntz, Ashish Deshpande (Graduate Student Research Assistant), U. of Michigan

Physical cooperation among small vehicles is a solution to improving their mobility on rough terrain.

We are developing a system of a pair of small vehicles that cooperate to cross a gap. In past, we carried out static analysis of the system that provides guidelines for design improvements. We demonstrate the working of this system with hardware implementation. We have used two toy sized tanks (about 15 inches long) and have designed a mechanism which facilitates cooperation without additional actuation. The control laws are designed analytically based on a model of the vehicles and are implemented with an OOPic microcontroller. The hardware implementation demonstrates that a simple, low cost system can built to achieve physical cooperation among small vehicles to improve mobility. In addition, we have developed control laws which exploit the vehicle dynamics to facilitate physical cooperation to relaxing the design constraints

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April 1, Thursday

By Thrust Area 2:

Vehicle Interior Design for Accommodation and Safety:
Past, Present, and Future
Matthew P. Reed, University of Michigan, Transportation Research Institute

During the first 100 years of automobile design, vehicles changed dramatically while the people who drive them remained about the same. People are a little taller now, and markedly heavier, but they take up about the same amount of space and have similar preferences. One might think the methods for laying out vehicle interiors maximize driver accommodation and safety would be a mature discipline, but the rate of change in the theory and practice has never been greater.
This presentation will highlight some of the major contributions to the field over the past 60 years to provide a context for the current research being conducted in the ARC. The coupled trends toward greater use of computer technology and shortened product development cycles have emphasized the need for computer tools that capture human dimensions, behavior, and preferences. These digital human models and the science that underlies them are the major focus of current research activity.

Haptic Interface for Improving Driver-Vehicle Performance:
Rejecting and Injecting Disturbances
Prof. Brent Gillespie, University of Michigan, Mechanical Engineering

High performance from a driver-vehicle system makes certain demands on the driver's cognitive and physical capabilities that can be reduced with the application of control and haptic interface. This presentation will highlight two projects: one aimed at reducing the effects of vibration feedthrough, and the other aimed at reducing perceptual and cognitive workload on the driver. Haptic interface is used to either reject disturbances, or assist with the driving task in such a way that the driver remains in-the-loop, still able to exercise authority (in a way, inject disturbances). Results from human subject experiments will be presented to demonstrate the methods and contributions.

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April 22 , Thursday

Abstracts are not available.

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April 29, Thursday

Internal meeting for 10th ARC Conference preparations.

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