Mechanical Engineering/College of Engineering and Applied Sciences
MECHANICAL ENGINEERING DEPARTMENTAL SEMINAR

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Center for Advanced Vehicular Systems
Mississippi State University MS 39762

Title: **Modeling and Simulation Strategy for Fuel Cell Performance Improvements**

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Abstract

Modeling and simulation of fuel cells can be a great tool for understanding the fundamentals of fuel cell operation, optimizing their design and developing control and diagnostics strategies. However, there are two main challenges facing the fuel cell modeling and simulation for the purpose of design optimization, control and diagnostics. The first is validation of the simulation. The applicability of the models used for each component, the parameters used in each model, and the model assumptions must be carefully examined. In addition, the data used to validate the simulation results should be systematically collected to ensure repeatability and reliability. The second challenge is that the time required for executing the simulation should be feasible for a required mission. No existing PEM fuel cell simulation software program meets this challenge. To address these issues, the Center for Advanced Vehicular Systems (CAVS) initiated fuel cell modeling and simulation efforts a few years ago. These efforts draw upon the strong simulation capabilities developed at the High Performance Computing Collaboratory (former Engineering Research Center) and also upon collaborations with other departments such as the Dave C. Swalm School of Chemical Engineering and the Department of Chemistry. A multi-resolution fuel cell simulation framework has been developed. Using a modular design for each component, the time required for model implementation and upgrade has been reduced. Further, the multi-resolution approach also makes feasible the simulation of industrial size fuel cells for operation and design optimizations. A state-of-the-art experimental test bed, including impedance spectroscopy and mass spectroscopy, has been established for the validation efforts. Fuel cell fabrication capabilities have also been developed to serve the purpose of model validation and design of model-based control and diagnostics strategies. The future research directions that we are pursuing in the area of alternative energy will also be discussed.

Biography

Dr. Charlie Wu works as a Research Assistant Professor at the Center for Advanced Vehicular Systems, part of the High Performance Computing Collaboratory at Mississippi State University. He received his MS and Ph.D. degrees in Aerospace Engineering from Georgia Institute of Technology in 1994 and 1999 respectively, and his BS degree in Mechanics from Peking University, China in 1992. Dr. Wu's early research interests were in modeling and simulation of turbulent reactive flows using large eddy simulation techniques with applications ranging from clean combustor design to investigation of environmental impact of jet plumes. His recent research interests have been in the area of zero or ultra low energy devices such as fuel cells, batteries and related balance of plant systems including fuel reformers. He leads efforts in developing a multi-resolution, multi-scale fuel cell /battery simulation suite for the optimal design, control and diagnosis of fuel cell /battery systems. He also leads the efforts in the development of fuel cell test systems for evaluating and analyzing the performance of fuel cells with powers ranging from a few watts to kilowatts. Recently, Dr. Wu works collaboratively with chemical engineers, electrical engineers, chemists and physicists on campus in a project sponsored by US Army to study and improve the performance of a fuel cell/rechargeable battery hybrid system that employs fuel cells as the charger of the rechargeable batteries. Dr. Wu is also a primary investigator of a project sponsored by a major automobile company for development of efficient numerical models to optimize the vehicle HVAC system designs.

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