Modeling of an Extended Powertrain with regard to Gear Shift Processes in Automatic Transmissions

Relevance to the Automotive Industry:	In order to develop new control algorithms aimed towards increasing comfort in passenger cars, precision in simulation models describing load change phenomena and shift processes are required. Current drivetrain control models consider backlash, however, they are only based on differential equations describing the main components of the powertrain. Because of this, shift processes, vehicle pitching, and tire slip are not included in those models, and the influence on drivetrain oscillations remains unclear.	
Research Location:	TUD Institute for Mechatronic Systems (IMS)	
Homepage (Engl.):	http://www.ims.tu-darmstadt.de	
Faculty Mentor:	Prof. Dr.-Ing. Stephan Rinderknecht	
Faculty Mentor Email:	rinderknecht@ims.tu-darmstadt.de	
Graduate Mentor:	Leonard Yousif, M.Sc. Ivan Rot, M.Sc.	
Graduate Mentor Email:	yousif@ims.tu-darmstadt.de rot@ims.tu-darmstadt.de	
Project Description: May 21 - Jul 12, 2013; (8 weeks, 40h/week)	The TUD Institute for Mechatronic Systems (IMS) is working to understand how load changes and shift processes influence drivetrain oscillations in automotive powertrains. Hence, two NSF REU students will work with their graduate mentors to extend and modify an existing backlash afflicted powertrain. The main focus of this research is based on the analysis of the influence of the shift dynamic on the drive train oscillations at different operation points. The objective is for the students to develop a model using Matlab/Simulink that considers the powertrain, including an automatic gearbox. This joint effort will be organized in three phases: PHASE 1: During the first two weeks, the two NSF REU students will become familiarized with the subject and scope out the specifics of the project. They will be provided with a several model components that they need to assemble and enhance to produce the desired complete model during this project. PHASE 2a: During the next 4 weeks, one NSF REU student will first focus on connecting together the individual models in Simulink in a modular form. Then the model will need to be parameterized with an appropriate optimizing algorithm and validated using available measurement data. The influence of the individual model enhancements should be analyzed and documented. PHASE 2b: Simultaneously, the other NSF REU student will focus on transforming the relevant differential equations of these model components into a (hybrid) state-space model, described as a single compiled Matlab function. This new function-based state-space model will then need to be compared with the usual Simulink model with regards to performance and robustness. PHASE 3: During the final two weeks, the two NSF REU students will coordinate results and generate a presentation, report, and a conference paper.	
Target publications:	• Vehicle System Dynamics • International Conference Vehicle Dynamics • SAE World Congress 2014	
Necessary Skills/ Knowledge:	• Matlab/Simulink, system modeling (PDE/ODE), and automotive engineering	
Desirable Skills/ Knowledge:	• Student #2: Strong programming skills	
Additional Online Resource(s):		

NSF REU Students must have completed at least two semesters of engineering studies prior to the proposed summer research, and they must have at least one semester remaining before they can earn their BS in Engineering.