Todd D. Murphey (t − murphey@northwestern.edu), Mechanical Engineering, Northwestern University, 2145 Sheridan Road, Evanston, IL 60208, *Controllability and Kinematic Reductions for Overconstrained Mechanical Systems*

Controllability and reduction theory have both been extensively studied for smooth mechanical systems. However, nonsmooth mechanical systems have not received as much attention in this context. In particular, systems can potentially have more nominal constraints (both holonomic and nonholonomic) than they have degrees of freedom, thereby ensuring that at least some of these constraints cannot be satisfied. In some cases, particularly those involving friction, determining which constraints are satisfied can be very difficult and sensitive to uncertainty in the model. For instance, the Mars rover has sufficiently many nonholonomic constraints that the only motion it has which satisfies all of its constraints is the straight forward motion. Once the wheels are turned, some wheels must slip. At the same time, we can expect the Mars rover to share characteristics with the kinematic car studied frequently in the nonlinear control community. Properties such as controllability and reducibility are well established for the kinematic car, and we would like them to be useful for the rover as well. We have been developing tools for the purpose of analysis and control design for overconstrained systems (such as the Mars rover and some MEMS problems). I'll give an overview of our recent results including the use of set-valued Lie brackets for controllability analysis and a necessary and sufficient condition for kinematic reducibility for nonsmooth mechanical systems.