Geometric Control of Mechanical Systems

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This talk will outline a comprehensive set of modeling, analysis and design techniques for a class of mechanical systems. We concern ourselves with **simple mechanical control systems**, that is, systems whose Lagrangian is kinetic energy minus potential energy. Example devices include robotic manipulators, aerospace and underwater vehicles, and mechanisms that locomote exploiting nonholonomic constraints.

Borrowing techniques from nonlinear control and geometric mechanics, we propose a coordinate-invariant control theory for this class of systems. First, we take a Riemannian geometric approach to modeling systems defined on smooth manifolds, subject to nonholonomic constraints, external forces and control forces. We also model mechanical systems on groups and symmetries. Second, we analyze some control-theoretic properties of this class of systems, including controllability, averaged response to oscillatory controls, and kinematic reductions. Finally, we exploit the modeling and analysis results to tackle control design problems. Starting from controllability and kinematic reduction assumptions we propose some algorithms for generating and tracking trajectories.

Journal and conference article are available electronically at `http://motion.csl.uiuc.edu` and `http://penelope.mast.queensu.ca`

- A. D. Lewis and R. M. Murray. Configuration controllability of simple mechanical control systems. *SIAM Journal on Control and Optimization*, 35(3):766–790, 1997
- F. Bullo. Averaging and vibrational control of mechanical systems. *SIAM Journal on Control and Optimization*, 41(2):542–562, 2002
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This talk surveys the results that will appear in

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