Contribution ID: **22** Type: **not specified**

Computation of the flat output for a class of underactuated Lagrangian systems

The flatness-based approach is a powerful method for solving a variety of control theoretic problems such as motion planning, trajectory tracking, and stabilization of nonlinear systems. This method is limited to control systems with endogenous linearizing feedback, and the idea of parameterizing the trajectories and inputs of such systems in terms of the flat output and its derivatives goes back to the works of Hilbert and Cartan on under-determined differential equations. In general, the problem of checking flatness remains open, although many important classes of mathematical models, including fully-actuated Lagrangian systems, are known to be flat.

In this talk, we consider a nonlinear Lagrangian mechanical system with a scalar input. We are interested in computing a flat output in a neighborhood of unstable equilibrium of this system. An analytic solution of the system of partial differential equations that defines the flat output is presented. The leading terms of the obtained flat output are compared with the Brunovsky output for the linearized problem, for which an efficient computation algorithm is available.

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Track Classification: Talks