A new Lagrangian approach to control affine systems with a quadratic Lagrange term

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In this work, we consider optimal control problems for mechanical systems with fixed initial and free final state and a quadratic Lagrange term. Specifically, the dynamics is described by a second order ODE containing an affine control term. Classically, Pontryagin's maximum principle gives necessary optimality conditions for the optimal control problem. For smooth problems, alternatively, a variational approach based on an augmented objective can be followed. Here, we propose a new Lagrangian approach leading to equivalent necessary optimality conditions in the form of Euler-Lagrange equations. Thus, the differential geometric structure (simular to classical Lagrangian dynamics) can be exploited in the framework of optimal control problems. In particular, the formulation enables the symplectic discretisation of the optimal control problem via variational integrators in a straighforward way.

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