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Exploration of Kinematic Optimal Control on the Lie Group $SO(3)$

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Abstract:

We investigate a generalization of the infinite time horizon linear quadratic regulator (LQR) for systems evolving on the special orthogonal group $SO(3)$. Using Pontryagin's Maximum Principle, we derive the necessary conditions for optimality and the associated Hamiltonian equations. For a special class of weighting matrices, we show that the optimal feedback can be computed explicitly and we prove that the non differentiable value function is the viscosity solution of an appropriate Hamilton-Jacobi-Bellman equation on $SO(3)$. For arbitrary positive definite weighting matrices, numerical simulations allow us to explore the relationship between the optimal trajectories and weighting matrices, and in particular to highlight nontrivial non differentiability properties of the value function.