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Riemannian formulation of Pontrygin's principle for robotic manipulators

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SUMMARY

In this work, we consider mechanical systems for which the mass tensor is considered as a metric quadratic form in a Riemannian manifold. Optimal control evolution becomes a covariant second-order ordinary differential equation featuring the Riemann curvature tensor that constrains the command variable. The cost functional can be invariant or not in this geometrical framework (see [1]). In the context of invariance, Pontryagin's principle introduces adjoint variables which are the first-order representation of the second-order control variable evolution equation. Numerical tests (see [2]) show that the proposed invariant cost functionals, as compared to their non-invariant versions, lead to lower joint power consumption and narrower joint angular amplitudes during motion.

Keywords: optimal control, robotics, Riemannian geometry, Riemann curvature tensor, invariance, multibody dynamics

AMS Classification: 49S05, 51P05; 53A35, 70E60

References

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