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Combining the Pontryagin's Principle and Hamilton-Jacobi-Bellman Equation for Constrained Optimal Control

The H2020 project SeaClear (SEarch, identificAtion and Collection of marine Litter with Autonomous Robots) aims to employ a team of robots to clean the oceans from litter. To account for our problem settings, we apply novel results for infinite- and finite-horizon optimal control problems with nonlinear dynamics and constraints. We use the Valentine transformation to convert a constrained optimal control problem into an unconstrained one and show uniqueness of the value function to the corresponding Hamilton-Jacobi-Bellman (HJB) equation. From there, we show how to approximate the solution of the initial (in)finite-horizon problem with a family of solutions that is Γ -convergent. Optimal solutions are efficiently obtained via a solver based on Pontryagin's Principle (PP). The proposed methodology is demonstrated on the path planning problem using the full nonlinear dynamics of an unmanned aerial vehicle (UAV) and autonomous underwater vehicle (AUV) involving state constraints in 3D environments with obstacles.