Summary: The weighted essentially non-oscillatory (WENO) methods are popular and effective spatial discretization methods for nonlinear hyperbolic partial differential equations. Although these methods are formally first-order accurate when a shock is present, they still have uniform high-order accuracy right up to the shock location. In this paper, we propose a novel third-order numerical method for solving optimal control problems subject to scalar nonlinear hyperbolic conservation laws. It is based on the first-discretize-then-optimize approach and combines a discrete adjoint WENO scheme of third order with the classical strong stability preserving three-stage third-order Runge-Kutta method SSPRK3. We analyze its approximation properties and apply it to optimal control problems of tracking-type with non-smooth target states. Comparisons to common first-order methods such as the Lax-Friedrichs and Engquist-Osher method show its great potential to achieve a higher accuracy along with good resolution around discontinuities.

MSC:

49M25 Discrete approximations in optimal control
65L06 Multistep, Runge-Kutta and extrapolation methods for ordinary differential equations
65M22 Numerical solution of discretized equations for initial value and initial-boundary value problems involving PDEs
35L65 Hyperbolic conservation laws

Keywords:
nonlinear optimal control; discrete adjoints; hyperbolic conservation laws; WENO schemes; strong stability preserving Runge-Kutta methods

Full Text: DOI

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