High-Order Shock Capturing for Computational Aeroacoustics

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Jet noise is not only an annoyance to passengers and communities near airports, it is a major contributor to hearing loss in veterans who served on aircraft carriers, as well as a significant limiting factor for the growth of commercial airlines. High-fidelity large eddy simulation (LES) is an important tool for analyzing and predicting jet noise; however the utilized non-dissipative high order finite difference schemes produce instabilities at shock waves. Schemes for capturing shock waves, however, are more dissipative and do a poor job preserving turbulent structures and acoustic waves. To maximize the strengths of both approaches, hybrid methods utilize shock capturing locally where the flow is discontinuous and traditional LES methods over the remaining regions. In this study, a sixth-order compact scheme is hybridized with a weighted essentially non-oscillatory (WENO) method for local shock-capturing. Furthermore, improvements are made to the dissipative and dispersive qualities of WENO. Optimized bandwidth resolution and reduced nonlinearity are found to improve resolution of flow structures passing through shocks on standard test problems. Additionally, proper detection of shock waves is critical to overall performance of hybrid schemes, so several approaches are examined. Superior efficiency and accuracy are obtained through careful selection of shock wave detectors.