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Dissertation Abstract

"You can't live in a smooth world anymore." C.W.Shu

Discontinuous functions have become an important part of numerical analysis. Compressible flows make up a large part of the problems faced today. Supersonic jets and engines, acoustic waves, and combustion are examples of problems with non–smooth solutions. In order to perform numerical calculations for these problems, new techniques are needed to analyze discontinuous functions and to compute solutions to PDEs for discontinuous solutions. This dissertation describes two new techniques.

The first technique locates discontinuities in data. While other people work to overcome Gibbs' Phenomena, the shock location technique benefits from the oscillations associated with Gibbs' Phenomena. The first half of this technique approximates the shock location to within a grid point. Combining this estimate with the Gegenbauer Polynomial reconstruction of Gottlieb et. al. will recover exponential accuracy of a discontinuous function from its Fourier coefficients. The second half refines the first approximation to provide a highly accurate estimate of the shock location. This estimate will provide a highly accurate expansion of the discontinuous functions using sawtooth and trigonometric functions.

The second technique addresses a problem with Essentially Non–Oscillatory (ENO) schemes. While ENO schemes are excellent high order schemes which avoid oscillations near shocks, they require many *if–then* statements to compute the flow in and out of each cell. The solution proposed here does not reduce the number of *if–then* statements for each cell, instead reduces the number of computational cells. The method determines an optimal computational grid which minimizes the number of computations and still maintains equivalent truncation errors throughout the domain. Maintaining the optimal computational grid is done by dividing and joining cells. The resulting method greatly reduces the number of computations and cpu time in 1–dimension. Further work will be to implement this scheme in 2–dimensions.