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High-order wavelet reconstruction/differentiation filters and Gibbs phenomena RICHARD LOMBARDINI, Department of Physics and Environmental Science, St. Mary's University (San Antonio, TX), RAMIRO ACEVEDO, ALEXANDER KUCZALA, KERRY KEYS, CARL GOODRICH, BRUCE JOHNSON, Department of Chemistry, Smalley-Curl Institute and Laboratory for NanoPhotonics, Rice University — We have developed an efficient method to accurately represent 1D or 2D, smooth or discontinuous, solutions to partial differential equations (PDE's), such as Schrodinger or Maxwell's equations, in an orthogonal Daubechies wavelet basis. This is a crucial step in the future development of a wavelet method that solves these PDE's. There are two main developments from this research. First, a reconstruction transform for smooth functions, discovered in previous works [Keinert and Kwon (1997) and Neelov and Goedecker (2006)], is generalized in order to develop a systematic way of tuning its error. This transform converts the wavelet basis representation back to the actual point values of the function. Since this reconstruction can far exceed the wavelet approximation order, it is shown that shorter wavelets can be used while maintaining a high-order accuracy resulting in an increase of computational efficiency. Second, a new "truncated" reconstruction transform is developed, using pieces of wavelets, or "tail functions", which can be applied to discontinuous functions. Not only does it avoid the wavelet Gibbs phenomenon, but also maintains a tunable accuracy similar to the smooth function case.

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