The use of local truncation error for the optimal increase in accuracy of the linear finite and quadratic isogeometric elements used for the heat and wave equations

Bikash Dey

Texas Tech University

Abstract

A new numerical approach is developed to increase the accuracy of the linear finite and quadratic isogeometric elements used for the time dependent heat and wave equations as well as for the time independent Laplace equation. By minimizing the order of the local truncation error in the stencil equation for structured rectangular grid, the order of the linear finite elements is increased from the order 2 to the order 4 for the heat and the wave equations and from the order 2 to the order 6 for the Laplace equation. At the same computational cost the numerical results obtained by the new approach is more accurate than those obtained not only by the linear finite elements but also by the quadratic finite elements. Applying the same approach to the quadratic isogeometric elements, the order of accuracy is increased from the order 4 to the order 8 for the heat and the wave equations and from the order 6 to the order 18 for the Laplace equation on a square grid. As these improvements are made by minimizing the order of the local truncation error of the stencil equation, the order of accuracy cannot be improved anymore and is optimal for the linear finite and quadratic isogeometric elements.