Switching between dimensions in spectral collocation method of solution for partial differential equations

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The key feature in the numerical solution of the differential equations involves the generation of a linear algebraic system of equations from the discretization process. The system of equations is, in turn, solved directly using any mathematics application that supports matrix computations. The complexity of assembling coefficient matrices of the linear algebraic system of equations especially when solving partial differential equations (PDES) is proportional to the number of independent variables involved. Considering a purely spectral collocation type of discretization, numerical solutions for two-dimensional PDEs exists but those of three-dimensional problems are missing. In this work, we aim at demonstrating the construction of a numerical scheme for solving three-dimensional problems using a purely Chebyshev spectral collocation method. First, we review the description of numerical schemes that is well-known for two-dimensional (21)) case, then explore a transition to the three-dimensional (3D) problems. We test the practical applicability of the numerical schemes by solving 21) and 3D problems reported in the literature. Pertinent properties of accuracy, computational efficiency, stability, and convergence of the numerical schemes are analyzed and discussed in graphical and tabular forms.

Keywords: Spectral Collocation Method; Two and Three Dimension; Partial Differential Equations; Chebyshev-Gauss-Lobbato Points.