On the Solution of Boundary Value Problems Blended with Hybrid Block Methods

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Abstract : This paper explores the application of hybrid block methods for solving boundary value problems (BVPs), which are prevalent in various fields such as science, engineering, and applied mathematics. Traditionally, numerical approaches such as finite difference and shooting methods, often encounter challenges related to stability and convergence, particularly in the context of complex and nonlinear BVPs. To address these challenges, we propose a hybrid block method that integrates features from both single-step and multi-step techniques. This method allows for the simultaneous computation of multiple solution points while maintaining high accuracy. Specifically, we employ a combination of polynomial interpolation and collocation strategies to derive a system of equations that captures the behavior of the solution across the entire domain. By directly incorporating boundary conditions into the formulation, we enhance the stability and convergence properties of the numerical solution. Furthermore, we introduce an adaptive step-size mechanism to optimize performance based on the local behavior of the solution. This adjustment allows the method to respond effectively to variations in solution behavior, improving both accuracy and computational efficiency. Numerical tests on a variety of boundary value problems demonstrate the effectiveness of the hybrid block methods. These tests showcase significant improvements in accuracy and computational efficiency compared to conventional methods, indicating that our approach is robust and versatile. The results suggest that this hybrid block method is suitable for a wide range of applications in real-world problems, offering a promising alternative to existing numerical techniques.
Keywords : hybrid block methods, boundary value problem, polynomial interpolation, adaptive step-size control, collocation methods