SOLVING BOUNDARY VALUE PROBLEMS USING THE SINC COLLOCATION METHOD WITH DERIVATIVE INTERPOLATION

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Abstract

We consider the application of a Sinc-Collocation approach based on first derivative to solve boundary value problems (BVPs) arising from fluid dynamics related models. Even in the presence of singularities that are often present in fluid dynamics problems involving boundary layers, the Sinc-collocation technique provides exponentially convergent approximations including those posed on unbounded domains. The typical Sinc strategy is to start with the Sinc interpolation of the unknown function and to obtain its first and higher derivatives through successive differentiation in order to transform the BVP into discrete system which has a basic drawback as it is well-known that numerical differentiation process is highly sensitive to numerical errors. However, the first derivative interpolation approach presented in this paper uses Sinc-based integration to approximate the unknown has advantages over the customary Sinc method since integration has the effect of damping out numerical errors that are inherently present in numerical approximations. Moreover, the approach presented in this paper preserves the appropriate endpoints behaviors of the Sinc bases, resulting in a highly accurate and computationally efficient method [1]. The accuracy and stability of the proposed method is demonstrated through several fluid dynamics model problems including a hydrodynamic model of wind-driven currents and the Blasius and nonlinear BVPs [2]. It is further shown that the proposed approach is more accurate and computationally efficient than those obtained by other approaches.

Keywords: Boundary Value Problems, Sinc-Collocation, Fluid Dynamics

References

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