

METHOD OF DIRECTLY DEFINING THE INVERSE MAPPING FOR SOLUTIONS OF SINGULAR BOUNDARY VALUE PROBLEMS

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Traditionally, researchers widely used perturbation and asymptotic techniques to gain analytical approximations for nonlinear problems. When nonlinearity becomes strong, perturbation and asymptotic approximations of nonlinear problems often fail. The Homotopy Analysis Method (HAM) was proposed to solve highly nonlinear problems. Unlike perturbation techniques, the HAM does not depend on any small or large physical parameters, and it gives a convenient way to guarantee the convergence of solution series. HAM allows for great freedom in the selection of base functions, initial guesses, and linear operators. However, to find unknown functions, one should calculate the inverse of the linear operator. In scientific computing, calculating the inverse operator for the differential equation consumes a significant amount of time. To overcome this obstacle, a new approach, the Method of Directly Defining inverse Mapping (MDDiM), was proposed with the freedom to directly choose the inverse linear mapping. Later, this method was extended to systems of nonlinear ordinary differential equations. In this study, MDDiM was extended and applied to obtain an approximation series solution for a class of nonlinear singular boundary value problems. The singularity in the problem makes it more challenging to solve compared to other nonlinear boundary value problems. Since the inverse operator was directly defined, the series solutions were obtained using less CPU time, low error, and less complicated terms. The proposed technique produced a highly accurate and reliable solution to the problems within an error range of 10^{-5} to 10^{-9} in a few iterations. Therefore, it can be concluded that MDDiM is easy to use and accurate.

Keywords: Homotopy analysis method, Method of Directly Defining inverse Mapping, Singular boundary value problems