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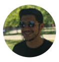
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# On an efficient hybrid method for solving singularly perturbed difference-differential equations exhibiting turning layer behavior

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## Abstract

Singularly perturbed differential equations that involve positive small perturbation parameter(s) $0<\varepsilon\ll 1$ as the multiplier to the highest order derivative term are important concepts of mathematical and engineering sciences. As $\varepsilon\to 0$, solution of this kind of problems exhibits rapid changes that we call *boundary layer behavior* since the order of the equation reduces and it is a well-known fact that classical numerical methods are often insufficient to handle them. One may encounter with singular perturbation problems in almost all science branches. Some application areas may be given as modelling of fluid flow problems at high Reynold numbers, electrical and electronic circuits/systems, nuclear reactors, astrophysics problems, control theory problems, combustion theory, quantum mechanics, signal/image processing, etc.

This study concerns with finding approximations to the solution of singularly perturbed two-point boundary value problems that exhibit interior layer (turning point) behavior. To achieve this, an efficient and easy-applicable asymptotic-numerical hybrid method is employed. The asymptotic part of the method is based on Successive Complementary Expansion Method (SCEM) and the numerical part is based on finite difference approximations that applies a Lobatto IIIa formula. As the first stage of present method, an asymptotic approximation to the solution of the singularly perturbed problem is proposed using SCEM with the help of stretching variable transformation and later the resulting two-point boundary value problems that come from the SCEM procedure are solved using the numerical procedure. Numerical experiments show that the present method is well-suited for solving this type of problems.

***Keywords:*** **Asymptotic approximation, Delay differential equations, Singular perturbation, Turning point**

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