Rapid Computation Using Multiple Scales

Rudrapatna V. Ramnath
Massachusetts Institute of Technology,
Cambridge, MA 02139, U.S.A.

Abstract

In developing the numerical computations on a wide range of physical and engineering phenomena, it is often found that standard numerical methods can be highly time-intensive and may require large amounts of computer time, which can be expensive. This is especially true in systems which exhibit a mixture of rapid and slow behaviors. Straightforward attempts to speed up the computation are often unsuccesful because of increase of errors. This is because the integration is carried out on inappropriate variables. This paper presents an approach based on the asymptotic technique of multiple scales to improve the computational efficiency in a class of such systems. The technique enables us to find the optimum fast and slow variables upon which the solutions are described in a relatively simple manner. This results in an increase of computational speed. Further, the rapid and slow variations inherent in the complex system dynamics are systematically separated, leading to enhanced insight. The approach is demonstrated in the context of a class of problems in space flight of an earth satellite.

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