

Trajectory piece-wise quasi-linear approximation of large non-linear dynamic systems

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Abstract: In this work we extend the trajectory piece-wise linear (TPWL) approximation of large, non-linear and input-affine dynamical systems to non-linear systems with non-linear input operators. The new technique is called the trajectory piece-wise quasi-linear (TPWQ) approximation. We explain the motivation for this technique in light of previously reported under-performance of the TPWL method and show that its a more general alternative, developing it is formulation and demonstrating its effectiveness in the process.

Keywords: large dynamical systems; model order reduction; MOR; non-linear systems; simulation; modelling; trajectory piece-wise linear; TPWL; quasi-linear; trajectory piece-wise quasi-linear; TPWQ.

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1 Introduction

Realistic and accurate mathematical-description of complex natural and artificial processes gives rise to dynamic system models of large dimensions. The simulation of such models requires expenditure of considerable amounts of computational resources and time. Additionally, the simulation may have to be carried out repeatedly, e.g., for

determination of optimal design or operating parameters. Approximation of the large systems thus being crucial, model order reduction (MOR) techniques are a means to realise this objective. They result in a dimensionally reduced system with input-output response characteristics similar to the large dynamic system.

It has been observed that many large linear time invariant (LTI) systems are poorly controllable and observable and their