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Orthogonal Functions Approach for Model Order Reduction of LTI and LTV Systems

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Abstract: In this paper, we elaborate new methods for model-order reduction of linear time invariant (LTI) and time variant (LTV) systems by using orthogonal functions. These techniques which can be efficiently applied in SISO (single-input single-output) and MIMO (multi-input multi-output) cases are based on the projection of the system parameters and variables on an orthogonal functions basis. The useful properties of the orthogonal functions basis such as operational matrices combined with the Kronecker product permit the conversion of the system differential equations into algebraic ones allowing the determination of the reduced model parameters.

Keywords: *model-order reduction; LTI and LTV systems; orthogonal functions; operational matrices; shifted Legendre polynomials.*

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1 Introduction

In all engineering fields, an accurate modeling is necessary to have good results in control and analysis of complex systems. If the system is internally complex, the use of modern control techniques such as optimal control, μ-synthesis or robust control may lead to a controller having a comparable order as the considered system. In order to study, simulate and control those systems and to avoid time consuming in computing procedures, it is convenient and sometimes necessary to reduce their complexity, preserving the input-output behavior.

The primary problem of interest in model reduction is the efficient computation of an accurate low-order model approximating a given dynamical system. The low-order model must match the original one in some sense. However, the conditions of accuracy, speed,

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