Ultra-Accurate Isogeometric Structural Vibration Analysis with Novel Higher Order Mass Formulations

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Abstract

The isogeometric analysis introduced by Hughes et al [1] has received significant attention during the past few years. In this study an ultra-accurate isogeometric structural vibration analysis is presented [2]. The key ingredient of the proposed methodology is the development of novel higher order mass matrices which are realized though a new two-step mass construction method. Firstly by using the standard consistent mass matrix a special reduced bandwidth mass matrix with equal order of accuracy is designed under the mass conservation constraint. A mixed mass matrix follows through a linear combination of the consistent mass matrix and the reduced bandwidth matrix. Subsequently the desired higher order mass matrix is then rationally deduced from the mixed mass matrix by optimizing the linear combination parameter in order to minimizing the frequency error. It turns out that the orders of accuracy associated with the proposed higher order mass matrices are two orders higher than those of their corresponding consistent mass formulations for the classical rod and membrane vibration problems. The numerical results well confirm the theoretically derived optimal accuracy orders for structural vibration frequencies. Meanwhile, appropriate imposition of essential boundary conditions is also briefly discussed within the context of isogeometric analysis [3].

Keywords: Structural vibration, Isogeometric Analysis, Higher order mass matrices, Frequency error

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