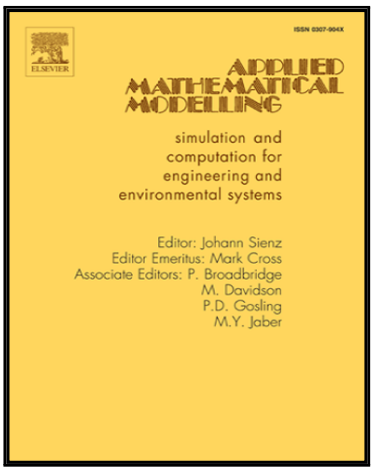

Response determination of linear dynamical systems with singular matrices: A polynomial matrix theory approach

Efstathios N. Antoniou, Athanasios A. Pantelous,
Ioannis A. Kougioumtzoglou, Antonina Pirrotta

PII: S0307-904X(16)30540-6
DOI: 10.1016/j.apm.2016.10.025
Reference: APM 11386

To appear in: *Applied Mathematical Modelling*

Received date: 9 April 2016
Revised date: 24 August 2016
Accepted date: 11 October 2016

Please cite this article as: Efstathios N. Antoniou, Athanasios A. Pantelous, Ioannis A. Kougioumtzoglou, Antonina Pirrotta, Response determination of linear dynamical systems with singular matrices: A polynomial matrix theory approach, *Applied Mathematical Modelling* (2016), doi: 10.1016/j.apm.2016.10.025

Response determination of linear dynamical systems with singular matrices: A polynomial matrix theory approach

Efstathios N. Antoniou[a], Athanasios A. Pantelous[b,*], Ioannis A. Kougioumtzoglou[c], Antonina Pirrotta[d]

[a] *Alexander Technological Education Institute of Thessaloniki, Department of Information Technology, 57400 - Thessaloniki, Greece*

[b] *University of Liverpool, Department of Mathematical Sciences and Institute for Risk and Uncertainty Liverpool, United Kingdom*

[c] *Columbia University, Department of Civil Engineering and Engineering Mechanics, 500 W. 120th St., 610 Mudd, New York, NY 10027*

[d] *Universita di Palermo, Dipartimento di Ingegneria Civile, Ambientale, Aerospaziale, dei Materiali (DICAM), Italy and University of Liverpool, Department of Mathematical Sciences Liverpool, United Kingdom*

Abstract

An approach is developed based on polynomial matrix theory for formulating the equations of motion and for determining the response of multi-degree-of-freedom (MDOF) linear dynamical systems with singular matrices and subject to linear constraints. This system modeling may appear for reasons such as utilizing redundant DOFs, and can be advantageous from a computational cost perspective, especially for complex (multi-body) systems. The herein developed approach can be construed as an alternative to the recently proposed methodology by Udwadia and coworkers, and has the significant advantage that it circumvents the use of pseudoinverses in determining the system response. In fact, based on the theoretical machinery of polynomial matrices, a closed form analytical solution is derived for the system response that involves non-singular matrices and relies on the use of a basis of the null space of the constraints matrix. Several structural/mechanical systems with singular matrices are included as examples for demonstrating the validity of the developed framework and for elucidating certain numerical aspects.

Keywords: Linear Constrained Structural/Mechanical Systems, Multibody Systems, Singular Matrix, Closed Form Solution, Polynomial Matrix Theory.

*Corresponding author

Email addresses: antoniou@it.teithe.gr (Efstathios N. Antoniou), A.Pantelous@liverpool.ac.uk (Athanasios A. Pantelous), ikougioum@columbia.edu (Ioannis A. Kougioumtzoglou), antonina.pirrotta@unipa.it, pirrotta@liverpool.ac.uk (Antonina Pirrotta)