The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

# Inverse Dynamics of Geometrically Exact Beams

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**Keywords**: *Inverse dynamics, Feedforward control, Simultaneous space-time integration, Trajectory tracking, Geometrically exact beam formulation.*

The inverse dynamics of spatially discrete mechanical systems is concerned with searching forces acting on the system such that a finite number of selected points of the system follow a prescribed motion. The motion of such systems may be governed by ordinary differential equations (ODEs) subjected to algebraic servo constraints. A numerically stable solution of the resulting differential-algebraic equations (DAEs) is thereby depending decisively on the differentiation index of the DAEs. Due to the non-standard nature of the servo constraints, the resulting DAEs are in general characterized by a high differentiation index. To get a stable numerical solution it is inevitable to reduce the index (cf. [1] and references therein).

In principle, the same approach is applicable to the inverse dynamics of spatially continuous systems. For this purpose, the underlying partial differential equations (PDEs), which govern the motion of the flexible system, can be discretized in space by applying common methods such as the finite element method. Unfortunately, the differentiation index of the resulting DAEs often increases with the refinement of the spatial discretization. This significantly restricts the applicability of the semi-discretization approach. In contrast to that, we've recently shown in [2] that a simultaneous discretization in space and time is much better suited to successfully solve the inverse dynamics problem under consideration.

After giving a brief repetition of the simultaneous space-time discretization strategies for the inverse dynamics of spatially continuous systems introduced in [2], we will show that the simultaneous space-time approach is also applicable to the inverse dynamics of geometrically exact beams. Numerical examples underpin the relevance of the presented methods.

## REFERENCES

[1] R. Altmann, P. Betsch and Y. Yang, Index reduction by minimal extension for the inverse dynamics simulation of cranes. *Multibody System Dynamics*, Vol. **36**(3), pp. 295–321, 2016.

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