Time varying mass and inertia in paper winding multibody simulation

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Abstract

This paper will discuss Modelica's unprecedented flexibility for multi-body simulations. Classical multi-body simulation has as a prerequisite constant mass and inertia for deriving the equations of motion for rigid bodies. However, there are industry applications, like the control development of paper winding, that require time dependency of mass and inertia. In these applications mass and inertia cannot be assumed constant and will thus constitute part of the differential equations system by means of introducing mass and inertia as states.

Introducing mass and inertia as states, rather than parameters, requires reformulation of the Newton/Euler formulation of the body model component in the Modelica mechanics multi-body library.

A successful new body model formulation has been created and is applied in an industrial example system model.

Keywords: dynamic mass, dynamic inertia, multi-body, mechanics, paper winding, vibration, FMI

Introduction

In the paper industry winding machines are used to reduce the inconveniently large paper roll into smaller paper rolls of just a few tons. The dynamic properties of these machines are heavily influenced by the change in mass and inertia of the paper rolls while winding and unwinding [1, 2]. The time varying resonance frequencies of the system will put limits on the machines throughput.

The paper industry has an interest to investigate the dynamic machine properties by simulation as the references are proof of. This publication will deal with one of the key aspects of a simulation package to handle; the mass and inertia time (revolution) dependency.

Mastering this topic of dynamic mass and inertia properties may not only allow for system controllers' validation in the time domain with Dymola's[1] real time capabilities, but also support algorithm development with FMI technology exporting models to control development environments. This publication shows Modelica's capabilities in to this specific topic of paper winding.

References

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2. Zwart, J., Tarnowski, W., *Winder Vibration Related to Set Throw-outs*, PAPTAC 89th Annual Meeting, Montreal, Canada, 2003

[1] Dymola is a registered trademark of Dassault Systèmes