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SIMULATION OF FLEXIBLE STRUCTURES WITH IMPACT: EXPERIMENTAL VALIDATION

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ABSTRACT

The dynamics of flexible systems, such as mechanisms and robotic manipulators, is becoming increasingly important due to high-speed operation, high accuracy requirements, and lightweight designs. Such flexible devices can undergo impact during operation, and this may lead to: (1) component failure due to high stresses, and (2) excitation of higher structural modes due to impulsive forces. The latter issue, the simulation of the dynamic behavior of flexible structures with impact, is experimentally and numerically investigated.

A radially rotating flexible beam attached to a rigid shaft is considered. Both experimental and numerical studies are undertaken. Experimental studies show excellent agreement with simulation studies using both the momentum balance (coefficient of friction), and spring-dashpot (impact pair) models. The simulation studies are even capable of predicting the high-speed multiple impacts which occur due to structural flexibility and which were experimentally observed using high-speed video photography. The results of the studies show that a simple momentum balance (coefficient of restitution) method for simulating the impact is sufficiently accurate in predicting the dynamic behavior of the system for most engineering applications. The momentum balance method cannot simulate the impact force which develops during the contact duration, but is computationally very efficient. The spring-dashpot model is more difficult to develop and requires significantly larger computation time, but can simulate impact forces and stresses due to impact.

The momentum balance (coefficient of restitution) method, although strictly not applicable to flexible bodies, has been shown to provide an accurate and computationally efficient method for simulating the dynamic behavior of flexible structures with impact when contact stresses are not needed.

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