COMPREHENSIVE MATHEMATICAL MODELLING OF A TRANSVERSELY VIBRATING FLEXIBLE LINK ROBOT MANIPULATOR CARRYING A TIP PAYLOAD

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The purpose of this paper is to describe the application of the Timoshenko beam theory (TBT) to the mathematical modelling of a planar one link flexible robot manipulator pinned at its actuated base and carrying a payload at its free end-point. The emphasis has been put on obtaining accurate and complete equations of motion that display the most relevant aspects of structural properties inherent to the modelled lightweight flexible link. So, in addition to the classical effects of shearing and rotational inertia of the link cross-section, two important damping mechanisms: external viscous air damping and internal structural viscoelasticity effect (Kelvin-Voigt damping) have been included. Gravity, torsion, and longitudinal elongation have been neglected. Numerical simulations, performed to show the free vibrational behaviour of the modelled system, demonstrate the important effect of the carried payload on the amplitude and the frequency of vibrations.

Key words: robot manipulator arm; flexible link; PDE model; Timoshenko beam theory; Lagrange; assumed modes method.

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