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The inPSMence of structural parameters upon static control performance of a flextensional transducer

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Flextensional actuators belong to a group of piezoelectric transducers of great practical importance. A typical flextensional transducer consists of a piezoceramic connected to a flexible structure which amplifies and changes the direction of the generated piezoceramic displacement. The process of designing a flextensional actuator leads to the construction of such a flexible structure, coupled to a piezoceramic element or piezoceramic stack, which maximizes the output displacement and generative force as a result of piezoelectric actuation. Hence, two goals must be well balanced during the development of new actuators, i.e. high output displacement, which requires adequate high structure compliance, and high generative force, which is obtainable for high structure stiffness. Topology optimization is a technique used for designing flextensional actuators which ensures fulfilling those two opposing requirements. Piezoelectric actuators combined with a hinge lever mechanism and described by Uchino exemplify such structures. In this paper, the effects of hinge flexibility, material properties and dimensional changes on the output displacement and the generative axial force of the flextensional transducer have been investigated. The actuator is composed of two rectilinear or initially deflected beams placed equidistantly from a centrally located piezoceramic rod. A link with a hinge strengthened by a rotational spring placed symmetrically on both ends of the structure is adopted as a flexible joint. A simplified analytical mathematical model has been developed on the basis of the stationary value of the total potential energy principle with the application of Bernoulli-Euler theory and von Karman non-linear strain-displacement relations. The numerical calculations show that the output displacement and internal axial force generated by both the externally distributed load and the electric field application can be manipulated easily by changing the actuator material, the distance between the beams and the rod, the amplitude of beam initial displacement as well as the flexibility of the hinge. To keep the piezoelectric rod compressed during the operation, the application of structure prestressing has been considered in the model and computations. The obtained results may have applications in the design process of such actuators.

Biography

Jacek Przybylski is a specialist in applied mechanics. At the early stages of his work for the Czestochowa University of Technology his scholarly research interests included the reliability theory of mechanical objects and the fatigue theory. Over the last thirty years he has been mainly concerned with the stability and vibration of mechanical systems. During that period he has published his doctoral and postdoctoral theses and many technical papers and articles. He has also been conducting research into other subject areas, such as the theoretical and experimental investigations of vibration of the divergence-pseudoPSMttter systems, computer aided design of mobile cranes and resonance boxes of musical instruments as well as the interaction problems between the supports of truck cranes and the ground of particular rheological properties. In the last ten years his investigation has been focused on the inPSMence of the piezoelectric actuation on the static and dynamic behaviour of mechanical systems, including the geometrically non-linear systems. His work in the above areas has been published in a large number of various Polish and international highly reputable journals. Moreover, he has published as an author or co-author seven research monographs in the field. He is the author of curriculum-oriented textbooks, laboratory instructions and concepts of many laboratory and didactic stands for graduate and postgraduate students at various stages of higher education. For his scientific and didactic activities Polish Ministry of Science and Higher Education has awarded him two individual and three collective prizes. He has also been awarded twelve prizes by the Rector of CUT.

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