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MOTION DESCRIPTION OF MECHATRONIC FLEXIBLE JOINT

Michael Valasek, Vaclav Bauma, Tomas Vampola

Czech Technical University in Prague, Faculty of Mechanical Engineering, Department of Mechanics, Biomechanics and Mechatronics, Czech Republic
Michael.valasek@fs.cvut.cz ; Vaclav.bauma@fs.cvut.cz ; Tomas.Vampola@fs.cvut.cz

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Summary: The paper deals with the description of motion of mechatronic flexible joint. Flexible joints are used in compliant mechanisms. If they are actuated they are called mechatronic flexible joint. However, the examples are compliant arms of traditional robots as well as inflated/deflated smart structures or compliant mechanisms from hyperelastic materials with traditional as well as not traditional actuators.
The ultimate challenge is the development of methods using computation and efficient measurement for determination of kinematic transformation of the mechatronic flexible joint in order to enable its precise position control under real operation condition (especially loading). The open problem of basic research is the methods for description and calibration of kinematical transformation of mechatronic flexible joint without simplifications in similar way as it is realized for traditional joints of mechanisms (revolute, translational). The open problem is the transition from fully compliant FEM model into some equivalence of rigid mechanisms. How the traditional geometrical variables of kinematics of rigid mechanisms originate from the compliant FEM description?
The paper answers positively these questions and describes the solution for two challenging questions:
(1) Could be mechatronic flexible joint precisely described by finite number of parameters? Under which conditions is it possible? Could be done joint by joint of for overall compliant mechanism only?
(2) Could be mechatronic flexible joint calibrated based on redundant measurement as mechanisms with traditional joints? Could be possible the self-calibration procedure for mechatronic flexible joint/compliant mechanism?
In particular the paper proves that the mechatronic flexible joint can be characterized by finite number of parameters equal to number of degrees of freedom of equivalent mechanisms and the number of actuators, its motion can be efficiently described by LOLIMOT approach for description of nonlinear systems and it can be self-calibrated using redundant measurements.
The paper includes both the theoretical development and the simulation of examples of mechatronic flexible joints.