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Abstract

Influence of industrial robot configuration on resonant vibrations

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This paper presents an analysis of the impact of an industrial robot configuration with flexible joints on the occurrence of resonant vibrations, which poses a key challenge in the context of using robots as a flexible and economical alternative to rigid CNC machines. The thesis identified a research gap related to the lack of comprehensive analyses that consider the impact of joint flexibility, mounting elements, and accessories on the dynamic properties of the system.

As part of the research, a mathematical model of the manipulator was developed, using the Euler-Lagrange equations to describe the dynamics. The analytical solution allowed for the determination of natural vibration frequencies and their corresponding vibration modes depending on the angular position of the joints over a wide range of angular positions. The model was verified on an experimental setup using independent measurement systems: an accelerometer and a vision system. A comparison of the modeling results with the experimental results, supported by relative error analysis and graphical presentation for the first three vibration modes, confirmed the high consistency of the developed approach.

The conducted research allowed for a comprehensive assessment of the impact of the manipulator configuration on its vibration properties. The test results allowed not only a quantitative assessment of natural frequencies depending on the arm position but also a qualitative determination of the trends and relationships governing the system's dynamics. The presented modal analysis enabled the identification of the manipulator configurations most susceptible to vibration.