RZESZÓW UNIVERSITY OF TECHNOLOGY Rzeszów, 05.02.2025
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POSITION-FORCE CONTROL OF AN INDUSTRIAL ROBOT UNDER CONSTRAINT UNCERTAINTY

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Key words: hybrid position-force control, robotics, robotic machining

Abstract:

The paper focuses on the problem of hybrid position-force control of an industrial robot under constraint uncertainty in machining applications. The introductory section discusses the impact of technological advancements on the automation and robotization of industrial processes. A literature review was conducted, analyzing the current state of knowledge regarding modeling and control methods for robots interacting with their environment. Furthermore, the motivation for bridging the existing research gap was outlined, and the objectives and scope of the study were defined.

The research describes the configuration of the experimental setup and presents the software platform developed to facilitate the testing of custom control algorithms. A mathematical model of the IRB 2400 robot, which is part of the experimental setup, was formulated to describe its kinematics and dynamics. Both the Euler-Lagrange and Newton-Euler formalisms were employed to minimize computational errors. The physical parameters of the model were estimated and validated by comparing the computed torques values with actual measurements.

A hybrid position-force control system was synthesized, explicitly accounting for uncertainties in geometric constraints. To achieve this, the mathematical model was transformed into the task-space representation, and an additional virtual reaction force component was introduced to adapt to variations in the contact surface shape. The stability of the proposed control algorithm was formally proven.

The next section describes conducted experiments presents methodology and results of simulation studies aimed at evaluating the performance of the developed algorithm. Subsequently, three experimental tests were conducted: validation of the control algorithm, comparison with a conventional hybrid position-force control system, and assessment of the proposed approach's applicability in machining operations.

The conclusions drawn from the research conducted indicate that the developed solutions constitute a significant contribution to the advancement of control methods for industrial robots under constraint uncertainty. The proposed approach has potential applications in manufacturing processes, particularly in machining, where maintaining a prescribed motion trajectory and compensating for uncertainties in the workpiece geometry are critical.