2023 IEEE/ASME International Conference on
Advanced Intelligent Mechatronics (AIM)
June 28-30, 2023. Seattle, Washington, USA

Paper No. 52

AIM/TMech Focus Section Paper

Title of the paper:

Compliant Control of Flexible Joint by Dual-Disturbance Observer and Predictive Feedforward

Authors:

Wan, Hongyu (Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences)

Chen, Silu (Ningbo Institute of Materials Technology and Engineering, CAS)

Zhang, Chi (Ningbo Institute of Material Technology and Engineering,CAS)

Chen, Chin-Yin (Ningbo Institute of Material Technology and Engineering, CAS)

Yang, Guilin (Ningbo Institute of Material Technology and Engineering, Chinese Academy of Sciences)

Abstract

The compliant control of a flexible joint relies on accurate external torque information and effective internal disturbance compensation. To achieve this, most of prior works use a built-in torque sensor and a lumped disturbance observer based on a single encoder. This increases the weight and cost of the system. In this paper, a novel dual-disturbance observer (DDOB) based on the encoder feedbacks from both the motor and link sides is proposed, so that the friction and external torque are estimated and compensated separately without the torque sensor. Thereby, a feedforward-feedback-DDOB composite scheme is formed for position control. The modified reference sensitivity of this scheme suggests that better tracking accuracy and disturbance rejection ability are achieved. In addition, the estimated external torque is used to alternate the reference trajectory with the given admittance model. To ensure the feedforward control is realizable, the prediction of the alternated trajectory is done by the online fitting of a polynomial. The output turbulence caused by prediction errors is effectively suppressed by a single dead-beat compensator with the most ancient prediction in memory, while other predictions are weighted by the time-varying ratios. Simulations and real-time experiments are performed to demonstrate the practical appeal of the proposed method.