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P4.141 Deformation Modeling and Compensation Control of Manipulators for DEMO

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It is foreseen the most challenging tasks currently in remote maintenance of DEMO are the remote handlings of multi module blanket segment and divertor. Both of them are large and heavy, and must manoeuvre through precise trajectories in a limited space by remote manipulators. The manipulator deformation, due to the heavy payload, will deviate the handled component from the desired trajectories, which may cause the collisions of the manipulator with the surroundings. In order to implement the remote handling processes accurately by highly automatic manipulators, the manipulator deformation model has to be developed to predict its deformation displacement. Thus resultant displacement with respect to the desired trajectories can be compensated in control system in real time.
The hybrid deformation modeling method for generic serial manipulators has been employed, and the compensation method in a feedforward control system has been developed. Artificial neural networks (ANNs) are used to model equivalent deformation physics of the consisting links and joints, and the hybrid deformation model is constructed by integrating the ANNs deformation into kinematics. The distal deformation displacement of manipulator end-effector are computed through hybrid deformation model, and taken as extra trajectory errors for the compensation in control system. The errors are fed forward to a deformation compensation controller, which inversely compute the compensations in joint space. The joint's compensations, together with the joint interpolation errors are fed to a PID controller, which finally outputs the commands for the joint driving system.
The proposed deformation modeling and compensation methods are applied to a serial manipulator. The comparison results of trajectory tracking are presented, with respect to the control system without feedforward deformation compensation controller (FDCC). The results indicate the trajectory tracking accuracy can be significantly improved with the FDCC, and the methodologies developed herein can be extrapolated to realistic manipulators in DEMO.

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