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Precise End-Effector Pose Estimation in Spatial Cable-driven Parallel Robots with Elastic Cables using a Data Fusion Method

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Abstract

In this paper a new method for estimating the end-effector pose in the cable-driven parallel robots (CDPRs) with elastic cables is introduced. In many applications, the end-effector pose is determined considering the direct kinematic and motor rotations obtained from encoders. Since the cable flexibility in the CDPRs leads to the end-effector vibration, the fast dynamic movement, caused by the cable flexibility, cannot be observed using only motor rotation. The issues concerned with the other common sensors, include expensiveness, inaccuracy for vibration measurement and requiring precise cable model. In this study, an inertial measurement unit (IMU), mounted on the end-effector and consisted of accelerometer and gyro sensors, is employed to detect the vibrational states. Therefore, motor encoders observe the slow dynamic movement whereas IMU detects the fast dynamic movement of the end-effector. Since the measurements, particularly using IMU, include noise and bias, the Kalman approach is employed for the data fusion of two measurement systems. Employing the contextual information, the estimations obtained by the encoders, IMU and Kalman estimator are fused based on the degree of trust to each data. The Kalman filter (KF) is typically applied to linear or linearized systems. Therefore, using the Feedback Linearization (FL) control law the slow error dynamic of the

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