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

Kinematic Analysis and Robust Control of a Spherical Motor Based Visual Tracking System

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Abstract**—**This paper presents the concept of a spherical-motor-based visual tracking system. Unlike conventional gimbal systems consisting of serially articulated motors/gears for achieving multi-DOF negotiation of optical axis of a camera, the spherical motor is capable of providing three-DOF in one joint, thus greatly reducing the unwanted inertia and frictions of the rotating parts. The kinematic model relating the image projection motion and the spherical motor orientation is established for the omni-directional visual tracking configuration, based on which an image-based visual servo (IBVS) algorithm is derived. A cascaded visual tracking controller consisting of an IBVS control and a complementary H_2-H_∞ (C-H_2-H_∞) control is proposed for precisely controlling the spherical motor in presence of external disturbances. The capability of the proposed system for tracking a flying target is investigated and the performances are compared to a conventional gimbal system. The results demonstrate that the spherical-motor-based tracking system with the proposed controller can avoid singularities usually encountered in conventional articulated gimbals and provide fast and precise visual tracking of flying targets.