An Interpretation of Vision-based Control for Rigid Body Motion: A Geometric Framework

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This paper investigates the rigid body motion (involving both translation and rotation) control problem of vision-based robotic systems. Visual feedback systems of the eye-in-hand configuration typically use three coordinate frames which consist of a world frame, a target object frame and a camera (end-effector) frame. In this control strategy, one of the control objectives is to track the moving target object in a three-dimensional workspace by image information. Hence the model of the relative rigid body transformation, which represents the position and orientation of the target object frame relative to the camera frame, can be described by the nonlinear systems on the group of rigid motions, which shall be denoted as $SE(3)$.

At first, we consider a model of the relative rigid body motion based on a geometric framework [1], [2]. However, the relative rigid body motion can not be measured directly in visual feedback systems. Hence, we propose a nonlinear observer which will estimate the relative rigid body motion from image information. The estimation error and error model between the relative rigid body motion and the estimated relative rigid body motion can be derived based on a geometry approach. An interpretation of relation between the model of the estimation error and an expression of velocity can be provided thanks to this approach.

The control error and error model between the estimated relative rigid body motion and the reference of the relative rigid body motion should be defined to track the moving target object. A model of the visual feedback system consists of the control error model and the estimation one. For this system, we lead a structural passivity-like property. Moreover, stability and L_2-gain performance analysis are discussed based on passivity. The main contribution of this paper is that the interpretation of our proposed strategy [3] has been given based on a geometric framework.

References

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