

**Stony Brook University
The Graduate School**

Doctoral Defense Announcement

Abstract

Computer Aided Synthesis of Rational Motions under Kinematic Constraints

By

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Since the seminal work of Shoemake, there has been considerable effort in applying curve design techniques in the field of Computer Aided Geometric Design (CAGD) to the problem of synthesizing freeform rational motions of rigid bodies. For applications in computer graphics and motion animation, it is often sufficient to be able to synthesize freeform rational motions without taking into account geometric or kinematic constraints. For applications in Cartesian trajectory in robotics and task specification in the design of mechanisms and robotic systems, however, it is desirable to be able to synthesize rational motions that take into account of the kinematic constraints of the mechanical systems.

This dissertation deals with the problem of synthesizing piecewise rational motions under kinematic constraints of planar, spherical, and spatial open or closed mechanisms. Through the use of planar quaternions, it is shown that the problem of synthesizing rational motion of a planar mechanism can be transformed into that of rational curve interpolation, and the kinematic constraints of a planar mechanism are transformed into geometric constraints for the rational interpolation. By choosing the quaternion representation of the spherical displacements, the problem of synthesizing rational motions of a spherical mechanism is reduced to designing curves in the space of quaternions. We use dual quaternions for synthesizing rational motion under kinematic constraints of a spatial mechanism. Several iterative algorithms for the constrained motion interpolation are developed that detect extreme positions on the rational motion that violate the kinematic constraints. These extreme positions are then modified so that they are in compliance with the kinematic constraints and are added to the list of positions to be interpolated.

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