

Seminar

DEPARTMENT OF AEROSPACE ENGINEERING

A New Dimension to (Aerospace) Mechanics

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Abstract

Many of the concepts that guide our understanding of motion in three dimensions have been generalized to cover motion in higher dimensions. Included in this is the generalization of Euler's equations of rotational motion of a three-dimensional rigid body, an idea first put forth by Arthur Cayley more than 150 years ago.

The rotational motion of rigid bodies in three dimensions can be studied using Lagrange's equations in quasi coordinates. This same approach is used to explore the higher-dimensional case and this leads to a more generalized version of the equations than previously published.

Some of the most important and elegant concepts in higher-dimensional kinematics are related to the Cayley transform between a skew-symmetric and a proper orthogonal matrix. The Cayley transform is used to reinvestigate the rotational motion of higher-dimensional rigid bodies and this reveals an intimate relationship between the rotational motion of these abstract bodies and the motion of real, mechanical systems.

The relationship between the rotational motion of abstract bodies and the motion of real, mechanical systems motivates an investigation of applying spacecraft attitude control to a broader class of problems. This controller is shown to have good performance due to the sensitivity of the rotational kinematics to small motions near the reference configuration. In a sense, this gives automatic control gain scheduling and damping scheduling.

Some other practical aspects of dynamical systems research are briefly discussed, including equational forms that may be better suited for numerical integration and linearization techniques for systems governed by PDEs.

About the Presenter

John E. Hurtado received his Ph.D. from Texas A&M University in 1995. He was at Sandia National Laboratories in Albuquerque, NM from 1995 to 2001, where he was first part of the Structural Dynamics Division and then part of the Intelligent Systems and Sensors Division. He returned to TAMU in 2001, where he is currently an Assistant Professor in the Department of Aerospace Engineering.

