An Introduction to Spatial (6D) Vectors and Their Use in Robot Dynamics

Course at a Glance

This course provides an introduction to spatial vector algebra, which simplifies the task of solving problems in rigid-body dynamics by reducing the number of quantities and equations that are needed. The course also covers the most important recursive dynamics algorithms: the Recursive Newton-Euler, Composite-Rigid-Body and Articulated-Body algorithms.

Instructors

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Hours and Credits

approx 15 hours, 5 credits

Synopsis

Spatial vectors combine the linear and angular aspects of rigid-body motion, so that a single vector can provide a complete description of a body's velocity, acceleration, momentum, or the forces acting upon it. The result is a large reduction in the quantity of algebra needed to describe and solve a problem in rigid-body dynamics: fewer quantities, fewer equations, and fewer steps to the solution. There is also a large reduction in the quantity of computer code needed to calculate the answer. This course explains spatial vectors in sufficient detail to allow students to understand what they are, how they work, and how to use them in their own research.

Tools used:

Software

- Matlab and Simulink
- spatial_v2 (available from http://royfeatherstone.org)

Syllabus

- Motion and force
- Plucker coordinates
- Differentiation and acceleration
- Equation of motion
- Motion constraints
- Dynamic models
- Inverse dynamics – recursive Newton-Euler algorithm
- Forward dynamics – composite-rigid-body and articulated-body algorithms

Final exam

There will be a final examination for those students who wish to receive credits for this course.

Prerequisites

A basic knowledge of Newtonian dynamics is required (i.e., dynamics using 3D vectors), such as can be obtained from a first course in dynamics at undergraduate level. A basic knowledge of linear algebra is also required.

Reading List
The book *Rigid Body Dynamics Algorithms* (Springer, 2008) covers the material in this course in much greater depth, and is recommended for those students who wish to make serious use of spatial vectors. Otherwise, several useful items can be found on http://royfeatherstone.org/spatial/.

Venue
IIT via Morego

Course dates
Jan – March