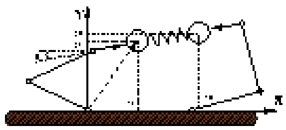
Stiffness and Compliance

Chairs: Herman Bruyninckx, Imin Kao

Internal force-based Impedance Control Of Dual-arm Manipulation of Flexible Objects

A. S. AlYahmadi and T. C. Hsia
University of California, Davis

- Simple, efficient scheme for handling flexible objects
- Object dynamics compensated for using sensed forces
- Internal force is used to deform an object
- Simulation of two arms inserting a flexible object into a fixture



Minimal Realization of an Arbitrary Spatial Stiffness Matrix with a Parallel Connection of Simple and Complex Springs

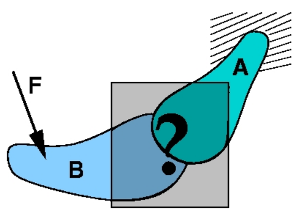
Rodney G. Roberts
Florida State University

- Any spatial stiffness matrix K can be realized with simple and complex springs.
- The minimum total number of springs is equal to the rank of K.
- To reduce complexity, one should minimize the number of complex springs.
- An algorithm is introduced to realize K with the minimum number of complex springs and the minimum total number of springs.

An Eigenscrew Analysis of Mechanism Compliance

P. L. McAllister and R. E. Ellis
Queen's University

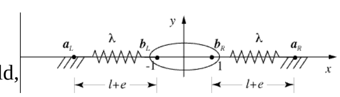
- Compliance (C) of devices of unkown geometry cannot be found analytically
- An SPSD approximation to C was obtained from simulated noisy statics data
- Eigenscrew decomposition yielded directions and magnitudes of compliance
- Simulations showed the method was reliable for well-conditioned poses



The Spatial Stiffness Matrix from Simple Stretched Springs

J. M. Selig
South Bank University

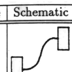
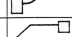
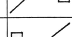
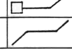
- Systems of simple stretched springs considered.
- Stiffness matrix derived from the potential function.
- Differentiation on group manifold, no constraints used.
- Form of the stiffness matrix investigated.



Classification Structure and Compliance Modeling for Serial Manipulators

Jeffrey Hudgens[1], Daniel Cox[2] and Delbert Tesar[2]
[1]Applied Materials, Inc. and [2]University of Texas, Austin

- Robot manipulators are inherently flexible when subjected to a load disturbance. The result is inaccurate knowledge of the end-effector pose under load. The objective of this paper is to develop a structural compliance model for a general serial manipulator that includes both joint and link compliance sources in any general distribution of revolute and prismatic joints.
- The compliance modeling strategy accommodates both joint and link compliance sources. A more reliable method for placing the link compliance frames is introduced. Special consideration is given to modeling the variable local compliance properties of a robot containing one or more prismatic joints.
- The distinct structures for prismatic joints are (1) Constant, (2) Proximally Variable, (3) Distally Variable, and (4) Fully Variable. The link is segmented into variable and constant compliance segments and the compliance of each segment is treated separately. The link compliance modeling strategy addresses the four distinct link structures.
- A structural compliance model for a general serial manipulator that includes both joint and link compliance sources is developed. An improved linear quasi-static compliance model for serial robot structure comprised of both revolute and/or prismatic joint is provided. The model can be used with parameter estimation techniques to determine compliance parameters for the manipulator which can be applied in real-time on-line deflection compensation schemes.

Type	Schematic	Name	Membership
1		Constant	R – R
			$P_{proximal} - R$
			$R - P_{distal}$
			$P_{proximal} - P_{distal}$
2		Proximally Variable	$P_{distal} - R$
			$P_{distal} - P_{distal}$
3		Distally Variable	$R - P_{proximal}$
			$P_{proximal} - P_{proximal}$
4		Fully Variable	$P_{distal} - P_{proximal}$

Synthesis of Spatial Compliances with Simple Serial Elastic Mechanisms

Shugang Huang and Joseph M. Schimmels
Marquette University

- compliance synthesis and realization
- use serial mechanism with springs loaded across individual prismatic and revolute joints
- not all compliances are realizable with mechanisms of this type; restriction on compliance matrices identified
- serial mechanism synthesis procedure for compliances satisfying restriction defined