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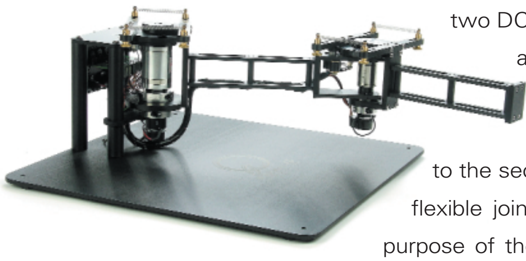
SPECIALTY CONTROL CHALLENGE

2DOF Serial Flexible Joint Experiment

Product Information Sheet S31 - 1 - rev. B

Description

The 2DOF Serial Flexible Joint is a simplified model of a robotic arm in which the joints are designed as to exhibit visible harmonics during accelerations, while the links are rigid in comparison. This system consists of two DC motors each driving harmonic gearboxes (zero backlash) in a two-bar serial linkage. Both links are rigid. The primary link is coupled to the first drive by means of a flexible joint. It carries at its end the second harmonic drive which is coupled to the second rigid link via another flexible joint. Both motors and both flexible joints are instrumented with quadrature optical encoders. The purpose of the experiment is to design a control system to position the robot tip in a plane (2-DOF) as rapidly as possible with minimum vibrations. The end-effector planar position to track and/or regulate is of the two-bar serial-kinematic mechanism that has two flexible joints. The Multi-Input Multi-Output (MIMO) system is supplied with a decoupled state-feedback controller reducing flexibility-caused oscillations as well as link-coupling effects. However, this system is fully open-architecture and you may design any other controller you wish. A manual accompanies this experiment describing the development of the control law used, as well as providing useful setup information and specifications.



Key Features

- fully compatible with LabVIEW and MATLAB/Simulink
- high quality aluminum chassis with precision crafted components
- high-resolution encoders to sense both position and joint deflection
- interchangeable set of springs for variable torsional spring rate
- fully documented system models & parameters
- complete manual describing the development of the control laws used, as well as providing useful setup information and specifications
- open architecture design for maximum flexibility

Practical Controller Investigations

- Disturbance Rejection
- Tracking Control & Regulation
- Full-State Feedback
- Observer Design & Implementation
- Frequency Analysis
- Lead / Lag Compensation
- Vibration & Resonance
- System Modeling & Simulation
- Root Locus Design
- Nyquist Stability
- Robotics
- Real-Time Control
- Discrete Time Sampling
- System Identification
- Multivariable Control Design

Range of Quanser Specialty Experiments

Quanser has developed an extensive range of complex Specialty Challenges, a select sample of these experiments includes:

Specialty Control Challenges

2 DOF Helicopter	2 DOF Serial Flexible Link / Joint
3 DOF Helicopter	Industrial Mechatronic Drives Unit
3 DOF Hover	High Fidelity Linear Cart System
MAGLEV (Magnetic Levitation)	Triple Inverted Pendulum, Dual Inverted Pendulum ....
Coupled Tanks	5 DOF Open Architecture Robots
Heatflow Experiment	Mechatronics Kit
Shaker Tables and Smart Structures	The Cube
	3 DOF Crane

For details of these experiments and more, visit our website www.quanser.com

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Typical Response

These graphs depict the measured response of the system to a square-wave input, using a state-feedback control scheme tuned with the Linear-Quadratic Regulator (LQR) algorithm without taking coupling into effect. The first graph on the left plots the actual measured angle of the first joint (blue) vs. commanded (green trace) vs. on/off controller switching cycle (red trace). The graph on the right depicts joint deflection only as a response to the same inputs. Joint coupling may be observed.

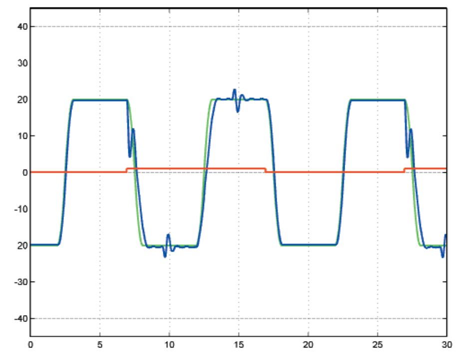

Figure 1 – Drive #1 Load Shaft Angular Response: θ11

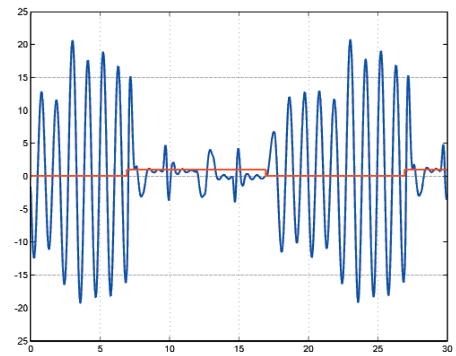

Figure 2 - Flexible Joint #1 Deflection: dθ1 = θ12 - θ11

System Requirements

The 2DSFJ system requires the following components to complete the experimental setup:

Component	Quanser Recommended (Common Configuration)	Alternative
Power Module	Quanser AMPAQ (included)	nil
Control Hardware	Quanser Q4, Q8 Series	dSPACE DS1104*
Control Software	Quanser QuaRC	The Mathworks – RTWT, xPC dSPACE – ControlDesk National Instruments – LabVIEW

* Quanser offers interface boards for dSPACE DS1104 boards.

System Specifications

Specification	Value	Units
Dimensions (w x d x h)	50.8 x 50.8 x 24	cm
Max. displacement – Axis 1	+/- 90	degrees
Max. displacement – Axis 2	+/- 90	degrees
Encoder sensitivity (Quadrature) - Axis 1	1.534E-5	rad/count
Encoder sensitivity (Quadrature) - Axis 2	1.918E-5	rad/count
Max. Continuous Torque – Axis 1	8.6	N.m
Max. Continuous Torque – Axis 2	1.7	N.m
Max. additional payload	0.5	kg