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ROTARY CONTROL CHALLENGE

SRV02 + ROTPEN = Rotary Pendulum Experiment

Description

The Rotary Inverted Pendulum modules (ROTPEN Series) offer the student the opportunity to balance a vertical rod by manipulating the angle at the base. This is the classical pendulum problem only now the trajectory is circular. This module is also configurable in 3 distinct configuration. The module can be used as a classical inverted pendulum; a gantry crane or in the self-erecting inverted pendulum.

Key Features

- Fully compatible with MATLAB/Simulink
- Modular design (experiments are easily inter-changeable)
- High Quality Aluminum chassis with precision crafted parts
- High Resolution Encoders to sense rod angle
- Variable Pendulum Rod lengths and mass
- 3 Distinct Configurations / Experiments
- Fully documented system models & parameters
- Fast and easy attachment to the SRV02 plant
- Open architecture design

Curriculum Topics

- Disturbance Rejection
- Tracking Control & Regulation
- Full State-Feedback
- Observer Design & Implementation
- Frequency Analysis
- System Modeling & Simulation
- Pole-Placement Technique
- Root Locus Design
- Nyquist Stability
- Non-Minimum Phase
- Limit Cycle
- Non-Linear Friction
- Real-Time Control
- Discrete Time Sampling
- System Identification
- Multivariable Control Design

Range of SRV02 Challenges

SRV02 Model Range

The SRV02 series serves as the base of Quanser's Rotary Control Challenges. With easily interchangeable modules, you can transform the SRV02 into any of these experiments:

SISO Configurations ***(Single Input, Single Output)***

SRV02: Position Control
SRV02-T: Rate Control
BB01: Ball & Beam
ROTFLEX: Rotary Flexible Joint
FLEXGAGE: Rotary Flexible Link
ROTPEN: Rotary Gantry
ROTPEN: Rotary Inverted Pendulum
ROTPEN-SE: Rotary Self-Erecting Inverted Pendulum
DBPEN: Double Inverted Pendulum

MIMO Configurations ***(Multiple Input, Multiple Output)***

2D ROBOT: 2 SRV02 modules coupled together to control 2 axis
2D GANTRY: Use the 2D ROBOT to control the position of the gantry in 2 planes
2D PENDULUM: Control the Inverted Pendulum with 2 degrees of freedom
2D BALL BALANCER: Control the position of the ball on a plate moving with 2 degrees of freedom

Some configurations require specific SRV02 model, please confirm at time of order

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Model	Description
SRV02	Standard Servo plant. Instrumented with a continuous turn potentiometer to measure output/load angular position.
SRV02-E	Same as the SRV02 with an optical encoder measuring the output shaft position.
SRV02-EHR	Same as the SRV02 model equipped with a high resolution optical encoder to acquire high precision position data.
SRV02-ET	Same as the SRV02-E with a tachometer attached to measure the speed of the motor.
SRV02-ETS	Same as the SRV02-ET but with a slip-ring mounted to the load gear allowing a continuous 360° motion.

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ROTPEN Model Range

Challenge	ROTPEN	ROTPEN-SE
Rotary Inverted Pendulum	✓	✓
Self-Erecting Inverted Pendulum		✓
Gantry Crane		✓

Typical Response

The following plot demonstrates the response of the load gear to a position command while maintaining the pendulum in the upright position. Notice the non-minimum phase in the plot as well as the limit cycle that arises due to the non-linear friction in the system.

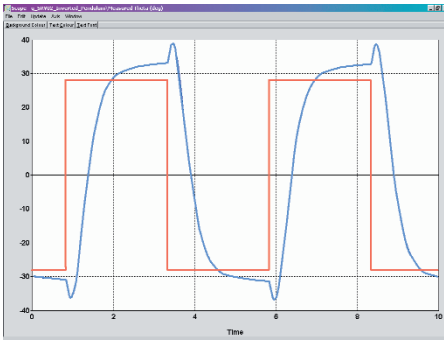

Figure 1 - Typical Resonse of the Inverted Pendulum

System Requirements

The ROTPEN range is designed as an attachment to the SRV02 plant. Along with the SRV02 plant, the following components are required to complete the experimental setup.

Component	Quanser Recommended (Common Configuration)	Alternative
Power Module	Quanser UPM 1503/2405	Alternate Power Amplifier (Minimum requirements: +/- 12V, 3A)
Control Hardware	Quanser Q4, Q8 Series Quanser Q3 ControlPaQ-FW*	dSPACE DS1104** National Instruments E- or M-Series DAQs**
Control Software	Quanser QuaRC	The Mathworks – RTWT, xPC dSPACE – ControlDesk National Instruments – LabVIEW

* configuration with Q3 ControlPaQ-FW amplifier-on-board control unit does not require UPM power module

** Quanser offers interface boards for NI E- and M- series & dSPACE DS1104 boards.

System Specifications

Specification	Value	Units
Coupled Arm Length	20	cm
Effective Short Rod Length	35	cm
Effective Short Rod mass	0.128	kg
Pendulum Link mass	0.278	kg
Potentiometer Bias Power	±12	Volts
Potentiometer Measurement Range	±5	Volts
Encoder Resolution (ROTPEN-SE)	4096	Counts/Rev.

For SRV02-Series specifications please refer to Product Information Sheet R1