

Prok.Phantom

prok-phantom.googlecode.com

Prok.Phantom is COM .NET component designed to interface MATLAB with with [Sensable](#) Phantom haptic robot. This component implements passive position measurement, force control and servo control of the robot.

REQUIREMENTS

- [Sensable](#) Phantom Haptic robot with OpenHaptics Toolkit (hd.dll)
- Mathworks MATLAB 6.5 or higher (32 bit). **No toolboxes required**
- Microsoft [Net Framework 2.0](#) or higher

USAGE

```
h = actxserver('Prok.Phantom');    % Activate this component
h.get                               % List all properties
h.invoke                             % List all methods
```

After activation of this component you can use its handle H to read and modify properties and invoke methods described below. If you are not familiar with COM programming in MATLAB I recommend MATLAB help (MATLAB/External Interfaces/COM Support in MATLAB).

PROPERTIES

`h.maximum_force`

Maximum allowed force magnitude or Inf (default).

`h.frequency`

Sampling frequency (default 1000). Look into the robot manual for limits.

`h.buffer_size`

Amount of samples in the circular buffer (default 100000).

`h.transform`

Transform from 3D Cartesian robot space into N dimensional user space (N by 4 matrix). Rows of this matrix are orthonormal 3D vectors plus their biases.

`h.dimensions`

Amount of work dimensions (N).

`h.position`

Current position of the robot (read-only vector of length N).

`h.force`

Current force applied by the robot (vector of length N).

`h.target`

Target position for servo control (properties described below).

`h.A`, `h.B`, `h.C`

Operators of delay difference equation (vectors of different length):

$A * \text{force} + B * \text{position} = C * \text{target}$

Alternatively these operators can be set by the STIFFNESS, VISCOSITY, and TAU properties (see below).

`h.stiffness`, `h.viscosity`, `h.tau`

Stiffness (N/mm, default 0.06), viscosity (N*ms/mm, default 2), and characteristic time for filtering target movement (ms, default 0). Setting up large values of stiffness and viscosity can cause robot instability! Maximum values I've succeeded to use are stiffness 1 and viscosity 2 with tau 100.

`h.available`

Amount of samples available in the output queue for reading.

METHODS

```
h.connect           % Connect to the robot
h.disconnect       % Disconnect from the robot
h.calibrate        % Perform calibration
h.flush           % Flush the queue
h.reset           % Reset all settings
[ POSITION, FORCE, TARGET ] = h.read(AMOUNT);
```

Blocking reading from the output queue of AMOUNT samples. All output parameters are AMOUNT by N matrices. AMOUNT can exceed the buffer size without causing problems.

```
[ POSITION, FORCE, TARGET ] = h.read(Inf);
```

Nonblocking reading of all samples available from the output queue. Rows of the output parameters are time samples.

```
h.write_force(DATA); % Send force data to the robot.
h.write_target(DATA); % Send target data to the robot.
```

The force of target data sequence is started immediately if the robot queue is empty. Otherwise the data sequence is appended to the end of the queue. The last data sample is extrapolated when the queue is finished. Rows of the matrix DATA are time samples. The amount of columns is equal to the amount of working dimensions N.

EXAMPLE

```
% Reading one second of 3D position data
h = actxserver('Prok.Phantom');
h.connect;
input('Press ENTER when ready to start');
h.flush;
position = h.read(h.frequency);
h.disconnect;
```

TECHNICAL DETAILS

This component supports three modes of operation:

1. Passive.

This is a default mode. No force is exerted. You can read instant robot position using the POSITION property or read continuous position data with the READ method.

2. Force control.

You can exert constant force using the FORCE property or send continuous force data using the WRITE_FORCE method. You can read both position and force data back.

3. Servo control.

You can set equilibrium position using the TARGET property or send continuous equilibrium data using the WRITE_TARGET method. You can read position, force, and target data back. Feedback parameters of the servo control can be modified either by changing the STIFFNESS, VISCOSITY, and TAU properties, or modifying the time difference equation directly using the A, B, and C properties.

Switching between these modes is automatic. In order to switch back to passive mode, set the FORCE property to zeros, or set the last data point in the WRITE_FORCE data argument to zeros.

Robot operates in Cartesian 3D space mode. You can decrease dimensionality specifying the TRANSFORM property. This can be useful if you need only one or two dimensions. Along unused dimensions the robot is moving freely with no force applied.

WARNING

This component can cause the robot to exert force and move resulting in damage or injury. Use the software for your own risk!