Suspension Group

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Goals of isolation and suspension subsystem modeling:

- aid in the overall structure design.
- aid in the local control system overall design.
- allow some optimization of design parameters:
  - natural resonance frequencies.
  - masses.
  - wire/spring sizes and attachment points.
  - local control compensation functions.
- allow prediction of local electronic and thermal noise propagation
- allow prediction of vibration transfer functions.

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Goals of combined system modeling:

- aid in selection of cascaded component systems.

- aid in ordering of systems.

- allow better optimization of design parameters.

- allow better prediction of total noise.

Example problem: high-Q pendulum mounted on low-Q active system.

- Coupling to outer stage thermal loss depends on loop gain in active system.

- Loop gain in active system affects isolation from outer noises.

- Unity gain point frequency regions of active stages can. exaggerate coupling to thermal losses.

- Perhaps we need to model complete. isolation/suspension system to calculate noise of last stage.

Collaboration in system modeling:

- Various groups are developing suspension/isolation candidate subsystems for advanced LIGO.

- Each group best able to create and test subsystem models against. experimental measurement.

- Ideally, these models should be developed with a goal of combining them with others.

Two ways to cascade models:

- Use individual state-space (or other) models to calculate matrices of frequency-dependant admittances among all connection points, then exchange results and combine. (likely to be too much work.).

- Write individual state-space models in a way that allows them to be cascaded.

Requirements for cascading state-space dynamic models with Matlab:

- Standard coordinate systems and units

- Equations of motion that are used to derive state spaces must be robust to (usually) small displacements and rotations of entire system.

- Inputs and outputs for inner and outer attachment points should be in standard places (indices) in each model, and have standard meanings.

Cascading systems with "soft connections."

When one system ends in a compliant member and the other is a rigid mass, it is sufficient to use the positions of the attachment points:

- input and output vectors each begin with the 6 DOFs of the upper (outer, "o") connection point, and the 6 DOFs of the lower (inner, "i") connection point. Write A, B, C, D for each subsystem such that:

$$u = \left[x^o, y^o, z^o, \phi^o_x, \phi^o_y, \phi^o_z, x^i, y^i, z^i, \phi^i_x, \phi^i_y, \phi^i_z, \ldots\right]^{\mathsf{T}}$$

$$y = \left[x^o, y^o, z^o, \phi^o_x, \phi^o_y, \phi^o_z, x^i, y^i, z^i, \phi^i_x, \phi^i_y, \phi^i_z, \ldots\right]^{\mathsf{T}}$$

- Use the Matlab `append` command to combine all state spaces (as independant subspaces).

- Use Matlab `connect` command to connect each system's attachment point outputs to the neighboring system's inputs, and defining which outputs and inputs are retained in the complete system.

- Use resulting A, B, C, D for desired purpose.

Arbitrary connection types:

When it is necessary to connect systems with other interface conditions, pairs of input/output variables must be connected, such as $\{F, v\}$ or $\{\tau, \theta\}$.

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Note 1, Linda Turner, 04/20/98 04:27:18 PM
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