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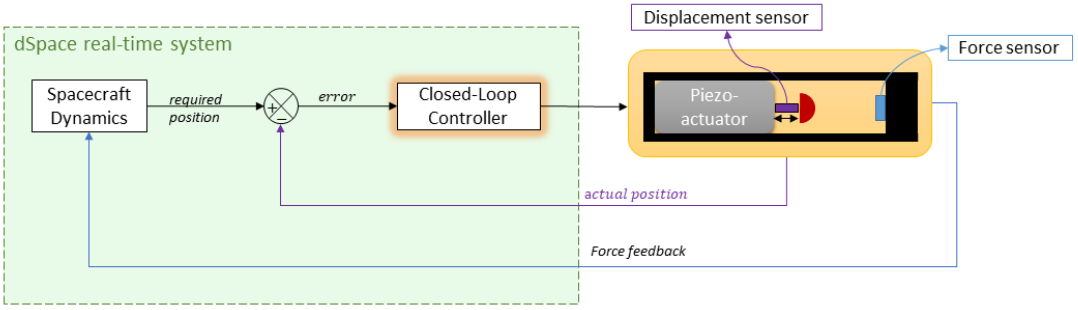
Design and implementation of piezoactuator closed-loop controller for validation of spacecraft docking contact dynamics using Hardware-In-the-Loop simulation

Objectives:

The aim of this thesis is about research, implementation and testing of various closed-loop controllers of a piezoactuator. After doing various testing, stability analysis, the most reliable controller is to be selected. Afterwards, docking contact dynamics is to be tested and analyzed using the 1DOF real-time Hardware-In-the-Loop (HIL) simulation testbed is to be carried out.

The goal of the docking HIL simulation testbed is to validate contact dynamics models for small and rigid spacecraft. This novel HIL testbed in our lab (using "dSpace" real-time system) consists of a piezoactuator, displacement sensor (to provide feedback to the controller) and a force sensor to measure the real contact force. Docking contact dynamics models will be validated by comparing the "predicted" results from the existing models with the "real" results from the HIL simulation.



Detailed work content:

A. Design and Implementation of closed-loop Controller

1. Literature review about piezoactuator closed-loop controllers.
2. Validate Experiment Setup and Calibration
3. Structured requirements definition.
4. Implementation, testing and analysis of potential closed-loop controllers
5. Stability analysis of the whole Hardware-in-the-loop simulation setup.
6. Select the most reliable closed-loop controller

B. Testing of contact dynamics models using HIL simulation

7. Modify an existing docking multibody model, to include the selected controller.
8. Test and validate the docking contact dynamics using the HIL simulation.
9. Test and analysis various docking scenarios (various s/c masses, and impact velocity).
10. Literature review of contact dynamics models.
11. Testing and validation of various contact models.
12. Documentation of the thesis.

Tools:

- dSpace shall be used as the real-time system

Requirements:

- Good score in related courses (mathematics, modeling, control theory)
- Advanced English Language skills
- Advanced Matlab/Simulink skills
- Familiar with Git

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