Dynamic Load Simulator for TVC Actuator Testing

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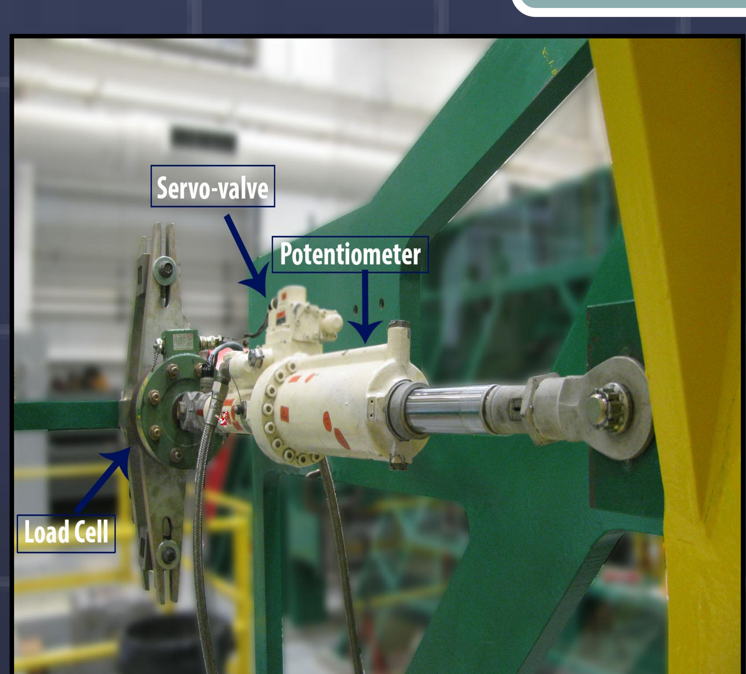
Project Description

An Aero90 controller was used to control an H-1 hydraulic servo-actuator mounted within a small Inertial Load Simulator (ILS) in the Thrust Vector Control Test Laboratory. Aero90 uses closed loop control by obtaining displacement feedback from a potentiometer inside the H-1 actuator and comparing it to the commanded value. Gain parameters were adjusted to achieve a desired frequency and step response. The actuator testing was simulated using MATLAB/Simulink to predict the changing parameters, and then compared against empirical results run from the Aero90 test setup.

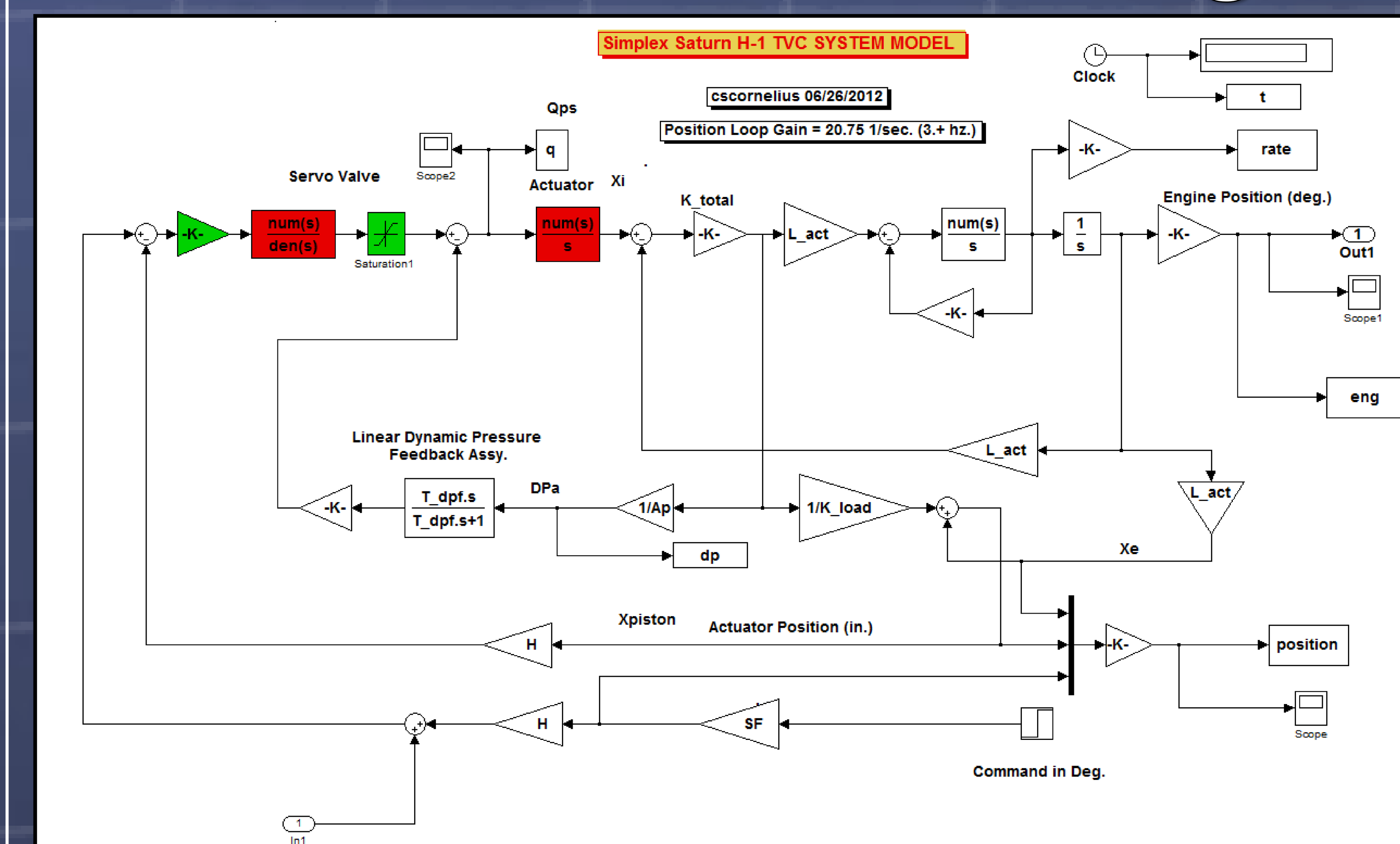
Hardware



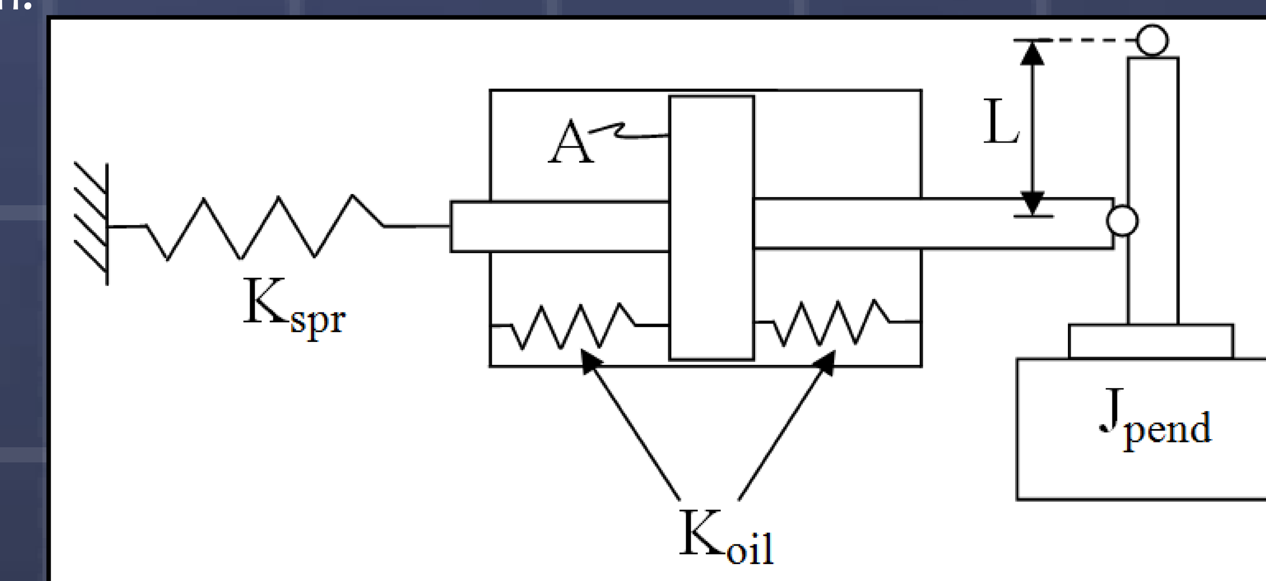
The H-1 rocket engine developed by Rocketdyne was used for the Saturn I and IB rockets of the Apollo Program. This legacy H-1 actuator has a built in potentiometer for displacement measurement and servo-valve used to direct hydraulic fluid. A load cell is also used to measure the applied force.

The Aero90 system, acquired by the TVC group, has the ability to control 32 separate channels and run simultaneous test profiles. It can relay command signals to servo-valves and receive feedback signals from the potentiometer inside the actuator.

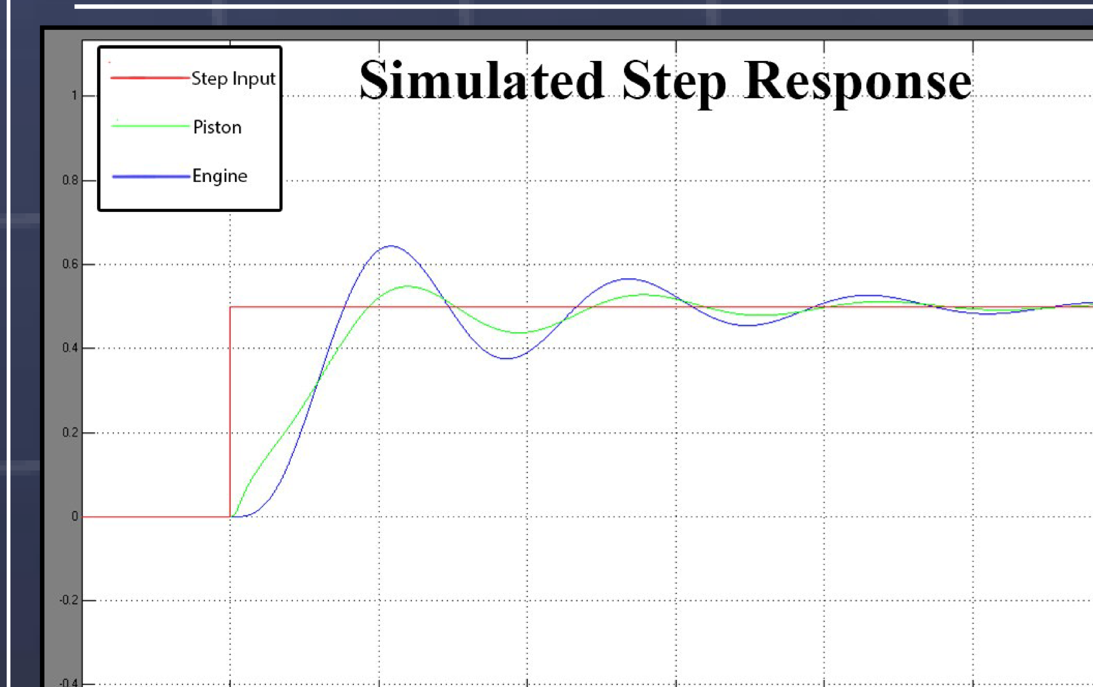
Modeling and Simulations

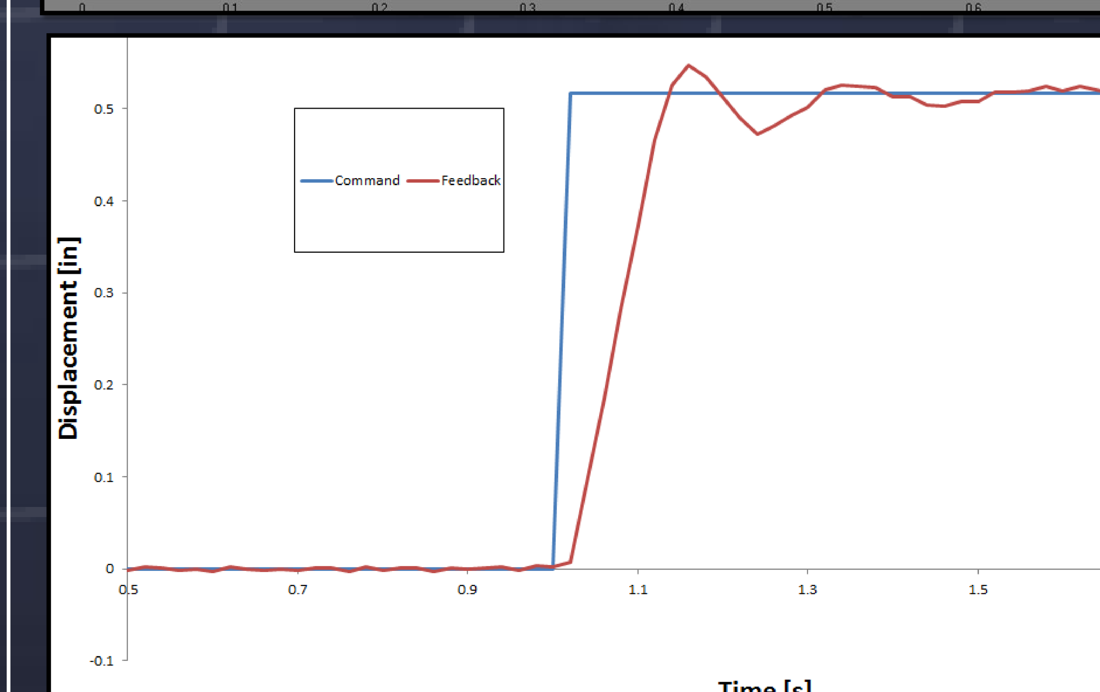


The MATLAB/Simulink model to the left was used to simulate system behavior prior to testing. The model was previously worked on and parameters were modified to match the test setup. The model will be used in future applications when dynamic loading is applied to the system.



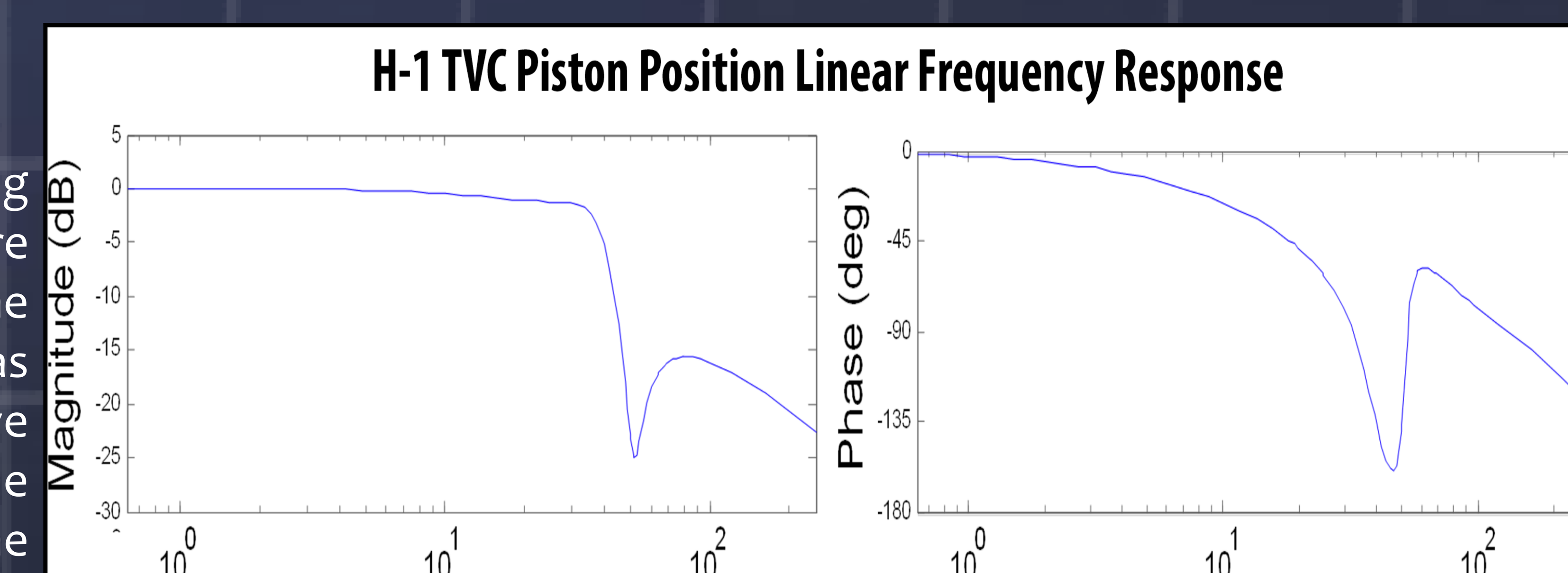
The block diagram above is a representation of the system and was used to develop the equations of motion used in the model.

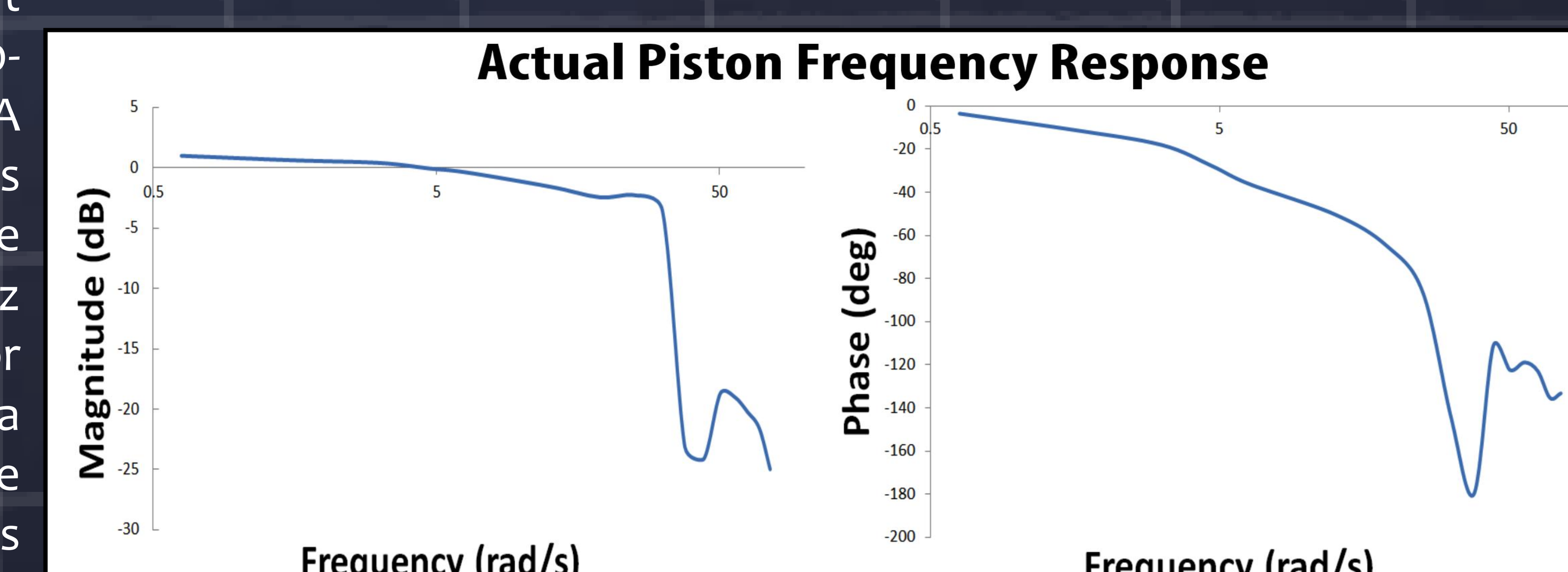




Results

Step commands ranging from 0.5-2 inches were input, and the proportional gain was adjusted to 3.9 to achieve a 10% overshoot. The frequency plot from the model shows a significant drop in the 6-7Hz (40-50rad/s) range. A frequency sweep was performed on the MATLAB model up to 16Hz and tested in the actuator setup from 0.1-12Hz. Data collected from the frequency sweep validates our model.





Conclusion

An Aero90 controller was setup to test an H-1 actuator's response to step and 0.1-12Hz frequency inputs. The results show the response of the H-1. actuator begins to fail at 6 Hz as predicted by the MATLAB model. In testing step responses, the gain was set so that overshoot was approximately 10%,. By using a proportional gain of 3.9, we were able to successfully match our predicted MATLAB results. With the knowledge gained from running the Aero90 system, it can be used for future TVC testing

Mentors

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