



AVT/ T-129

# Development of Control Strategies for the Vibration Control of Smart Aeronautical Structures

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Research and Technology Organization

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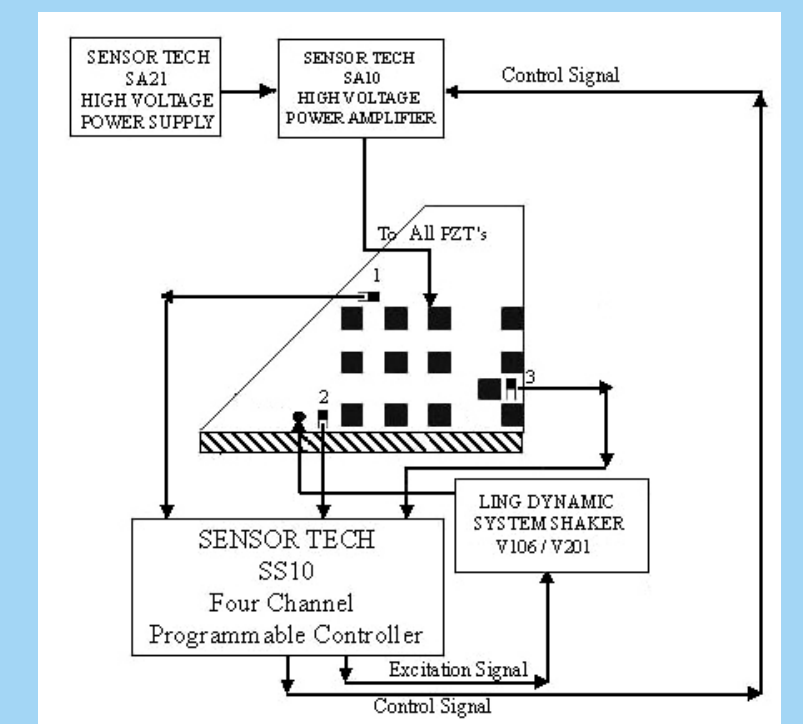
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Strain Measurements Set-up:  
Smart Fin

## PURPOSE:

The subject was the development of H-infinity and mu control strategies for the vibration control of smart fins (smart plate-like structures) by using PZT (Lead-Zirconate-Titanate) ceramic actuators.

## OBJECTIVES:

- . Application of smart materials (PZT) in the vibration control of smart structures.
- . Development of control strategies by using H-infinity and mu control techniques.
- . Experimental verification of developed strategies.

The studies were largely conducted in METU, Turkey. Sensor Technology Limited of Canada provided experimental set-ups and acted as consultant. Institute for Aerospace Research of Canada also acted as consultant.

## RESULTS:

Analytical and numerical modeling of aluminum beam-like and plate-like structures were completed during the previously supported AVT project T-121.

In terms of the control aspects, H-infinity controllers were designed and implemented for the smart beam (as SISO, Single Input Single Output, being 1 input to PZTs and 1 output from the beam by using strain gages or 1 input to PZTs and 1 output from the beam by using a laser displacement sensor) and mu controllers for the smart fin (as SISO, being 1 Input to all PZTs on one face of the fin only and 1 output from one of the strain gages or from the laser displacement sensor and as SIMO, Single Input Multi Output, being 1 Input to all PZTs on one face of the fin only and 2 outputs from two of the strain gages). Two different implementation procedures were used. First approach utilized a dedicated controller specifically designed for PZT applications by the Sensor Technology Limited called SS10. Measurements from the strain gages were considered. In the other approach LABVIEW based .vi programs were used to suppress the vibrations. A laser displacement sensor was utilized with data acquisition system. For both applications C algorithms were written.

Controllers were designed and implemented for both free and forced vibrations of the smart structures. For the free vibrations, only a tip displacement was given with zero initial velocity. For the forced vibrations a chirp signal was applied which had a frequency range enough to cover the relevant frequency range of both smart structures.

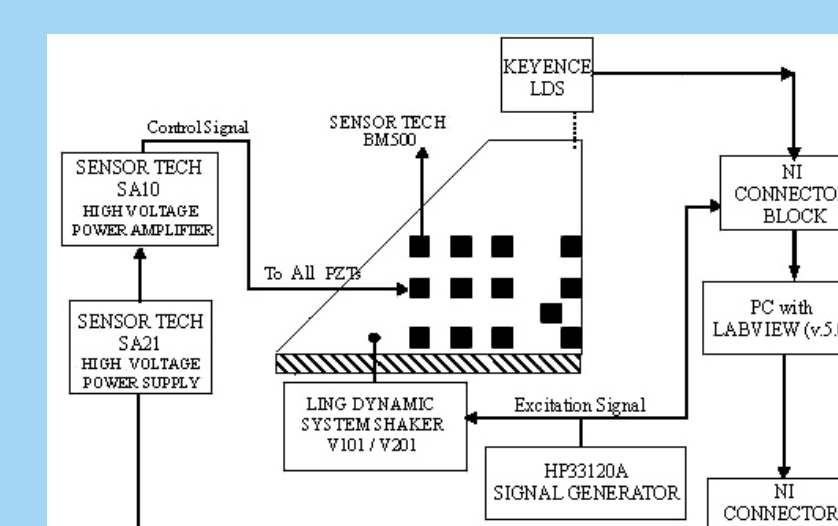
## PUBLICATIONS:

The following joint paper was published:

- 1) Yaman, Y., Ülker, F. D., Nalbantoglu, V., Çaliskan, T., Prasad, E., Waechter, D., Yan, B., "Application of H-Infinity Active Vibration Control Strategy in Smart Structures", AED2003, 3rd International Conference on Advanced Engineering Design, Prag, Czech Republic, 2003

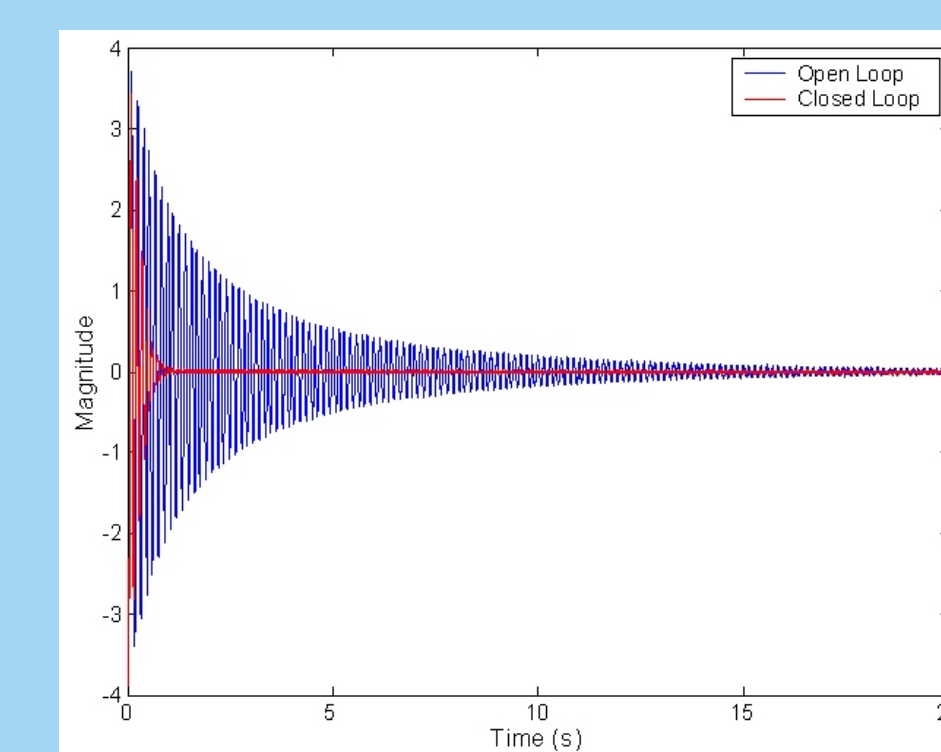
The following joint paper was accepted for publication:

- 1) Yaman, Y., Ülker, F. D., Nalbantoglu, V., Çaliskan, T., Prasad, E., Waechter, D., Yan, B., "Application of mu-Synthesis Active Vibration Control Technique to a Smart Fin", 6th Cansmart Meeting International Workshop on Smart Materials and Structures, Montreal, Quebec, Canada, 2003

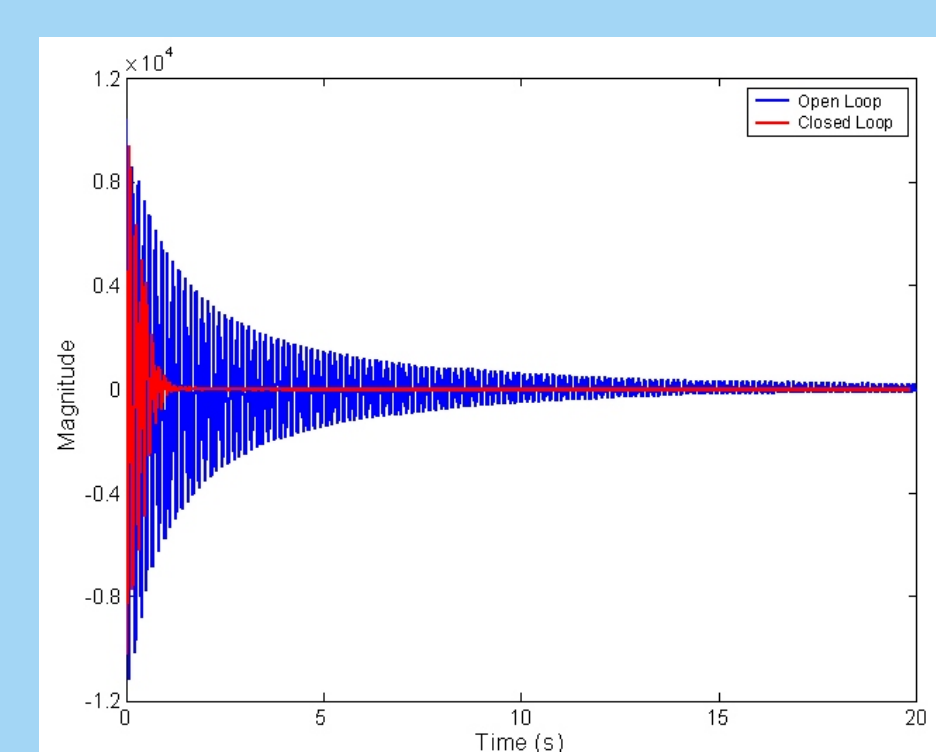
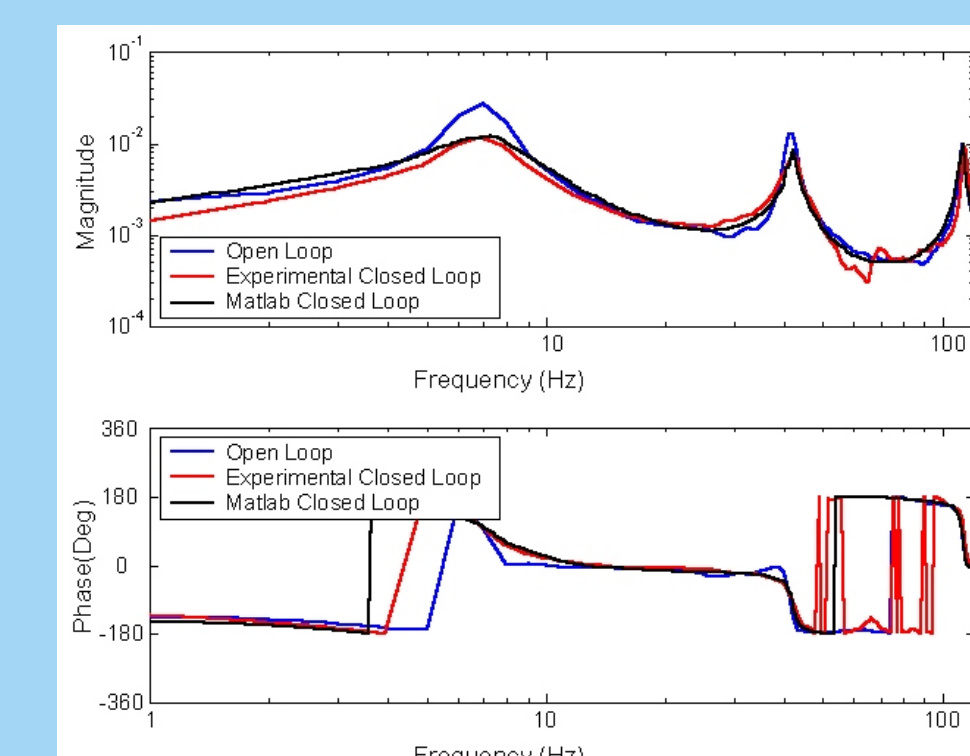


Laser Measurements Setup:  
Smart Fin

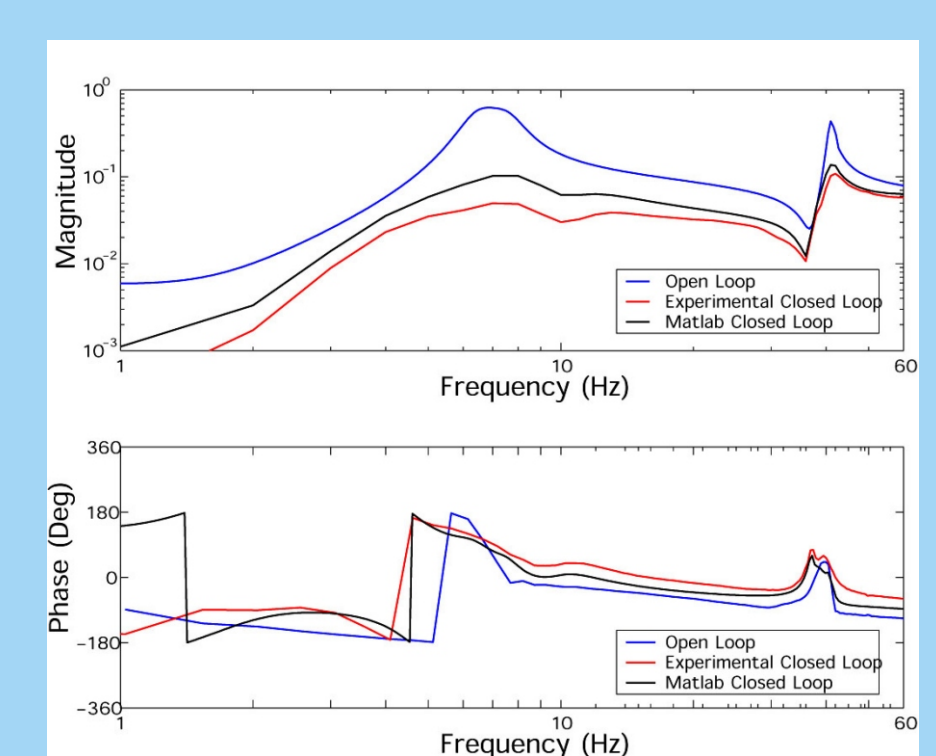
## Smart Beam Free and Forced Vibrations



Laser Measurements

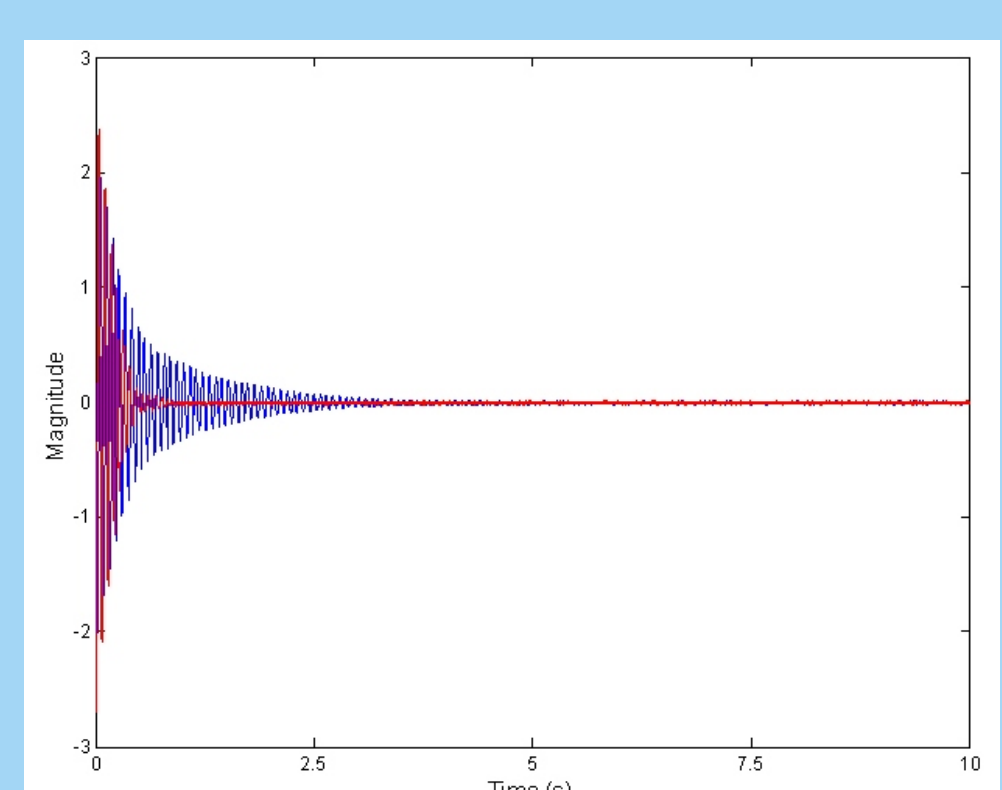
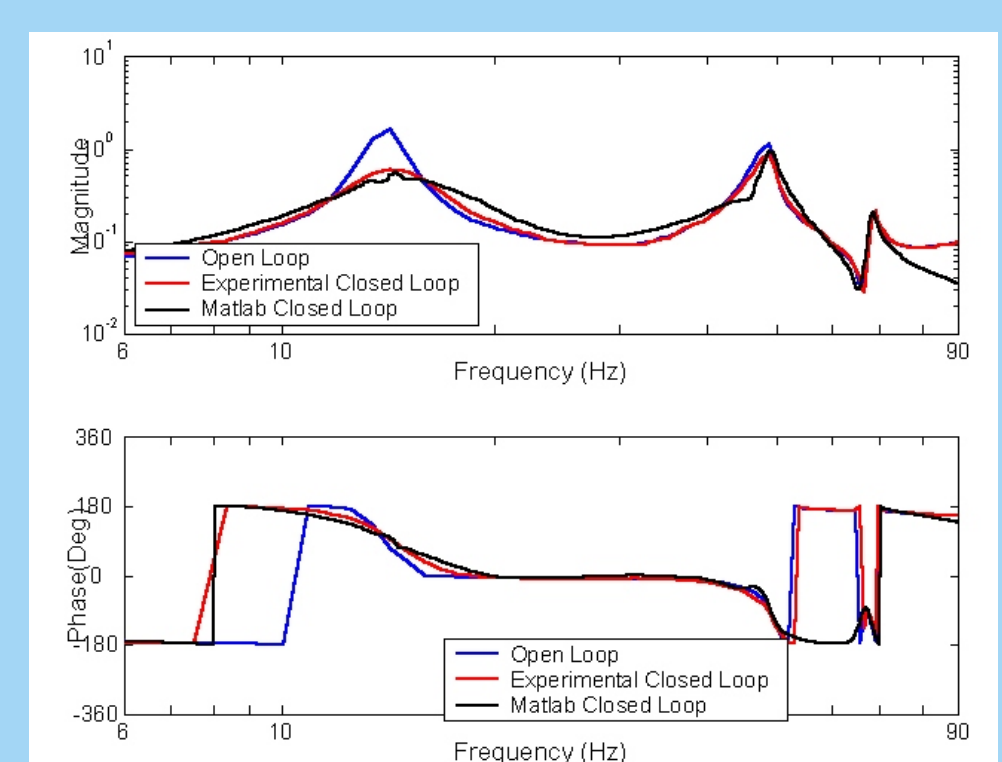


Strain Measurements



## Smart Fin Free and Forced Vibrations

Laser Measurements



Strain Measurements

