ICAST 2022

Vibration Suppression of Large Flexible Structures Subjected to Tonal Excitations via a Semi-Active Shunted Piezoelectric Tuned Mass Damper

Grigorios M. Chatziathanasiou, Nikolaos A. Chrysochoidis and Dimitris A. Saravanos

Department of Mechanical Engineering & Aeronautics, University of Patras, Patras University Campus, 26504, Greece
Email: grigoris.chatziathanasiou@gmail.com

Background and Motivation

Problem in lightweight structures

Engine speed/ rotor rations induce tonal vibrations

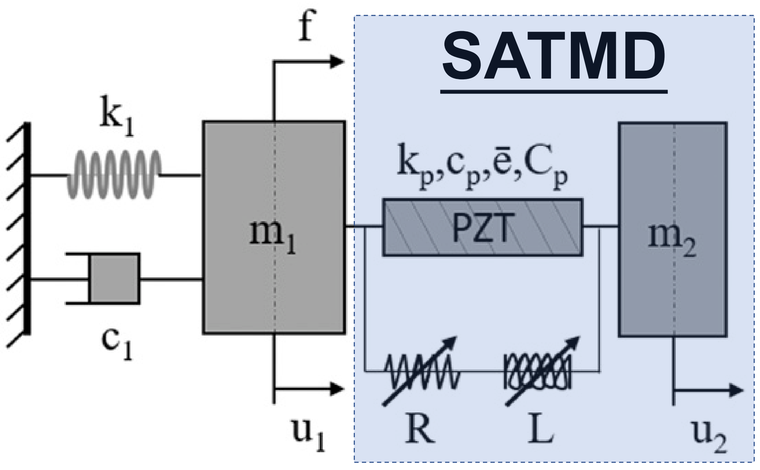
- Fundamental frequency and its harmonics
- In changing frequency bandwidths

➢ *Comfort and safety of passengers and pilots*

Challenges for Anti-vibration Device

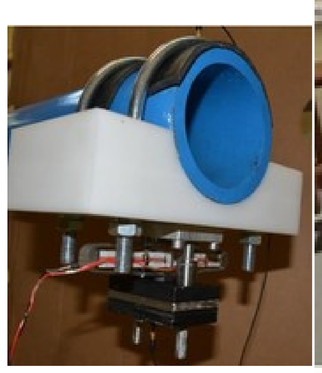
- Follow and tune to changing frequency bandwidths
- Tune and suppress multiple tonal excitations
- Achieve high vibration attenuation levels
- Lightweight, minimal structural interference

Semi-Active Shunted Piezoelectric Tuned Mass Damper

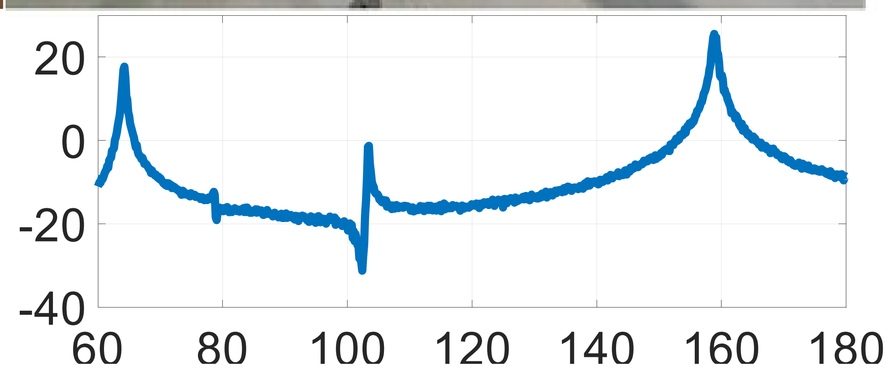


- ➢ Specialty spring-piezoelectric device.
- ➢ External resistive-inductive electric circuit.
- ➢ Resonant mass.

Case Study: Airframe



Airframe Tip FRF



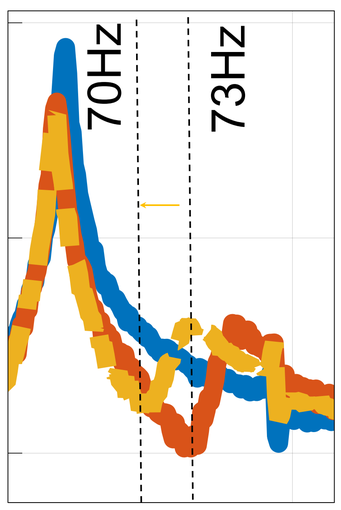
Objectives

Demonstrate the enhanced SATMD capabilities to:

A. *Retune* the detuned mass antiresonance and adapt to frequency fluctuations.
B. Tune and reduce the *tonal excitation frequency AND its critical harmonic*.

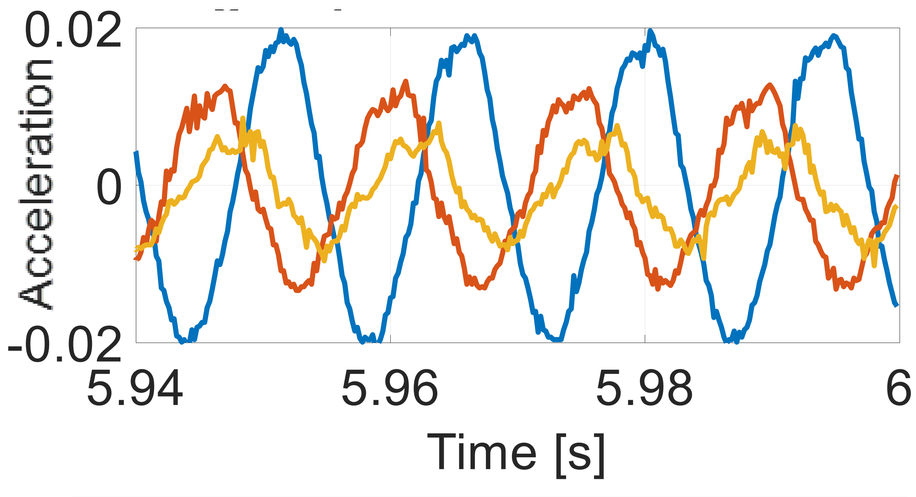
Experimental Results

A. Retune the detuned mass antiresonance



Baseline
TMD to 73Hz
SATMD to 70Hz

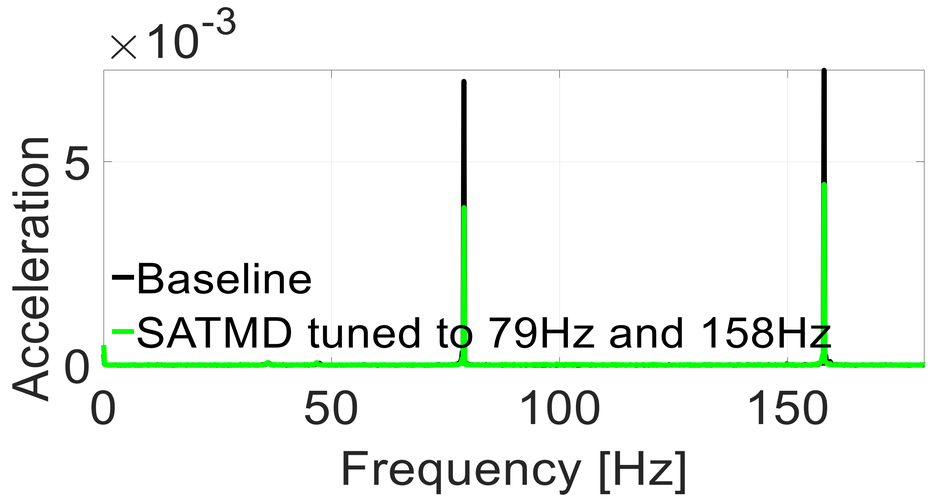
Fuselage Tip: Tonal Excitation at 70Hz



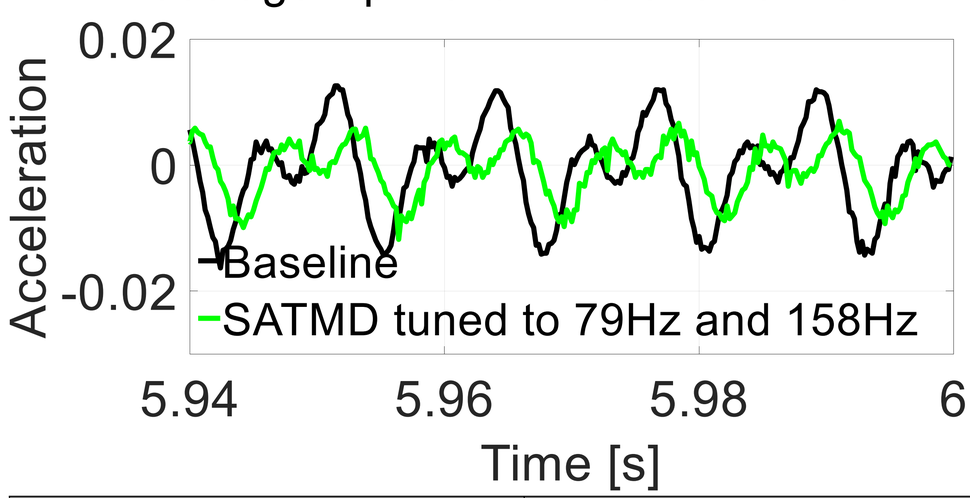
Mass tuned to 73Hz	Reduction at 70Hz
Detuned TMD	38%
Retuned SATMD	67%

B. Tune to tonal frequency and its critical harmonic

Fuselage Tip: FFT with Tonal Excitation at 79Hz



Fuselage Tip: Tonal Excitation at 79Hz



Frequencies	Reduction
79Hz	45%
158Hz	39%

Conclusions and Future Research

- ✓ Retuning of auxiliary mass antiresonance, thus ***capability of SATMD to follow frequency fluctuations.***
- ✓ Tuning to a tonal excitation AND its critical harmonic, thus ***capability of SATMD to reduce 2 tonal vibrations.***
- ❖ *Optimization expected to yield enhanced results.*