RESEARCH ON SMART MATERIALS AND STRUCTURES

FAPESP France Week 2025

Domingos A. Rade
(rade@ita.br)

Aeronautics Institute of Technology
Division of Mechanical Engineering
Laboratory of Dynamics & Vibrations

June 2025

OUR RESEARCH GROUP AT THE AERONAUTICS INSTITUTE OF TECHNOLOGY

FAPESP France Week 2025

MEMBERS:



Domingos A. Rade
(Professor)



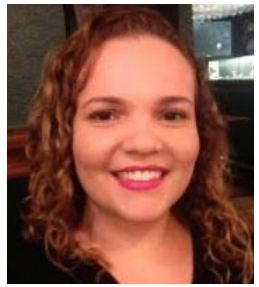
Thiago de P. Sales
(Assistant Professor)



Leandro R. Cunha
(Assistant Professor)



Vinicius G. Cleante
(Post-Doc Researcher)



Thaís L. A. Montanheiro
(Post-Doc Researcher)

COLLABORATORS:



Carlos De Marqui Jr.
(EESC-USP)



José R. de F. Arruda
(UNICAMP-retired)



Paulo J. P. F. Gonçalves
(UNESP-Bauru)



Leopoldo P. de Oliveira
(EESC-USP)



José M. C. dos Santos
(UNICAMP)



Ijar M. da Fonseca
(INPE - retired)



Cairo L. Nascimento Jr.
(ITA)



Daniel de A. Pereira
(Forza Composites)



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(Univ. Bourgogne Franche-Comté/ France)



Michael J. Brennan
(ISVR/UK - retired)



Timothy Waters
(ISVR/UK)



Jandro L. Abot
(UCA/USA)



Rui A. da S. Moreira
(Univ. Aveiro/Portugal)

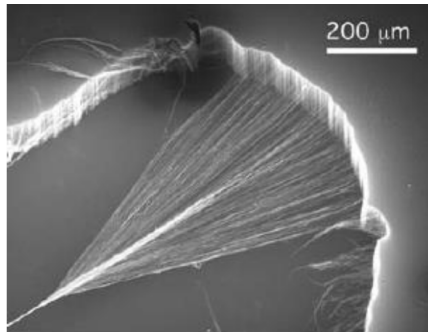
OUR CURRENT/RECENT RESEARCH TOPICS

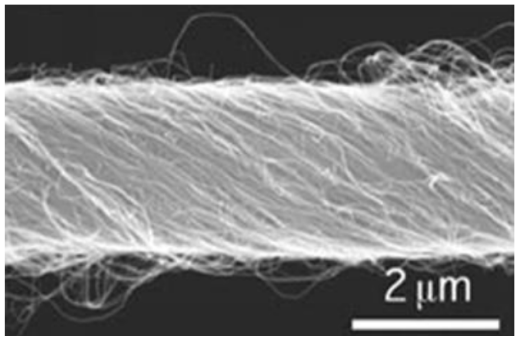
- Dynamics/aeroelasticity of advanced composite materials (variable-stiffness)
- Passive vibration/aeroelastic control using viscoelastic materials and vibration absorbers
- Vibrations and wave propagation in periodic structures and metamaterials
- Uncertainty quantification and stochastic modeling in structural dynamics and aeroelasticity
- Structural health monitoring using carbon nanotube-based integrated sensors
- Piezoelectric energy harvesting from vibration motion
- Vibration control of satellite panels using piezoelectric transducers
- Morphing aircraft components using shape memory alloys

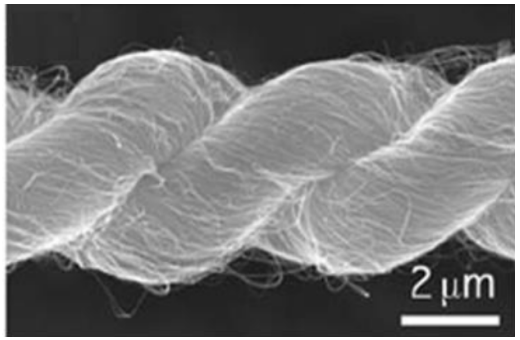
OUR RESEARCH DIRECTIVES

- Search for new/improved solutions to scientific/engineering problems.
- Mixed theoretical-numerical-experimental approaches.
- Projects funded by research agencies and industrial compagnies, with strong participation of graduate students and post-doc fellows.
- Collaboration with national and international partners.

STRUCTURAL HEALTH MONITORING USING CARBON NANOTUBE-BASED INTEGRATED SENSORS







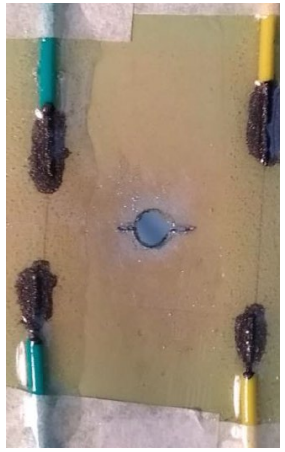
Monitoring principle: CNT yarns exhibit piezoresistive behavior

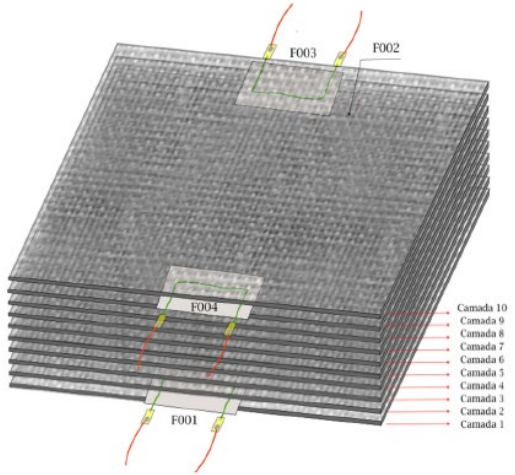
Advantages:

- Non-intrusive monitoring
- Monitoring of large areas
- Good sensitivity w.r.t strain and damage
- Full integration to the host structure

Objective:

- Increase the TRL aiming at industrial applications





Conclusions:

- Promising monitoring technique
- Problems being addressed: ageing, environmental influences

STRUCTURAL HEALTH MONITORING USING CARBON NANOTUBE-BASED INTEGRATED SENSORS

FAPESP France Week 2025

Composites Science and Technology 254 (2024) 110694

Contents lists available at ScienceDirect

Composites Science and Technology

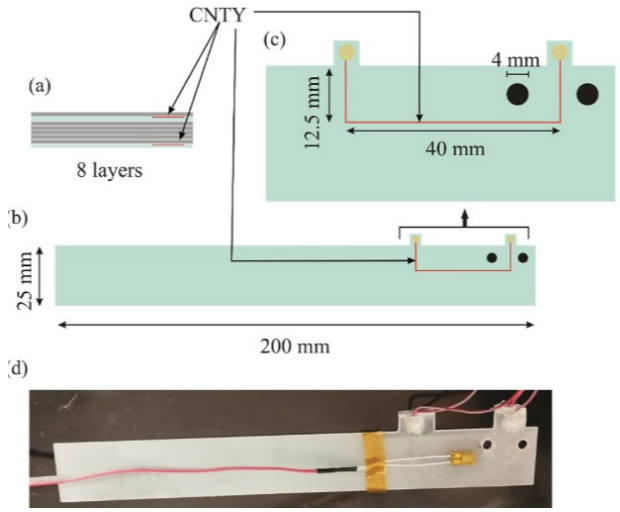
journal homepage: www.elsevier.com/locate/compscitech

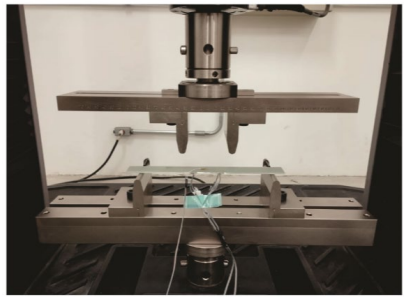
Monitoring of static and vibration responses of laminated composite materials using integrated carbon nanotube fibers

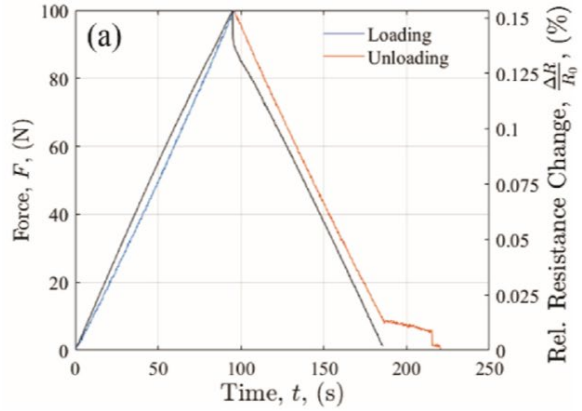
Jandro L. Abot [a,*], Thaís L.A. Montanheiro [b], Daniel de A. Pereira [c], Sérgio Nascimento Jr. [c], Cairo L. Nascimento Jr. [d], Juan R.B.F. Silva [d], Alexander H. Kasama [e], Domingos A. Rade [b]

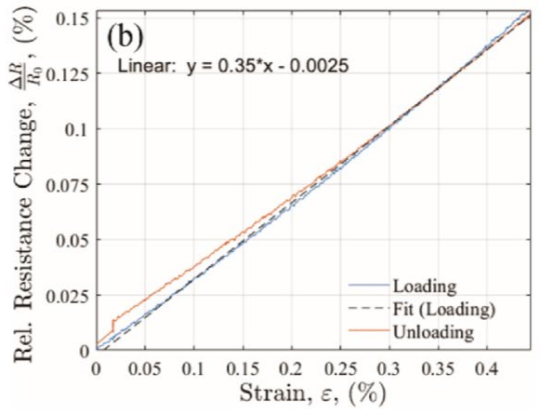
[a] Department of Mechanical Engineering, The Catholic University of America, Washington, DC, USA
[b] Instituto Tecnológico de Aeronáutica, Division of Mechanical Engineering, São José dos Campos, SP, Brazil
[c] Forza Composites, São José dos Campos, SP, Brazil
[d] Instituto Tecnológico de Aeronáutica, Division of Electronics Engineering, São José dos Campos, SP, Brazil
[e] CENPES, Petrobras, Rio de Janeiro, RJ, Brazil

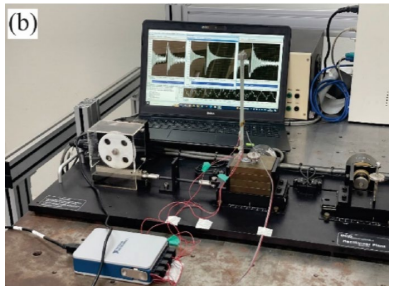
https://doi.org/10.1016/j.compscitech.2024.110694

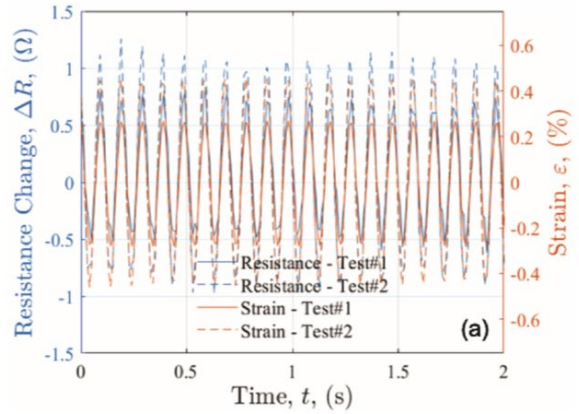


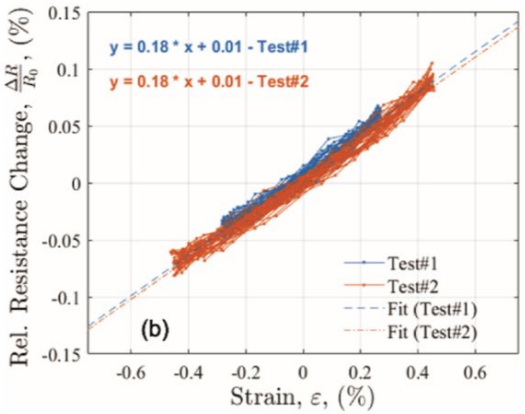












PIEZOELECTRIC ENERGY HARVESTING FROM VIBRATION MOTION

Mechanical Systems and Signal Processing 79 (2016) 141–148

Contents lists available at ScienceDirect

Mechanical Systems and Signal Processing

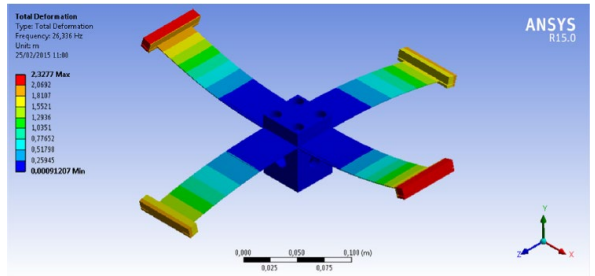
journal homepage: www.elsevier.com/locate/ymssp

Experimental evaluation of a cruciform piezoelectric energy harvester

Karina M. Tsuruta [a], Domingos A. Rade [b,*], Roberto M. Finzi Neto [a], Aldemir A. Cavalini Jr.[a]

[a] Federal University of Uberlândia, Av. João Naves de Ávila, n. 2121, Uberlândia, MG, Brazil
[b] Technological Institute of Aeronautics, Praça Marechal Eduardo Gomes, 50, São José dos Campos, SP, Brazil

https://doi.org/10.1016/j.ymssp.2016.03.005





Objective:

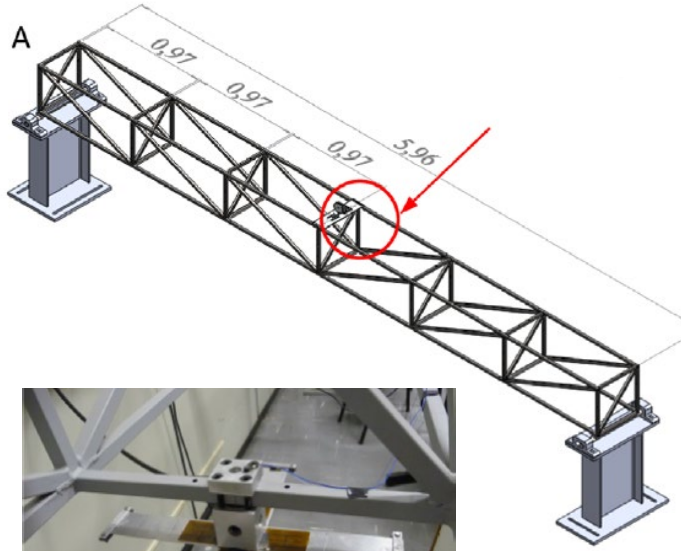
- Design and numerical/experimental evaluation of an enhanced piezoelectric energy harvester to be appended to vibrating structures.

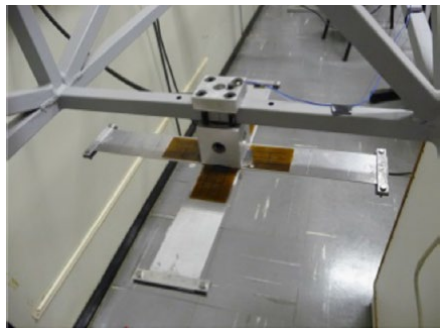
Interest:

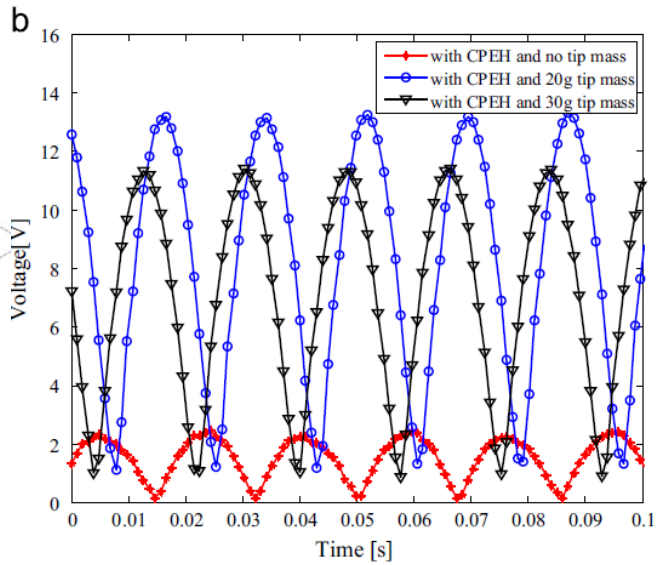
- Electric feeding of low-power remote sensing and signal transmission devices.

Conclusions:

- Validated concept
- Possible further improvements







VIBRATION CONTROL OF SATELLITE PANELS USING PIEZOELECTRIC TRANSDUCERS

Aerospace Science and Technology
Volume 29, Issue 1, August 2013, Pages 403-412

Passive vibration control of flexible spacecraft using shunted piezoelectric transducers

T.P. Sales [a], D.A. Rade [a] ✉, L.C.G. de Souza [b]

https://doi.org/10.1016/j.ast.2013.05.001

Objective:

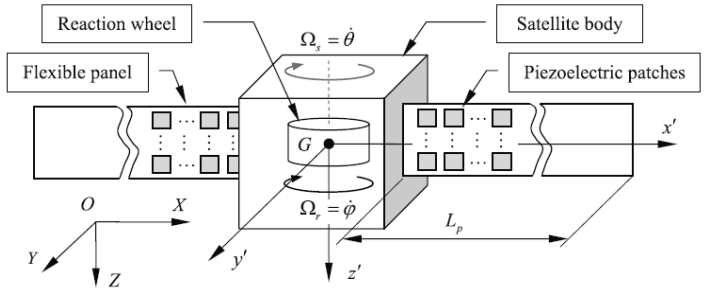
- Attenuation of the vibration of satellite panels induced by attitude correction maneuvers.

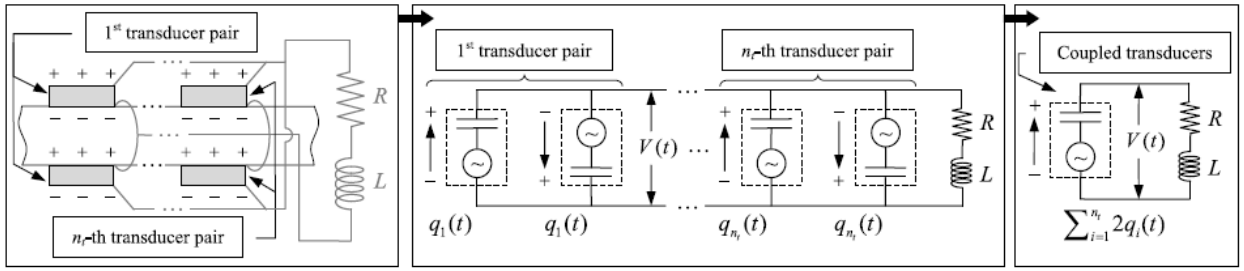
Approaches:

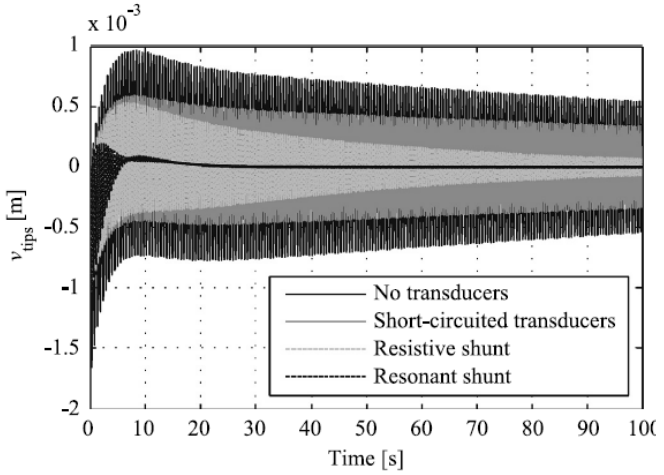
- Passive vibration control using piezoelectric transducers connect to resonant electric circuits (shunt circuits).

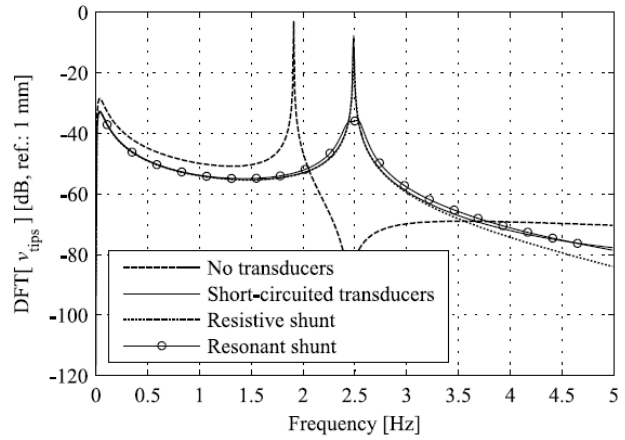
Conclusions:

- Effective vibration damping
- Need of TRL increase









VIBRATION CONTROL OF SATELLITE PANELS USING PIEZOELECTRIC TRANSDUCERS

Acta Astronautica 139 (2017) 357–366

Contents lists available at ScienceDirect

Acta Astronautica

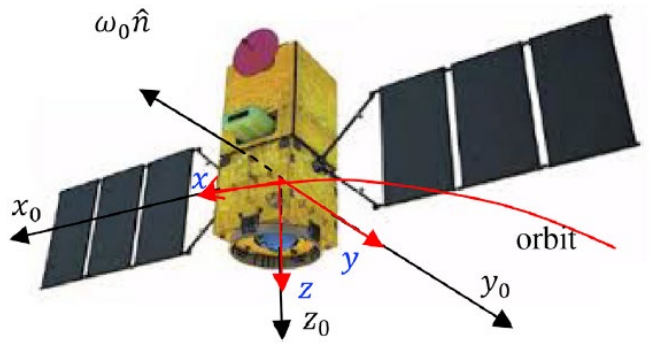
journal homepage: www.elsevier.com/locate/actaastro

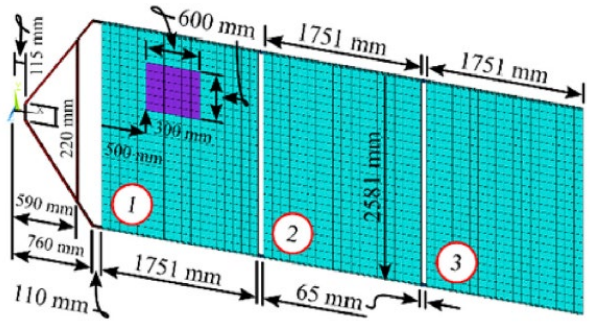
Attitude and vibration control of a satellite containing flexible solar arrays by using reaction wheels, and piezoelectric transducers as sensors and actuators

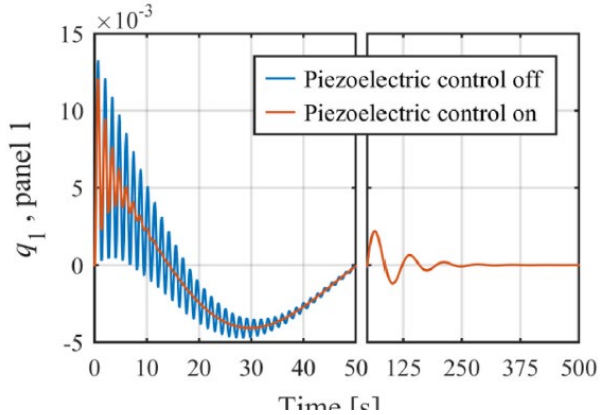
Ijar M. da Fonseca [a,*], Domingos A. Rade [b], Luiz C.S. Goes [b], Thiago de Paula Sales [c]

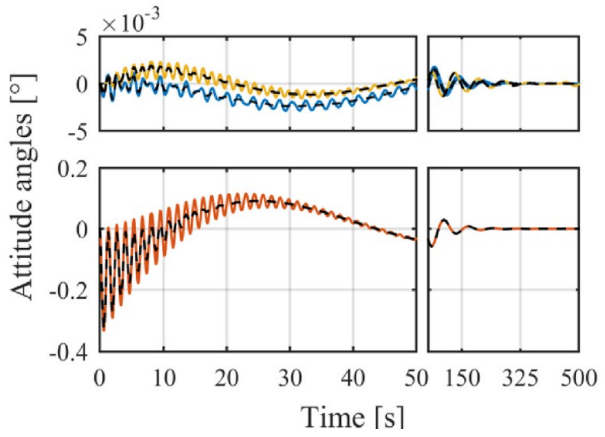
[a] Aeronautical Mechanics Division, ITA and Space Mechanics and Control Division, INPE, S. J. dos Campos, SP, Brazil
[b] Aeronautical Mechanics Division, ITA, S. J. dos Campos, SP, Brazil
[c] Federal University of Uberlândia, UFU, Uberlândia, MG, Brazil

https://doi.org/10.1016/j.actaastro.2017.07.018









Objective:

- Attenuation of the attitude/flexible vibration coupling induced by attitude correction maneuvers.

Approaches:

- Active vibration control using piezoelectric transducers as sensors and actuators.

Conclusions:

- Effective coupling mitigation
- Need of TRL increase

VARIABLE-CAMBER MORPHING WING USING SMA WIRES AND PERMANENT MAGNETS

FAPESP France Week 2025

Journal of the Brazilian Society of Mechanical Sciences and Engineering (2020) 42:122
https://doi.org/10.1007/s40430-020-2202-0

TECHNICAL PAPER

Check for updates

A morphing metastructure concept combining shape memory alloy wires and permanent magnets for multistable behavior

Thiago de P. Sales[1] · Domingos A. Rade[1] · Daniel J. Inman[2]

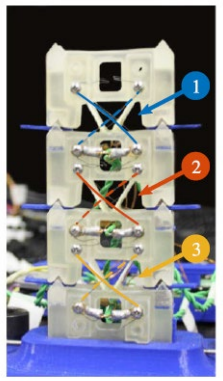
Received: 1 May 2019 / Accepted: 28 January 2020
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https://doi.org/10.1007/s40430-020-2202-0

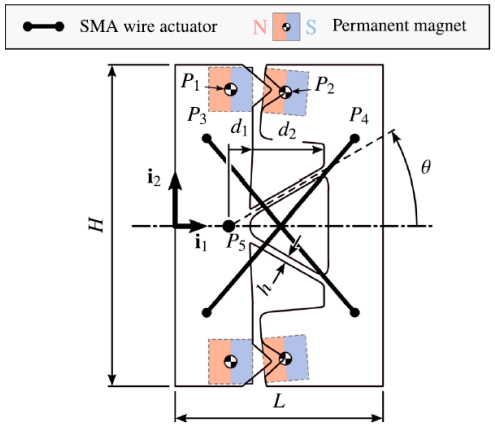
Objective: propose and assess strategies for the design of variable-camber morphing wings using SMA in association with permanent magnets to achieve multiple stable configurations.

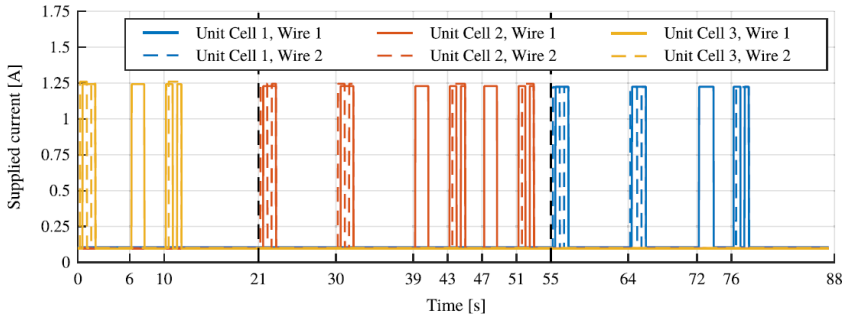
Conclusions:

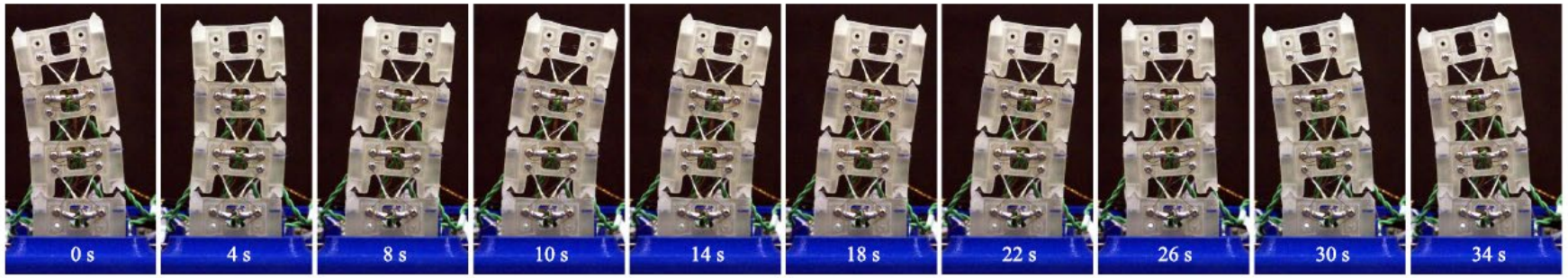
- Effective morphing capability
- Requires complex control procedures



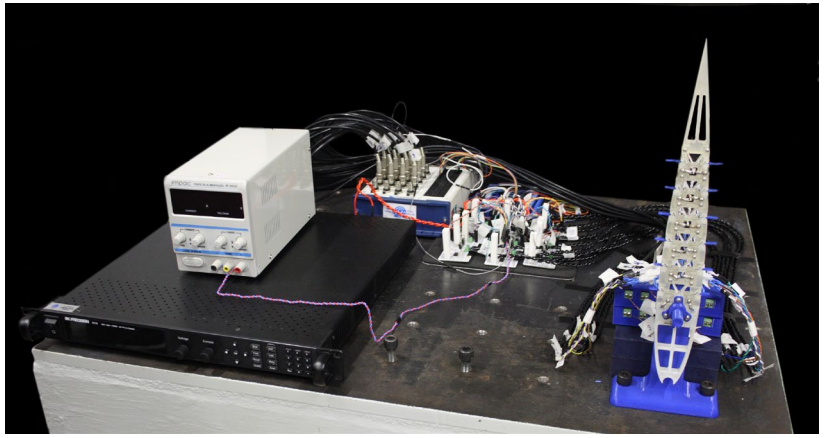
(b) Tested prototype

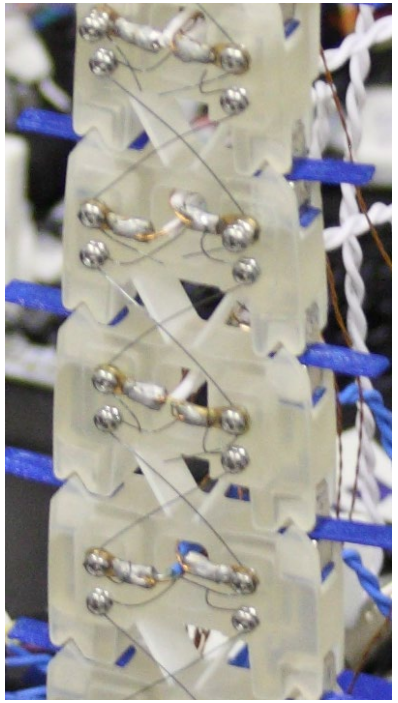


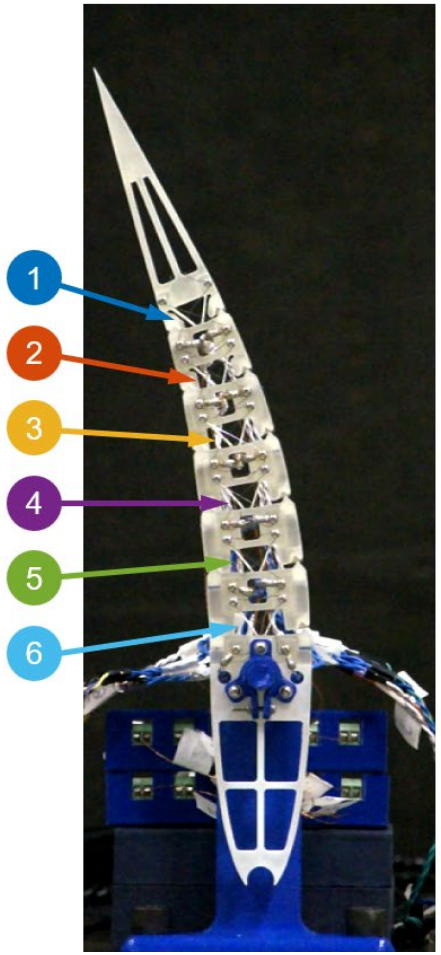


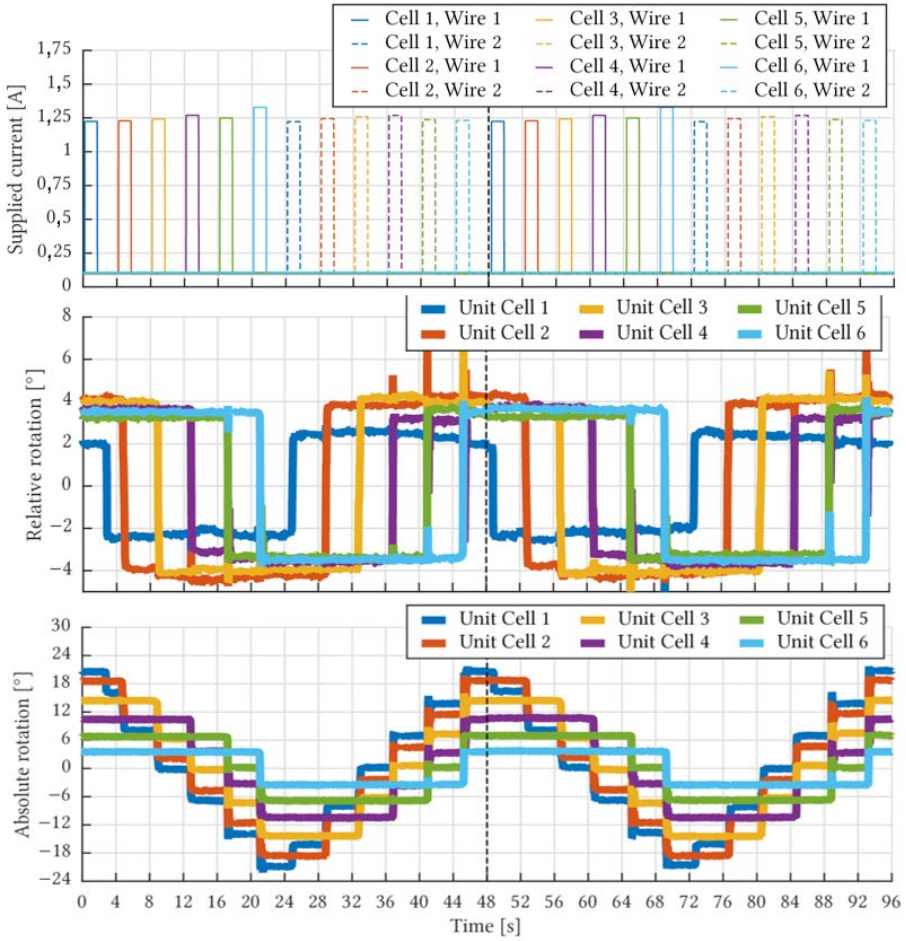


VARIABLE-CAMBER MORPHING WING USING SMA WIRES AND PERMANENT MAGNETS









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June 2025