DYNAMICS AND CONTROL OF HIGHLY FLEXIBLE STRUCTURES FOR AEROSPACE APPLICATIONS

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Outline

• Summary of the background and current focus
• Structural simulations on solar panels
• Simulations of the booms dynamics
• Preliminary design of the deployer
• Numerical simulations on morphing
• Conclusions and future work
Background

Membrane solar panels

ILC Dover, Teledesic Inflatable Solar Array

ESA/EADS Inflatable and Rigidizable Solar Array Breadboard

DSS’s Mega-ROSA

L’Garde Inflatable Torus Solar Array Technology
Background

Solar and drag sails

JAXA’s Ikaros

NASA’s NanoSail-D

ESA/DLR solar sail
Background

L’Garde’s LDP inflatable antenna

Membrane antennas

L’Garde/NASA’s Inflatable Antenna Experiment

L’Garde’s Synthetic Aperture Antenna
Background

Advantages:
• Lower mass and storage volume
• Lower launch costs
• Lower manufacturing costs

Drawbacks:
• Flexibility
• Low natural frequencies that can cause instabilities on the central body
• Membrane dynamics changes with:
  • tension state
  • presence of creases
Current focus

• Membrane solar panels for nanosatellites
  • About 50W of power each

• Tensioning system that keeps the membrane stretched
  • Bi-stable booms

• Deploying system
  • Motor to control the deployment rate

• Control system for damping vibrations on the booms (not included in the presentation)
  • Smart materials
  • Passive vibration control through damping materials
Bistable booms

Bi-stable booms:

- are elongated structures made of composite material (e.g. CFRP, GFRP...)
- have low mass per unit length (e.g. 65 g/m)
- can be stored in a compact fashion inside the satellite
- present two well-defined stable equilibrium configurations: the deployed (unrolled) and the stowed/coiled (rolled) one, with the lowest strain energy
Conclusions and future work

Thanks for your attention!
Any questions?