Multi-stable Morphing Structures

Shape Morphing
- Structures that change shape or state in order change their operating characteristics.
- Changes as a response to changes in the environment conditions.
- Deforms with heat, electricity and relaxes to remember shape.

Wing Morphing
- Potential Advantage
  - Possesses the ability to optimize and adapt their shape in order to achieve multi-objective missions.
  - Increased Cost Effectiveness by eliminating multiple mission specific aircrafts.
  - Aerodynamic performance improvement:
    - Flight envelope widening
    - Reduce drag to improve range
    - Reduce vibration or control flutter
    - Increase endurance for a given fuel load through improved lift-to-drag ratio.

Blade Morphing
- Adapts geometry to changing flow conditions.
- Stiff, single element wind turbine rotor blades can be replaced with blades that employ effective tailoring to change effective pitch and shape.
- Potentional high aerodynamic efficiency, simple construction and low weight.
- Lowering the cost per kilowatt of energy produced.

Biomimicry- Venus Flytrap
- Two layers of cells, mechanically connected to each other behave like bilayer couple where inplane contraction or expansion causes the change in curvature of the whole leaf.
- Dynamic sequence of the leaf closure. The time between images is 0.04 s. Colour indicates the value of the local mean curvature.
- Spatially averaged curvature and spatially averaged gaussian curvature as a function of time.

Rayleigh Ritz Method
- Multi-stability and Morphing
  - Characterised by very large displacements and nonlinear deformations that are undertaken during structural shape changes.
  - Actuations from one stable state to another.
  - Based on works by Hyer, Pierra and Weaver, Giglio, Dano.

Multi-Stability and Morphing

Multi-Stability Solar Wafers
- Plate Geometry
- Rayleigh-Ritz Results: Curvatures
  - Bifurcation diagram: eutectic (577 °C) to room temperature (20 °C).
- Comparison with FEM and Semi Analytical Solution

References