ISTITUTO
DI TECNOLOGIE DELLA
COMUNICAZIONE,
DELL'INFORMAZIONE
E DELLA
PERCEZIONE

PERCRO Perceptual
Robotics Laboratory

Scuola Superiore
Sant'Anna

Elementi di FEM

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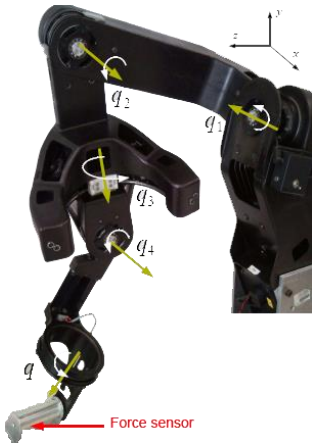
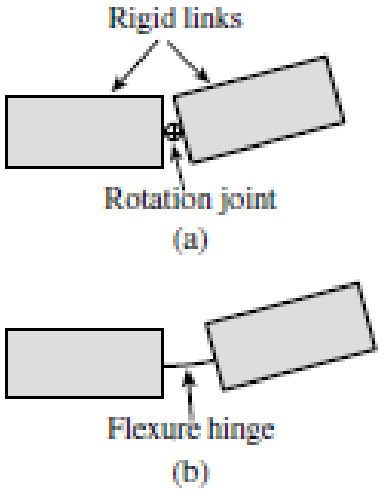


Design of flexure hinges

- Design of manipulators substituting joints with deformable structures
- Efficient for very small devices
- Suitable for
  - limited displacement
  - fatigue resistant materials
  - high resistance/stiffness ratio materials

Flexure hinges



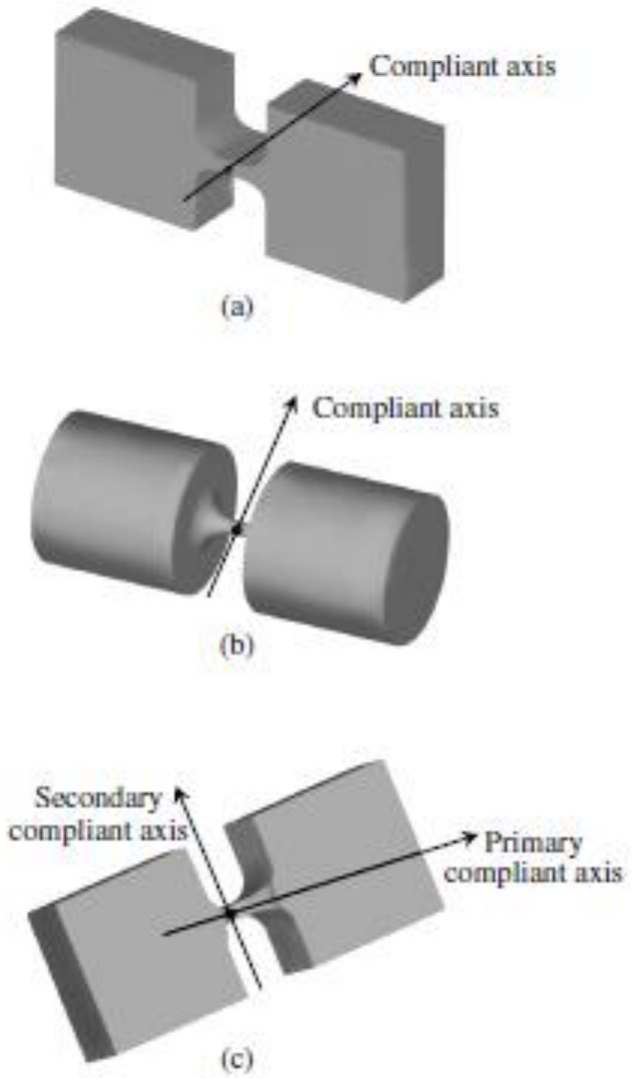
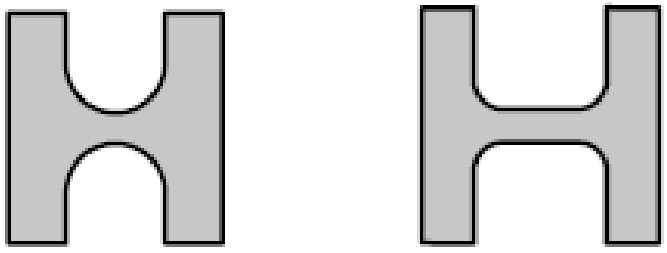
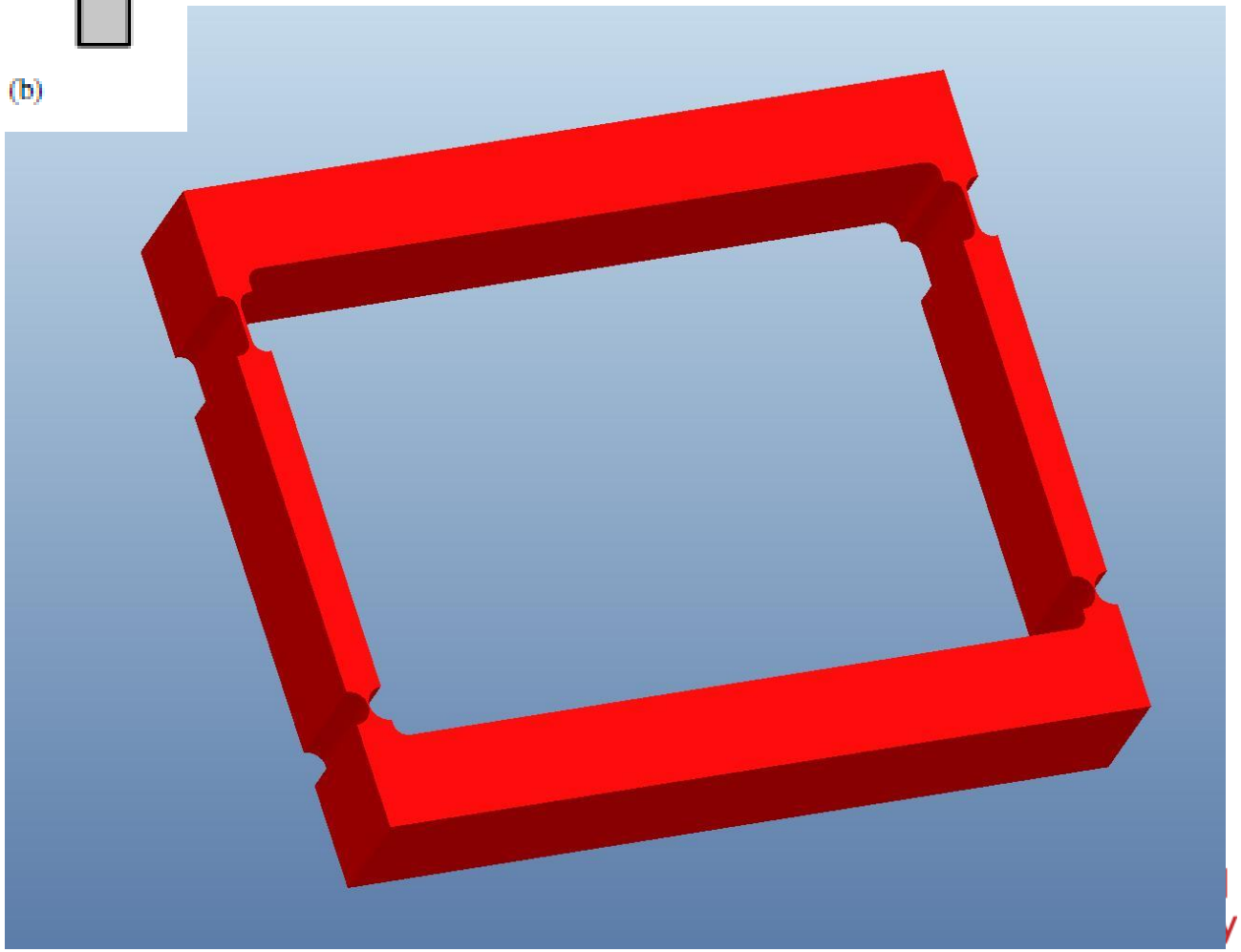


FIGURE 1.3
Three main categories of flexure hinge configurations: (a) single-axis; (b) multiple-axis (revolute); (c) two-axis.

Rotational joint with flexure hinges

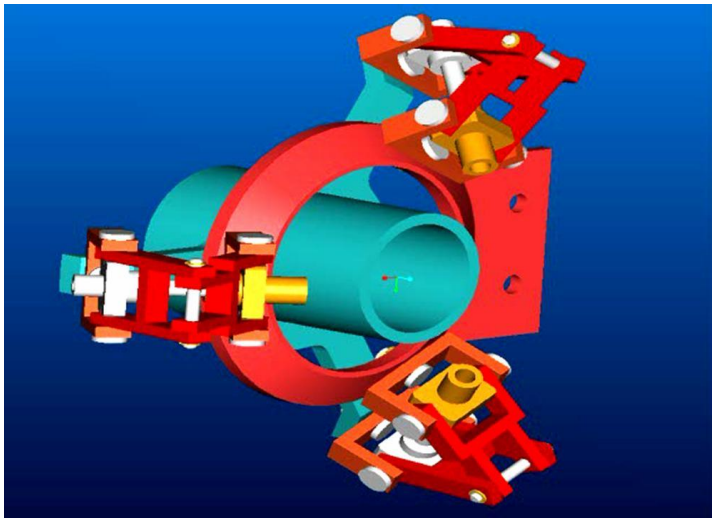


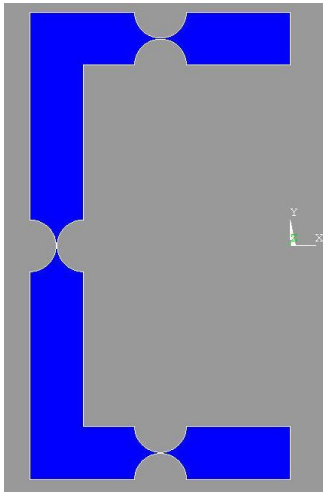
(a) (b)

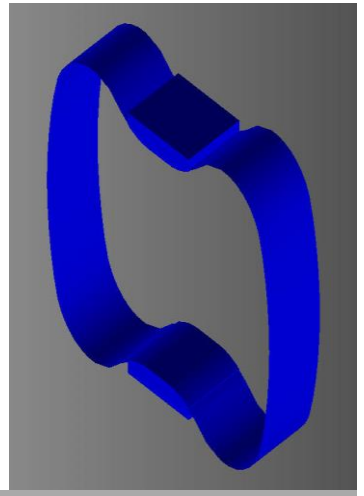


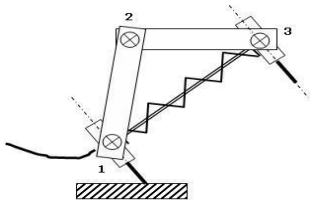
Applications

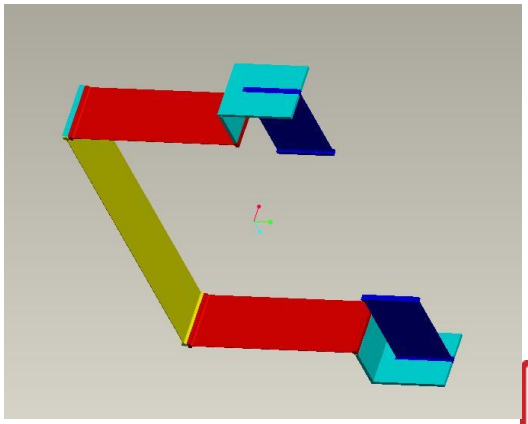
- 5 DoF leg of a parallel manipulator

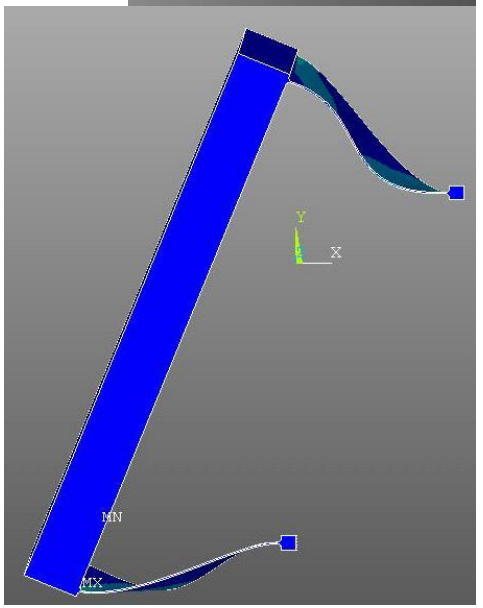






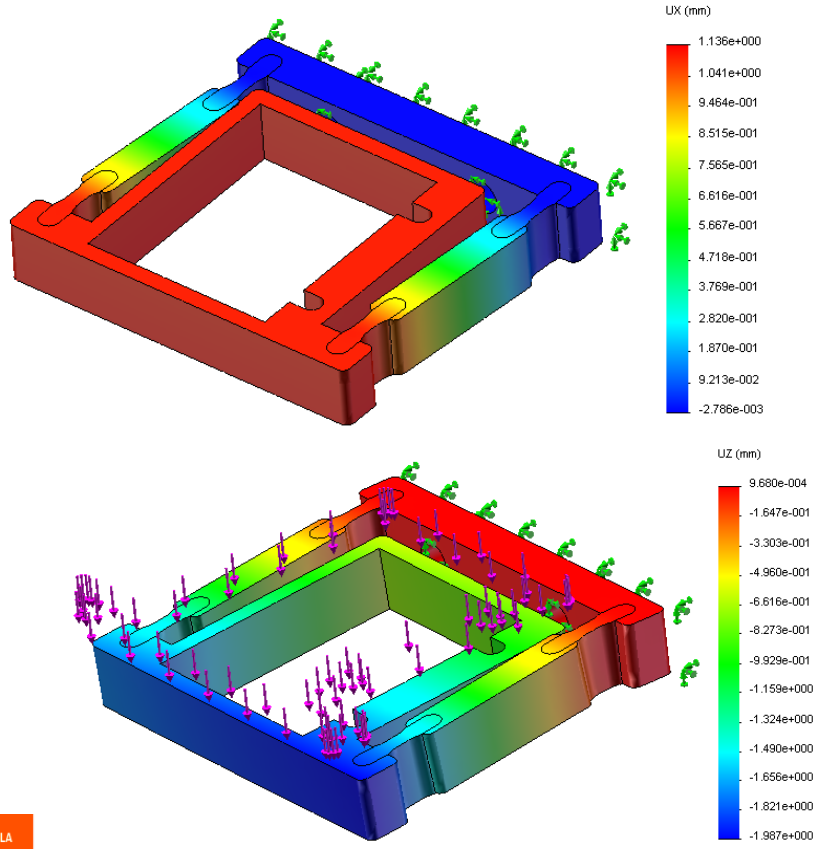


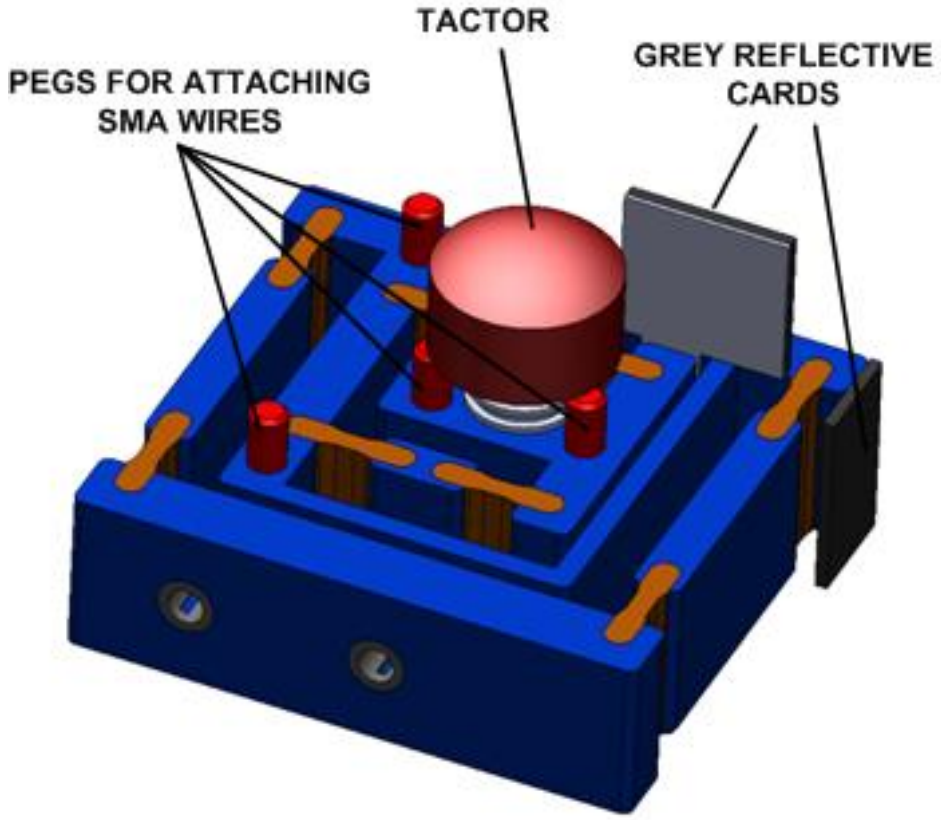




Applications

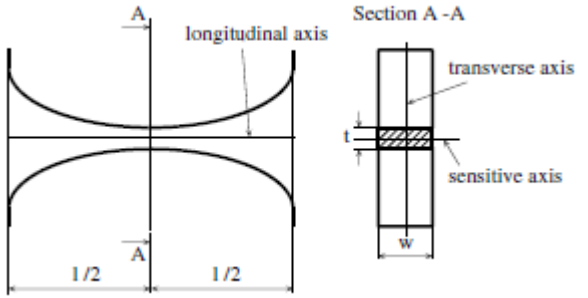
- 2 DoF platform made by two materials (stiff - compliant)



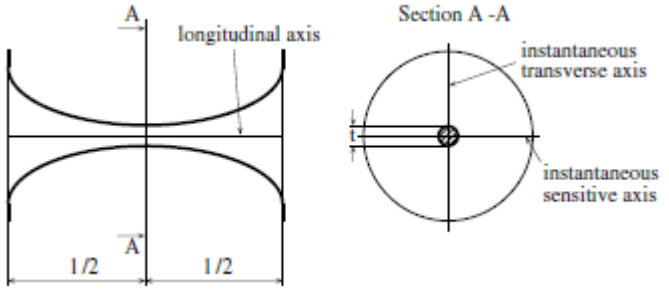


Examples

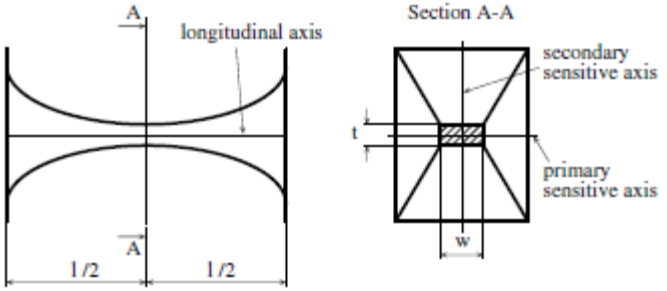
- Single axis hinge



- Multiple axis hinge



- Two-axis hinge



Statical analysis

- Analytical methods: principle of virtual work, Castigliano's second theorem

- FEM analysis: necessary for precise stress analysis of complex geometry, variable section regions and points of stress intensification

Kinematic analysis

- Flexure hinges are an approximation of a joint
- The precision of motion, represented by the position of the equivalent motion axis, changes depending of the pose of the hinge
- FEM analysis allow to verify the difference between theorical and effective motion of the hinge