

Smart Materials and Soft Robotics; How They Mimic Nature

Masoumeh Ozmaian, Assistant Professor, Mechanical Engineering, College of Engineering
mozmaeian@wtamu.edu



Introduction

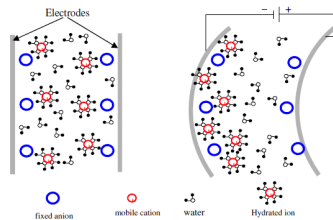
Despite the traditional robots, soft robots do not have heavy and expensive parts such as motors, instead they are made of more advanced materials. The natural complexity of smart materials is exploited to provide delicate movements that we need in variety of applications.

Advantages of Soft Robotics

- Adaptable shape
- Can achieve complex motion
- Low-cost materials
- Compatible for human interaction

Drawbacks of Soft Robotics

- Less powerful than rigid robotics
- Requires specific electronic controls

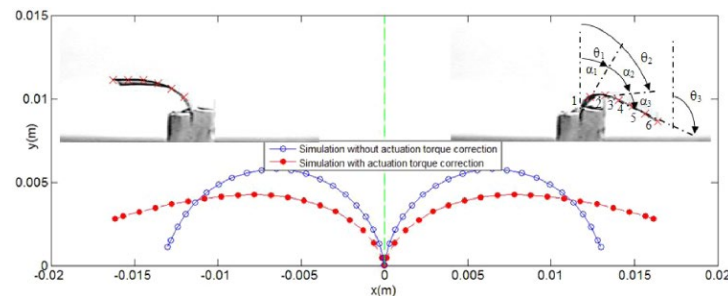


An example of a soft gripper in nature is the Venus flytrap. The rapid closure of the Venus flytrap leaf in about 100 ms is one of the fastest movements in the plant kingdom. This led Darwin to describe the plant as “one of the most wonderful in the world.”

Ionic-polymer metal nanocomposites (IPMNC)

A similar mechanism can be observed in the motion of Ionic polymer-metal nanocomposite (IPMNC). An ionic polymer-metal composite consisting of a thin Nafion sheet, platinum plated on both faces, undergoes large bending motion when an electric field is applied across its thickness. Conversely, a voltage is produced across its faces when it is suddenly bent.

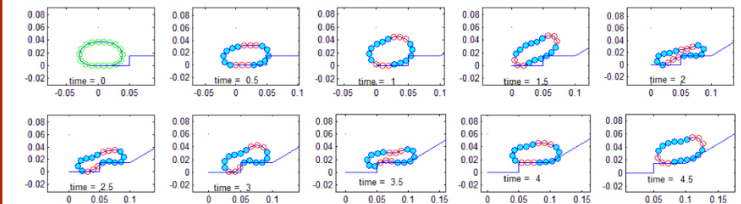
The following picture shows the deformation of a IPMNC strip under applied voltage. Using image processing, the deformation of the strip is measured.



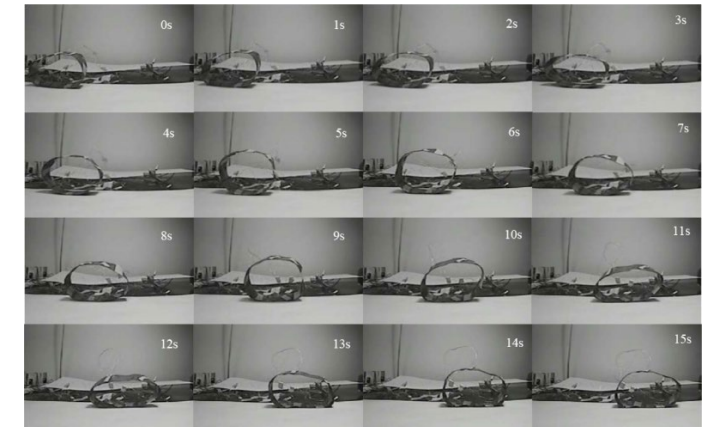
As the next step of this study, a deformable ring is made of a long IPMNC ribbon with a continuous polymer and electrode layer on one side and six electrically isolated electrode layers on the other side. These six segments make the deformations of the ring robot more accurate. The flexibility of the ring robot can be seen in the following pictures from simulation.

Ring-like Robot

A deformable ring with six segments passing obstacles.



Locomotion of the deformable ring made of IPMNC.



Scan the QR code to watch the video of ring-like robot.



References: [1] Firouzeh, A., M. Ozmaian, and A. Alasty. *Smart Materials and Structures* 21.6 (2012): 065011. [2] M. Ozmaian, M. Baghani, and R. Naghdabadi. *Mechanics Research Communications* (2014).