Enhancing the Performance of Elastomer Actuators Through the Approach of Distributed Electrode Array with Fractal Interconnects Architecture

Negar Danesh,*[1] Bhargav Koppolu[1]
Faculty: Sindhu Preetham Burugupally,[1] Yongkuk Lee[2]
[1] Department of Mechanical Engineering, College of Engineering
[2] Department of Biomedical Engineering, College of Engineering

Dielectric elastomer actuators are flexible and stretchable transducers which are known to achieve large displacements at high speeds and require low power for operation with applications in microrobotics, portable electronics, medical devices, and wearable technology.

A dielectric elastomer actuator consists of a thin elastomer membrane sandwiched between two compliant or rigid electrodes. Upon energizing the actuator by supplying actuation voltage, the electrodes move towards each other due to the electrostatic force of attraction, which results the compression of membrane in the thickness direction and expansion of the membrane in radial direction. To achieve large displacements in actuators with thin metal electrodes, we implement the approach of distributed electrode array with fractal interconnects. Here, a single large electrode is replaced with an array of N number of small individual electrodes (circles) physically linked together with stretchable springs/fractal interconnects. In this work, we characterized the static and dynamic response of the actuators for different voltage amplitudes V and frequencies f, fabricated with different number of electrodes N (N=1, 5, 13, and 25) in the array.

Our results test that for a given electrode array N, the actuator displacement and the response time increased with the actuation voltage amplitude V. Importantly, for a fixed actuation voltage amplitude V, the actuator displacement increases with the number of electrodes N in the array—demonstrating that our approach of distributed electrode array with fractal interconnects results in producing large displacement by at least four folds. This study highlights that our approach will help achieve large actuator displacements at high speeds, making these actuators suitable for driving microrobots.