Elastomer-Based Actuators for Wearable Haptics and Soft Robotics

Herbert Shea

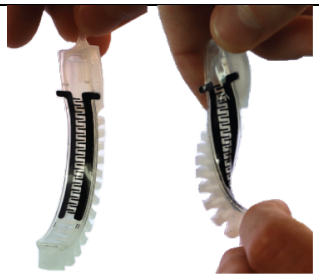
Institute of Microengineering (IMT), Ecole Polytechnique Fédérale de Lausanne (EPFL), Neuchatel, Switzerland

E-mail: herbert.shea@epfl.ch

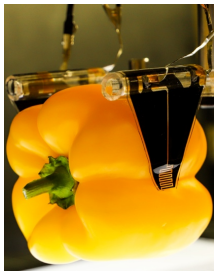
Abstract

Dielectric Elastomer Actuators (DEAs) are a type of artificial muscle consisting of a thin elastomer film sandwiched between two compliant electrodes. DEAs operate on electrostatic principles and can generate strains of over 100%. Using examples from our work in soft robotics and wearable haptics, I will illustrate how we have addressed many key limitations of DEAs, including obtaining high forces (16 N for a 1 g device), operating at high speed (5 kHz), and reducing drive voltage to 300 V, a level at which we can use SMD components for compact control electronics. This has enabled us to make fast untethered soft robots that autonomously follow complex paths, robust wearable haptic interfaces only 18 µm thick, compliant grippers able to delicately manipulate fruit and vegetables, and devices to stretch biological tissue very rapidly. I will introduce a stretchable all soft-matter pump that allows making soft robots using fluidic actuators, but completely does away with the need for pumps or compressors. Our ongoing work is aimed at embedding intelligence in soft machines.

Keywords: Soft Robotics, Dielectric Elastomer Actuator, Electro-active polymer, haptics

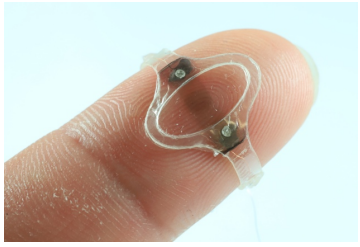


Stretchable pump with no moving parts driving a fluidic soft actuator



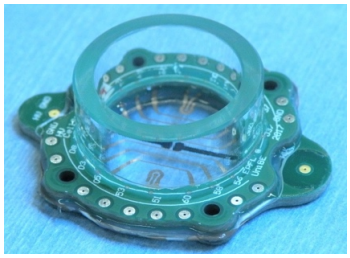
Compliant elastomer gripper able to hold 1000x its weight

0.2 g soft robot moving at 1.5 cm/s using DEAs operating at 300 V



“Feel-though” haptics with low-voltage DEAs

Flexible haptic display with 16 DEAs integrated with HV-TFTs



High speed DEAs for stretching cell cultures

Fig. 1. Examples of high-performance elastomer-based actuators.