Design and fabrication of a bio-inspired soft robotic gripper

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Abstract

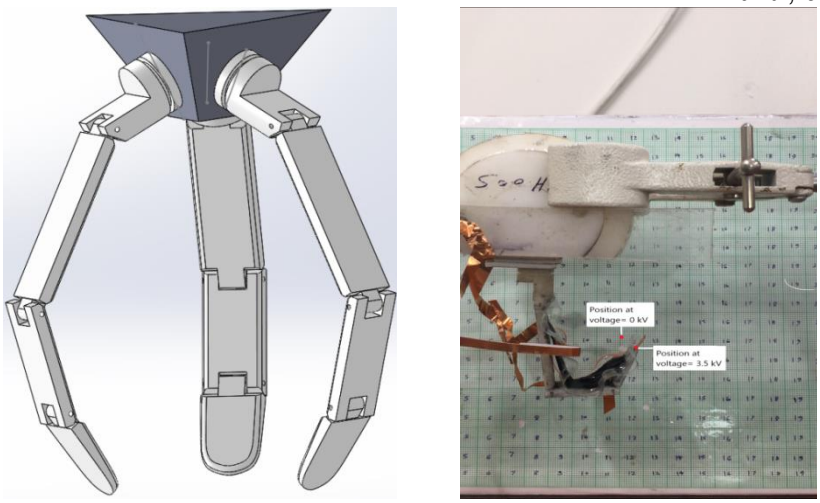
Soft compliant gripping is a promising way to protect soft objects from the grip damage. This paper deals with design of soft gripper inspired by human fingers. The gripping function is realized by means of 3D printed hard skeleton made of Acrylonitrile Butadiene Styrene (ABS) which is actuated by soft dielectric elastomer actuator. The possibilities of this gripper are demonstrated by different skeleton geometries. The applicability of this present design approach is characterized by lifting soft objects such as cake, cherry etc. It is shown that with gripper made using dimensions of ABS and Dielectric elastomer actuator (DEA) are able to grip and lift soft objects without damaging them.

1. Introduction

Design and fabrication of soft gripper is required for robots used in health care and food industry. Soft gripper has several advantages over existing rigid and complex robotic grippers such as better control of gripping force, adaptability towards the shape of the object, feel of human touch etc. For some designs of soft gripper such as four fingered gripper [1] and six pointed star gripper [2] the gripping is achieved with pneumatic actuation. There has been some initial investigation of hybrid soft rigid design space, but it is mainly focused on development of locomotion robots [3]. Bio-inspired soft grippers also have been developed which are based on natural species such as octopus [4]. Softness and compliance with the external environment is an important feature of human hand. Inspired by the construction of human fingers which have hard skeleton covered with soft tissues, the development of a soft gripper is carried in the present work. To this end, while the hard skeleton part is made using ABS, DEA is used for actuation of the fabricated gripper.

2. Procedure and configuration

DEAs are soft actuators which respond to the electrical stimuli. A thin membrane of dielectric elastomer is sandwiched between two compliant electrodes. On application of electric field, the membrane deforms due to Maxwell stress causing actuation [5]. Polydimethylsiloxane (PDMS) is used as the membrane with carbon grease as the electrode on both sides. The use of PDMS also ensures soft touch to the gripping object. Hard skeleton of each finger is multi-segmented. Each segment is joined by pin joint which gives a rotational degree of freedom to these segments. The combined effect of these segments results as in-plane motion of finger. The design of a soft gripper having three fingers is shown in Fig. 1a. Fig. 1b shows the actuation behaviour of a single finger under applied voltage.



(a) (b)

Figure 1. (a) Proposed design of three fingered soft gripper and (b) actuation behaviour of a single finger.

3. Conclusion

The skeleton of the soft gripper is fabricated using 3-D printer. Various design parameters and models are observed, based on the limitations and different challenges the best design is made for fabricating the soft gripper which is capable to grasp delicate objects like cotton balls and fruits.

4. References

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