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GRAPHITE-BASED RESISTIVE STRETCH SENSOR FOR FEEDBACK CONTROL OF SOFT ACTUATORS

Pravar Jain, Gokula Krishnan Ramachandran, Chen Hua Yeow

National University of Singapore, Singapore

Soft robotic actuators unlike rigid-link actuators are lightweight and easy to fabricate. However, these soft actuators lack suitable stretch sensing elements for feedback control. Commercially available sensors such as FlexiForce are flexible but not stretchable. Previously, researchers have developed soft sensors using conductive liquid, carbon nanotube, silver wires or by embedding rigid sensing elements in stretchable substrates. These sensors have complicated designs and are associated with high costs as they utilize materials like gold, silver wires, carbon nanotubes etc. Here, we present a simple, low cost, easy to fabricate, soft resistive sensor capable of stretch sensing. The proposed design utilizes graphite deposited on hyper elastic substrates to produce scalable stretch sensors. Using the technique of mixing, casting and curing, soft sheets of customized dimensions are fabricated using Eco-Flex. Graphite is deposited manually to obtain a conductive trace. The ends of the trace serve as terminals that are interfaced to the Analogto-Digital (ADC) pin of the micro- controller via a voltage divider. The microcontroller is programmed to deduce the resistance of the sensor from the voltage measured. Using a Universal Testing Machine (UTM), the electromechanical behaviour of the sensor was ascertained and a model correlating the sensor resistance with the induced stretch was developed.
The linear correlation obtained was implemented on a microcontroller to predict the amount of stretch. Evaluations using a UTM indicate that measurements from the sensor are coherent and re- producible. The gauge factor of the developed sensor is comparable with other carbon based strain sensors. This sensor was used for the feedback control of soft pneumatic wearable rehabilitation actuators made from hyper-elastic materials. Due to the high degree of compliance, this sensor can potentially be integrated with soft surgical robots, wearables for monitoring joint kinematics and also with devices used in physiotherapy such as elastic exercise bands.