

Finite element analysis of a tactile sensor for a robotic hand

Abstract

Using a bioinspired design approach, we describe the development of a tactile sensor for a robotic hand, based on the mechanoreceptors in the glabrous skin of the human, able to replicate the sensory function of both slow adapting and fast adapting receptors. Slow adapting receptors respond to initial contact and maintain firing throughout the contact period, whereas fast adapting receptors primarily respond during contact onset and offset. Strain gauges are used to emulate the slow adapting receptors, and polyvinylidene fluoride (PVDF) film is used to replicate the function of the fast adapting receptor. Finite element analysis is used to investigate the behaviour of the strain gauges and PVDF film embedded in a silicone elastomer, modelled as a hyperelastic material. One unit sensor consists of four strain gauges and a PVDF film, embedded underneath a square protrusion. The protrusion localises the applied force onto the region or 'receptive field' of the sensing unit. The strain gauges are arranged in an orientation to enable a unit sensor to identify the tri-axial force components. The PVDF film is used to measure vibration. Simulated random forces were applied to the sensor, and a regression model was developed based on the modelled strain gauge outputs. Simulations were also undertaken on the PVDF film to examine the load response to cyclical loads.

Keywords — Component, polyvinylidene fluoride (PVDF), strain gauge, tactile sensor