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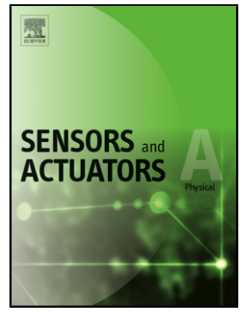

Title: PapillArray: An Incipient Slip Sensor for Dexterous Robotic or Prosthetic Manipulation – Design and Prototype Validation

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Title

PapillArray: An Incipient Slip Sensor for Dexterous Robotic or Prosthetic Manipulation – Design and Prototype Validation

Authors and Affiliations

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Highlights

- A sense of friction and/or grip security is essential for dexterous manipulation
- Such sensors for robotic gripping are inferior to their biological counterparts
- An incipient slip sensor is described that indicates grip security
- A simple model allows friction to be estimated when incipient slip is detected
- A proof of principle prototype is validated with multiple forces and frictions

Abstract

The major failing of robotic and prosthetic grippers in mimicking the dexterity of the human hand is thought to be a lack of adequate tactile sensing which provides feedback for grip control. The majority of existing tactile sensors focus on determining the contact forces; however, other tactile parameters, such as friction and the occurrence of incipient slip, are equally important for dexterous manipulation, particularly in unstructured environments. In this work, a design is presented for a grip security sensor – the PapillArray – which consists of an array of silicone pillars with different uncompressed heights. When the sensor is compressed, the tallest pillars in the centre are under greater normal stress and thus able to generate a greater friction force; this encourages the shorter outer pillars to slip first when a tangential force is applied. The incipient slip (as pillars slip independently) can be detected by measuring the deflection of the individual pillars, and continuous force/torque measurement is not strictly required. Each incipient slip event acts as a warning that the grip/normal force should be increased. A simple mathematical description of the principle of operation of one embodiment of the PapillArray with a single taller central pillar surrounded by eight shorter outer pillars (of equal height) is offered. A prototype of this embodiment is also presented and tested under different normal forces and frictional conditions. The deflection of the central pillar and a single outer pillar are determined by video recording and subsequent point-tracking methods. The outer pillar was observed to slip at a lower tangential force than the central