Challenges in Research of Touch and Soft Contact Interface in Bio-Mimicking and Sensing

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Throughout history, human inventions have always sought to mimic the appearance, mobility, functionality, and intelligent operation of humans and other living things. This field of biologically inspired technology, having the moniker biomimetics, has evolved from producing static copies of humans and animals (as in artwork and sculptures) to the emergence of robots that operate with lifelike behavior. Imagine a person walking towards you where suddenly you notice something strange about him or her – he or she is not real but rather is a robot. Your reaction would probably be "I can't believable it but this robot looks very real" just as you would react to an artificial flower that is convincingly real. You may even proceed and touch the robot to verify your assessment, but as opposed to the case of the flower, the robot may be programmed to respond physically and verbally. This science fiction scenario could become a reality as the current trends in the development of biologically inspired technologies continue.

The evolution of bio inspired technologies has led to the development of as artificial transducers
(i.e., sensors and actuators), artificial intelligence, and artificial vision as well as biomimetic capabilities in mechanical engineering, civil engineering, electronics, mechatronics, materials science, mechanics, electronics, computing science, information technology and many others.

When we observe the world around us, we see that the building blocks of human creation are typically rigid, noncompliant molecules in the form of steel, concrete, ceramics, plastics, etc.

Nature, on the other hand, has taken a slightly different tack, and has chosen the soft, compliant cell as its building block. Why is this?

It is interesting to note that, of the five faculties with which human beings have been blessed, it is only through the sense of touch that we can collect information directly from an object. For humans, touch sensing is the basis of dexterous manipulation, as it

provides us with information about mechanical properties such as compliance, friction, and mass. Indeed, people will have a difficult time sensing and manipulating objects with their hands when deprived of reliable tactile information due to numbness of the fingers. For the purpose of sensing and object manipulation, the advantages of soft contact interfaces over rigid ones are improved stability, contact transition, pressure distribution, and grip.

Despite these advantages, only recently have highly compliant sensors which mimic the human skin been developed. Such sensors require the analysis of explicit digital or analog electrical signals produced by the deformation of the sensor.

But perhaps there is another advantage inherent in the physical characteristics of soft tissue, specifically, the nonlinear viscoelastic behavior exhibited by compliant materials, including creep and relaxation. Exciting opportunities exist in studying the interplay between creep and relaxation in soft and/or biomedical tissues, as well as sensing, and determining if there is implicit information contained therein which will allow for more adaptable, scalable, and miniaturized intelligent sensors.