Soft Electronic Skin for Assistive Wearable Technologies

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1 Motivation

In contrast to existing electronics, machines, and robots, natural human tissue and organs are composed almost entirely out of soft, elastic, and fluidic matter. In order to preserve the body's natural mechanics, the wearable technologies that are used to monitor and assist human motor tasks must also be soft and elastic. This requires a re-examination of the materials and paradigms used to engineer the machines and electronics used for human motor assistance.

Efforts in soft-matter technologies for human motor assistance currently fall into two categories: Artificial Skin and Artificial Muscles. At the Soft Machines Lab we are currently producing new classes of artificial skin through a comprehensive research program that combines rapid prototyping, soft lithography fabrication, and theoretical insights from solid mechanics.

2 State of the Art

Artificial skin (aka Electronic or Robot skin) for wearable computing and sensing are typically produced with flex circuits and electric wiring woven into textiles. While flexible, these technologies have limited stretchability and can be bulky or uncomfortable to wear. In recent years, engineers have introduced wavy electronics that are as much as 100% stretchable and exhibit a broad range of sensing and logic functionalities.[1]

3 Approach & Results

Building on recent advancements in soft lithography and soft microfluidics, my research team and I have introduced new paradigms in artificial skin based on liquid-phase electronics.[2] Micro-channels of liquid-phase metal are embedded in thin sheets of elastomer. Elastic deformation leads to changes in electrical resistance, capacitance, and inductance, which are monitored to determine surface tractions and joint curvature.

With this method, we have produced several new classes of soft-matter sensors that measure elastic stretch, shear, and surface pressure. We have also introduced new methods for rapid and scalable fabrication using laser machining and micro-contact printing. Going forward, we expect to have a completely soft and elastic artificial skin capable of monitoring motion and surface traction.

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[1] Rogers et al. *Science* **333** 838-843 (2011).
[2] Majidi et al. *J. Micromech. Microeng., Smart Mater. Struct., IEEE ICRA, IEEE IROS, Appl. Phys. Lett.* 2010 – present