New skin-like sensors fit almost everywhere

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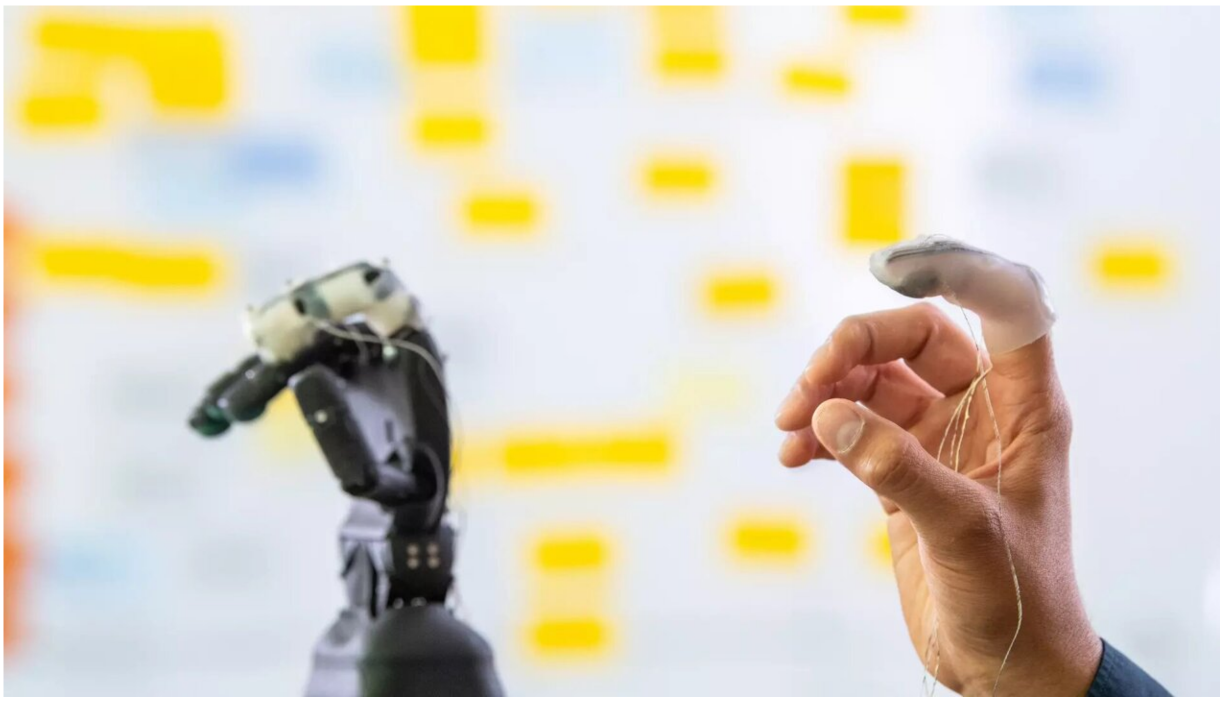

The sensor skin is very flexible and can be attached to many surfaces, including fingers, for example. Credit: Andreas Heddergott / TUM

Researchers from the Munich Institute of Robotics and Machine Intelligence (MIRMI) at the Technical University of Munich (TUM) have developed an automatic process for making soft sensors. These universal measurement cells can be attached to almost any kind of object. Applications are envisioned especially in robotics and prosthetics.

"Detecting and sensing our environment is essential for understanding how to interact with it effectively," says Sonja Groß. An important factor for interactions with objects is their shape. "This determines how we can perform certain tasks," says the researcher from the Munich Institute of Robotics and Machine Intelligence (MIRMI) at TUM. In addition, physical properties of objects, such as their hardness and flexibility, influence how we can grasp and manipulate them, for example.

The holy grail in robotics and prosthetics is a realistic emulation of the sensorimotoric skills of a person such as those in a human hand. In robotics, force and torque sensors are fully integrated into most devices. These measurement sensors provide valuable feedback on the interactions of the robotic system, such as an artificial hand, with its surroundings. However, traditional sensors have been limited in terms of customization possibilities. Nor can they be attached to arbitrary objects. In short: until now, no process existed for producing sensors for rigid objects of arbitrary shapes and sizes.

New framework for soft sensors presented for the first time

This was the starting point for the research of Sonja Groß and Diego Hidalgo, which they have now presented at the ICRA robotics conference in London. The difference: a soft, skin-like material that wraps around objects. The research group has also developed a framework that largely automates the production process for this skin. "We use software to build the structure for the sensory systems," says Hidalgo. "We then send this information to a 3D printer where our soft sensors are made."

The printer injects a conductive black paste into liquid silicone. The silicone hardens, but the paste is enclosed by it and remains liquid. When the sensors are squeezed or stretched, their electrical resistance changes.

"That tells us how much compression or stretching force is applied to a surface. We use this principle to gain a general understanding of interactions with objects and, specifically, to learn how to control an artificial hand interacting with these objects," explains Hidalgo.

What sets their work apart is that the sensors embedded in silicon adjust to the surface in question (such as fingers or hands) but still provide precise data that can be used for the interaction with the environment.

New perspectives for robotics and especially prosthetics

"The integration of these soft, skin-like sensors in 3D objects opens up new paths for advanced haptic sensing in artificial intelligence," says MIRMI Executive Director Prof. Sami Haddadin. The sensors provide valuable data on compressive forces and deformations in real time—thus providing immediate feedback. This expands the range of perception of an object or a robotic hand—facilitating a more sophisticated and sensitive interaction.

Haddadin explains, "This work has the potential to bring about a general revolution in industries such as robotics, prosthetics and the human/machine interaction by making it possible to create wireless and customizable sensor technology for arbitrary objects and machines."

The paper is published as part of the *2023 IEEE International Conference on Robotics and Automation (ICRA)*.

More information: Sonja Groß et al, Soft Sensing Skins for Arbitrary Objects: An Automatic Framework, *2023 IEEE International Conference on Robotics and Automation (ICRA)* (2023). DOI: 10.1109/ICRA48891.2023.10161344

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