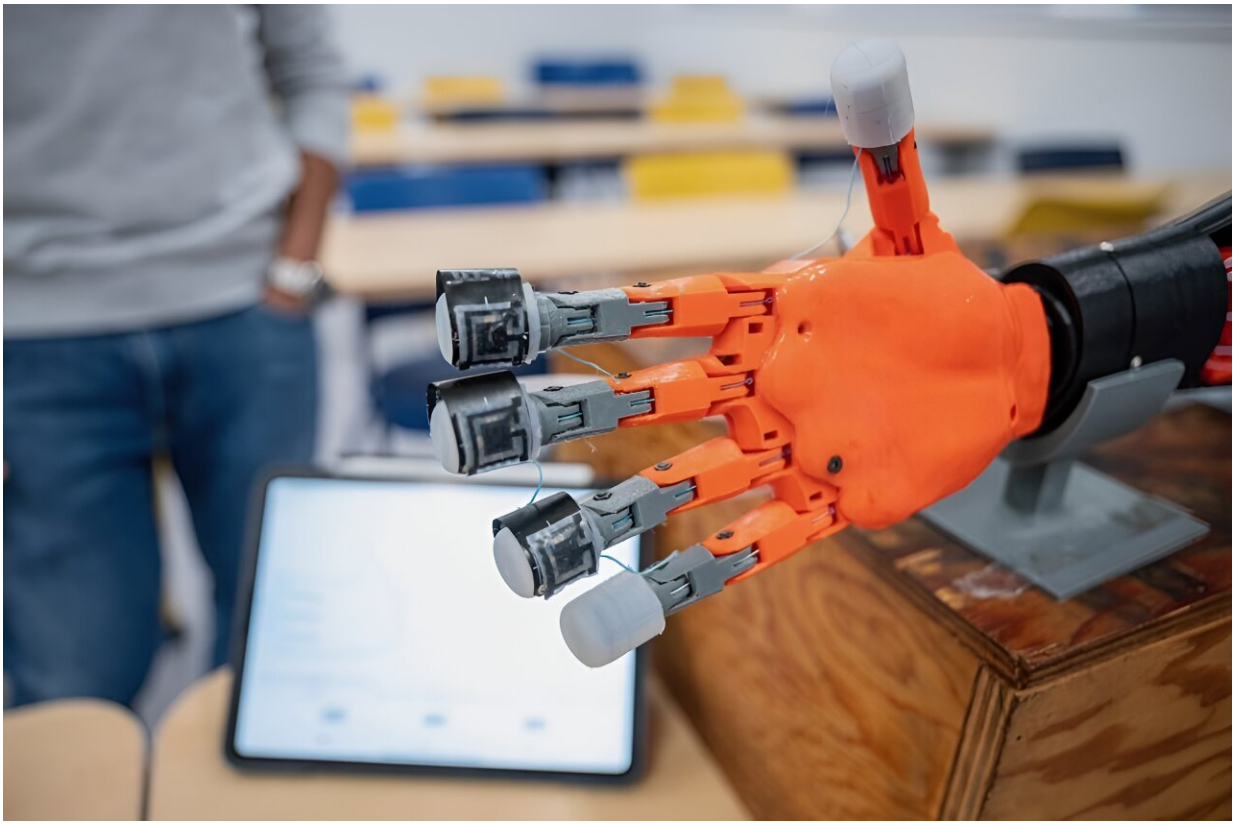
Engineers develop breakthrough 'robot skin'

October 26 2023, by Lou Corpuz-Bosshart

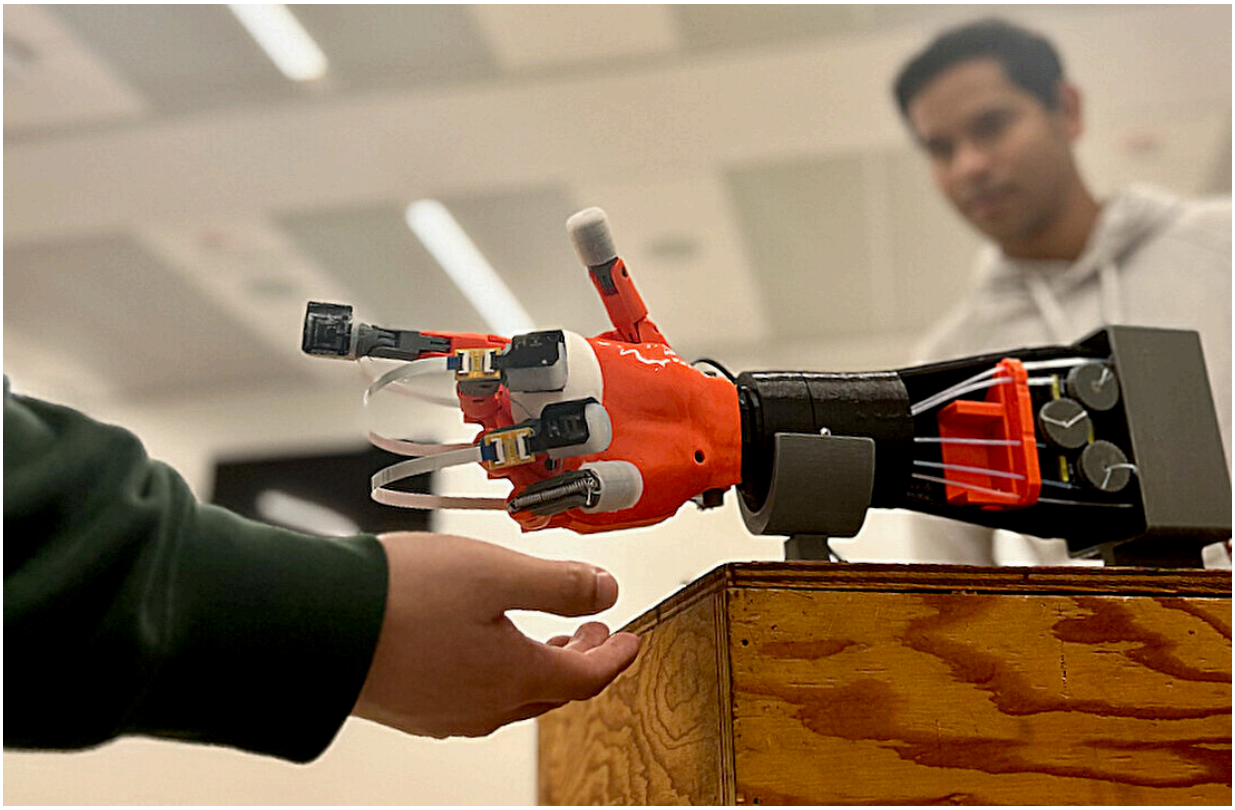


UBC engineers created the sensor in collaboration with Frontier Robotics, Honda's research institute. Credit: UBC Applied Science/Paul Joseph

Smart, stretchable and highly sensitive, a new soft sensor developed by UBC and Honda researchers opens the door to a wide range of applications in robotics and prosthetics.

When applied to the surface of a prosthetic arm or a robotic limb, the sensor skin provides touch sensitivity and dexterity, enabling tasks that can be difficult for machines such as picking up a piece of soft fruit. The sensor is also soft to the touch, like human skin, which helps make human interactions safer and more lifelike.

"Our sensor can sense several types of forces, allowing a prosthetic or robotic arm to respond to tactile stimuli with dexterity and precision. For instance, the arm can hold fragile objects like an egg or a glass of water without crushing or dropping them," said study author Dr. Mirza Saquib Sarwar, who created the sensor as part of his Ph.D. work in electrical and computer engineering at UBC's faculty of applied science.



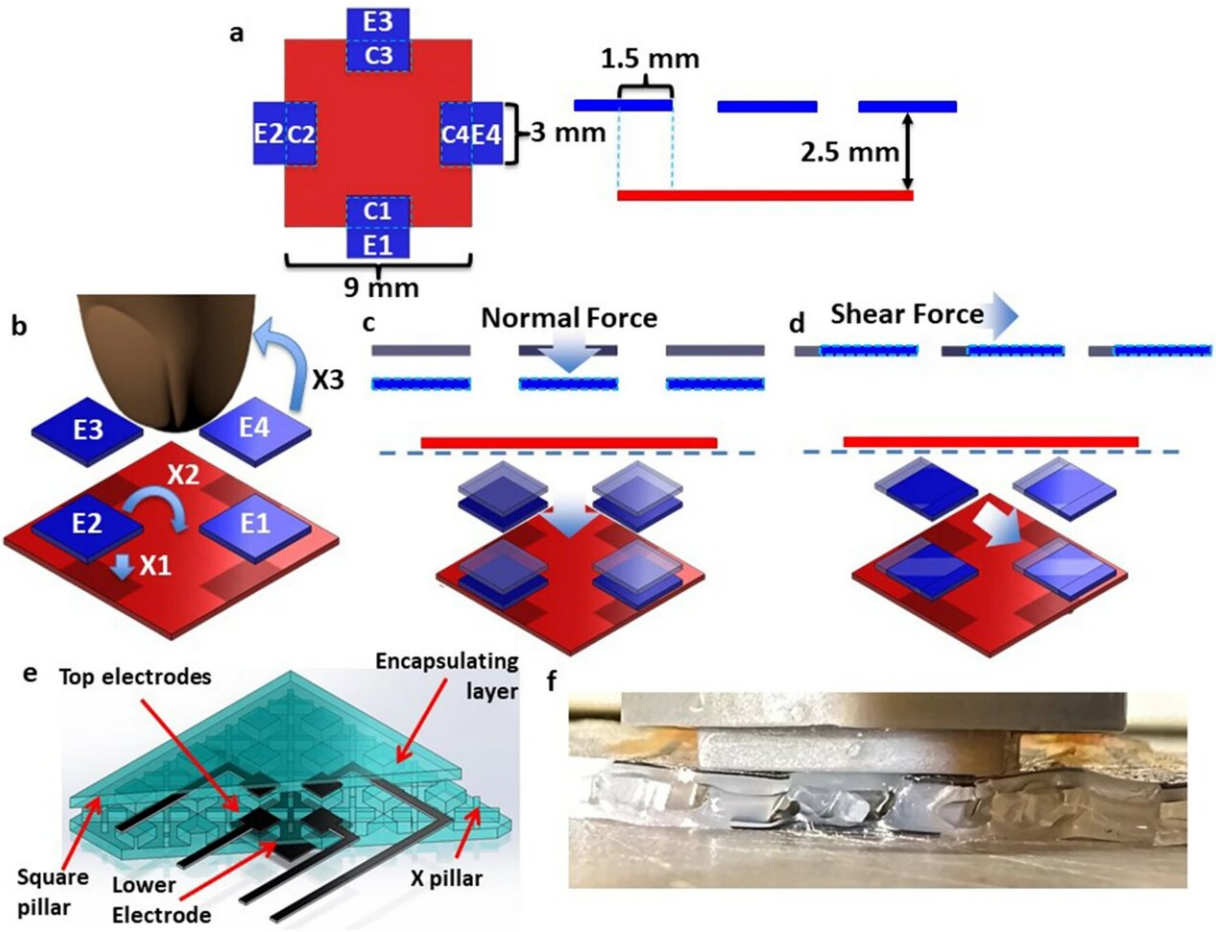
The sensor enables a prosthetic or robotic arm to respond to tactile stimuli with dexterity and precision, such as holding fragile objects like an egg without

dropping or damaging them. Credit: Lou Bosshart/UBC

Giving machines a sense of touch

The sensor is primarily composed of silicone rubber, the same material used to make many skin special effects in movies. The team's unique design gives it the ability to buckle and wrinkle, just like human skin.

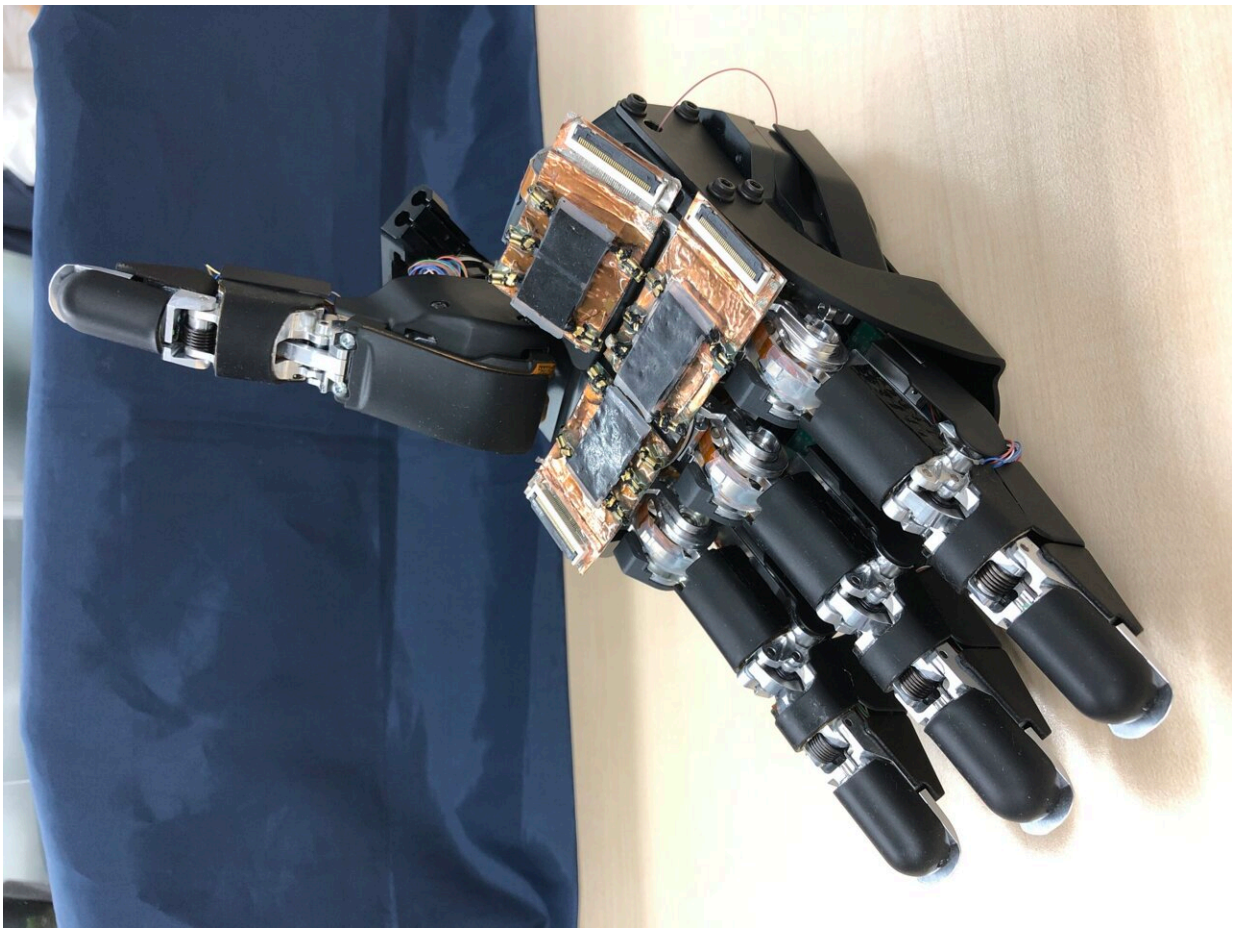
"Our sensor uses weak electric fields to sense objects, even at a distance, much as touchscreens do. But unlike touchscreens, this sensor is supple and can detect forces into and along its surface. This unique combination is key to adoption of the technology for robots that are in contact with people," explained Dr. John Madden, senior study author and a professor of electrical and computer engineering who leads the Advanced Materials and Process Engineering Laboratory (AMPEL) at UBC.



The sensor and working principle. (A) Top view of electrode architecture (left) and side view (right) (B) Sensor electrode layout showing four top electrodes (blue E1–E4) and one bottom one (red). Electric fields couple directly between the top and bottom electrodes (X1), while some fringing fields (X2, X3) extend above the plane of the device and can couple into a finger for proximity detection. The device is a mutual capacitive sensor in which in (D) an applied pressure displaces the top electrodes (originally gray) downwards (blue) to increase coupling with the bottom electrode (red), while (E) shear is detected by the lateral displacement and varying overlap of the top and bottom electrodes (dielectric omitted for clarity). In (F) portions of the sensor are cut away to display the structure and electrode arrangement. (G) Cross-section of sensor showing localized buckling upon shearing with a finger. Credit: *Scientific Reports* (2023). DOI: 10.1038/s41598-023-43714-6

The UBC team developed the technology in collaboration with Frontier Robotics, Honda's research institute. Honda has been innovating in humanoid robotics since the 1980s, and developed the well-known ASIMO robot. It has also developed devices to assist walking, and the emerging Honda Avatar Robot.

"Dr. Madden's lab has significant expertise in flexible sensors and we're happy to collaborate with this team in developing tactile sensors that can be applied to robots," said Mr. Ishizaki Ryusuke, one of the study's lead authors and chief engineer at Frontier Robotics.



Honda robot hand with the soft skin sensors added to the palm. The black squares represent the center of each touch pixel or "taxel". Each square enables

detection of force in three directions. Credit: Honda

Practical and scalable

The researchers say the new sensor is simple to fabricate, which makes it easy to scale to cover large surface areas and to manufacture large quantities.

Dr. Madden noted that sensors and intelligence are making machines more capable and lifelike, increasingly allowing people to work and play alongside them, but much more can be achieved.

"Human skin has a hundred times more sensing points on a fingertip than our technology does, making it easier to light a match or sew. As sensors continue to evolve to be more skin-like, and can also detect temperature and even damage, there is a need for robots to be smarter about which sensors to pay attention to and how to respond. Developments in sensors and artificial intelligence will need to go hand in hand."

The paper is published in the journal *Scientific Reports*.

More information: Mirza S. Sarwar et al, Touch, press and stroke: a soft capacitive sensor skin, *Scientific Reports* (2023). DOI: 10.1038/s41598-023-43714-6

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