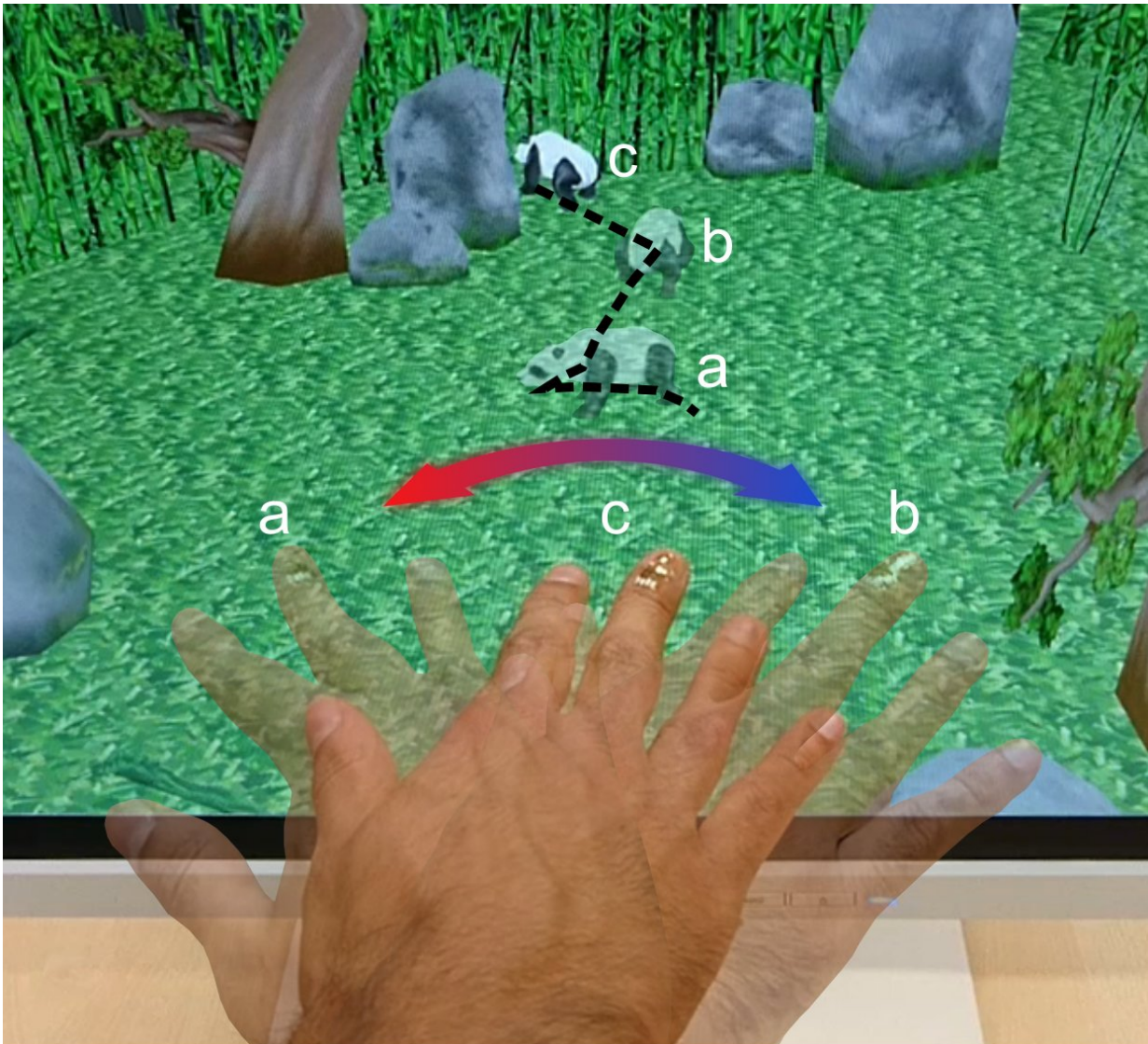


Electronic skin points the way north

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No bulky gloves, no sophisticated camera systems -- just an ultra-thin golden foil on the middle finger. That's all the Dresden researchers need to control a virtual panda with the help of the Earth's magnetic field. When the hand swipes left,

towards the magnetic north, the animal also moves in that direction (a). A swipe to the right, makes it go the opposite way (b). When the hand moves towards the middle, the panda moves back slightly towards the left (c). Credit: HZDR / G.S. Cañón Bermúdez

While birds naturally perceive the Earth's magnetic field and use it for orientation, humans do not share this ability—at least, until now. Researchers at the Helmholtz-Zentrum Dresden-Rossendorf (HZDR) in Germany have developed an electronic skin (e-skin) with magnetosensitive capabilities sensitive enough to detect and digitize body motion in the Earth's magnetic field. As this e-skin is extremely thin and malleable, it can easily be affixed to human skin to create a bionic analog of a compass. This might not only help people with orientation issues, but could also facilitate interaction with objects in virtual and augmented reality. The results have been published in the journal *Nature Electronics*.

Just swipe your hand to the left and the virtual panda on the screen will start making its way toward the bottom left. Swipe your hand to the right and you can make the black-and-white animal face the opposite direction. This demonstration is reminiscent of the famous scene from the movie *Minority Report* where Tom Cruise controls a computer with nothing but hand gestures. This science-fiction scenario has now become reality thanks to Dr. Denys Makarov and his team of HZDR [researchers](#). All it takes is a sliver of polymer foil, no more than a thousandth of a millimeter thick, attached to a finger—and the Earth's magnetic [field](#).

"The foil is equipped with [magnetic field sensors](#) that can pick up geomagnetic fields," says the lead author Gilbert Santiago Cañón Bermúdez. "We are talking about 40 to 60 microtesla—that is 1,000 times weaker than the magnetic field of a typical fridge magnet."

This is the first demonstration of highly compliant electronic skins capable of controlling virtual objects relying on the interaction with geomagnetic fields. The previous demonstrations still required the use of an external permanent magnet. "Our [sensors](#) enable the wearer to continuously ascertain his orientation with respect to the [earth's magnetic field](#). Therefore, if he or the body part hosting the sensor changes orientation, the sensor captures the motion, which is then transferred and digitized to operate in the virtual world."

Just like a regular compass

The sensors, ultrathin strips of the magnetic material permalloy, work on the principle of the so-called anisotropic magneto-resistive effect. Cañón Bermúdez says, "It means that the electric resistance of these layers changes depending on their orientation in relation to an outer magnetic field. In order to align them specifically with the Earth's magnetic field, we decorated these ferromagnetic strips with slabs of conductive material, in this case gold, arranged at a 45-degree angle. Thus, the electric current can only flow at this angle, which changes the response of the sensor to render it most sensitive around very small fields. The voltage is strongest when the sensors point north and weakest when they point south." The researchers conducted outdoor experiments to demonstrate that their idea works in practical settings.

With a sensor attached to an index finger, the user started out from the north, first heading west, then south and back again—causing the voltage to rise and fall again accordingly. The cardinal directions displayed matched those shown on a traditional [compass](#) used as a reference. "This shows that we were able to develop the first soft and ultrathin portable sensor which can reproduce the functionality of a conventional compass and prospectively grant artificial magnetoception to humans," Bermúdez says. The researchers were also able to transfer the principle to virtual reality, using their magnetic sensors to control a digital panda in the

computer game engine, Panda3D.

In these experiments, pointing to the north corresponded to a movement of the panda to the left, pointing to the south to a movement to the right. When the hand was on the left, i.e. magnetic north, the panda in the virtual world started moving in that direction. "We were able to transfer the real-world geomagnetic stimuli straight into the virtual realm," Denys Makarov says.

As the [sensors](#) can withstand extreme bending and twisting without losing their functionality, the researchers see great potential in multiple fields. "Psychologists, for instance, could study the effects of magnetoception in humans more precisely, without bulky devices or cumbersome experimental setups, which are prone to bias the results," Gilbert Santiago Cañón Bermúdez says.

More information: Gilbert Santiago Cañón Bermúdez et al, Electronic-skin compasses for geomagnetic field-driven artificial magnetoreception and interactive electronics, *Nature Electronics* (2018). [DOI: 10.1038/s41928-018-0161-6](#)

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