Wireless, ultrathin 'skin VR' to provide a vivid, personalized touch experience in the virtual world

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In an AR scenario, a virtual mouse hops forwards and rests briefly on each point of the hand. The hand patch, with hydrogel-based electrodes, has 32 electrotactile stimulation pixels on the palm side, allowing the threshold currents to be easily mapped for different users. Credit: City University of Hong Kong

Enhancing the virtual experience with the touch sensation has become a

hot topic, but today's haptic devices remain typically bulky and tangled with wires. A team led by the City University of Hong Kong (CityU) researchers recently developed an advanced wireless haptic interface system, called WeTac, worn on the hand, which has soft, ultrathin soft features, and collects personalized tactile sensation data to provide a vivid touch experience in the metaverse.

The system has application potential in gaming, sports and skills training, social activities, and remote robotic controls. "Touch feedback has great potential, along with visual and audial information, in virtual reality (VR), so we kept trying to make the haptic interface thinner, softer, more compact and wireless, so that it could be freely used on the hand, like a second skin," said Dr. Yu Xinge, Associate Professor in the Department of Biomedical Engineering (BME) at CityU, who led the research.

Together with Professor Li Wenjung, Chair Professor in the Department of Mechanical Engineering (MNE), Dr. Wang Lidai, Associate Professor in the Department of Biomedical Engineering (BME) and other collaborators, Dr. Yu's team developed WeTac, an ultra-flexible, wireless, integrated skin VR system. The research findings were published in *Nature Machine Intelligence*.

Light-weight, wireless, wearable hand patch instead of bulky gloves

Existing haptic gloves rely mostly on bulky pumps and air ducts, powered and controlled through a bunch of cords and cables, which severely hinder the immersive experience of VR and augmented reality (AR) users. The newly developed WeTac overcomes these shortcomings with its soft, ultrathin, skin-integrated wireless electrotactile system.

The system comprises two parts: a miniaturized soft driver unit, attached to the forearm as a control panel, and hydrogel-based electrode hand

patch as a haptic interface.

The entire driver unit weighs only 19.2g and is small (5cm x 5cm x 2.1mm) enough to be mounted on the arm. It uses Bluetooth low energy (BLE) wireless communication and a small rechargeable lithium-ion battery. The hand patch is only 220 μm to 1mm thick, with electrodes on the palm. It exhibits great flexibility and guarantees effective feedback in various poses and gestures.

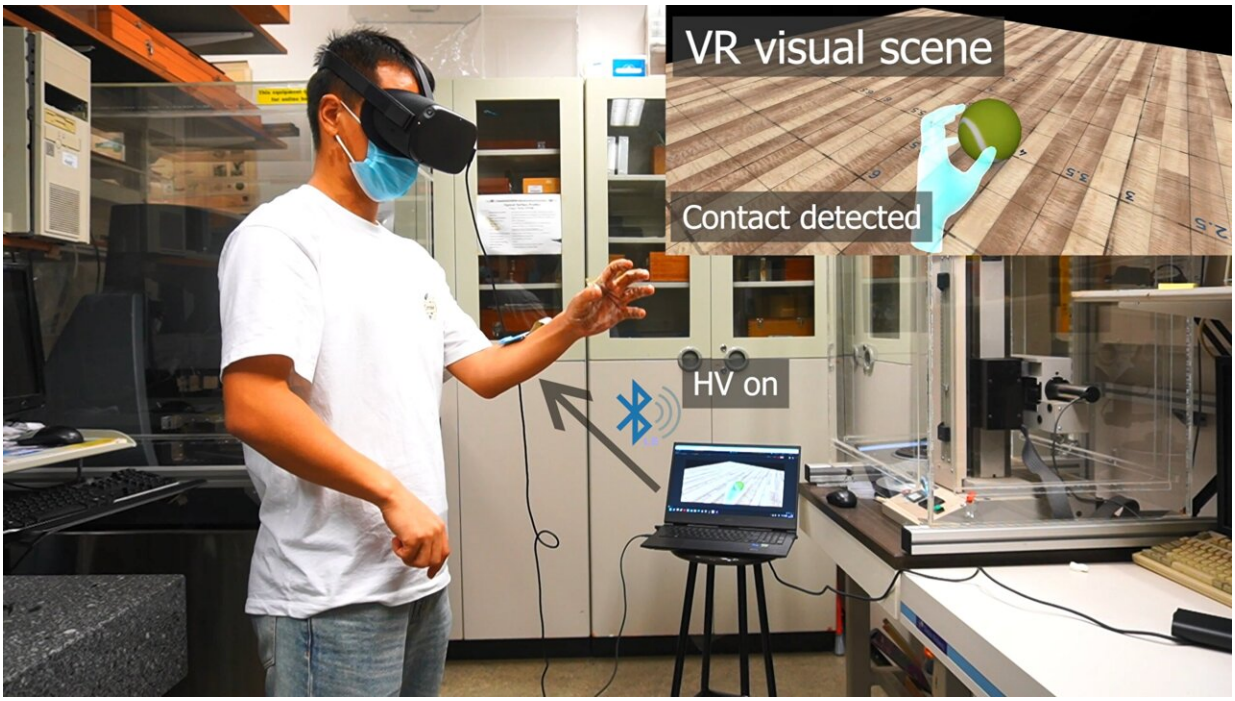
The wireless skin-integrated electrotactile system comprises two parts: a soft driver unit (right), attached to the forearm, and the hand patch (left). Credit: Dr Yu Xinge's research group / City University of Hong Kong

High pixel-density device provides a personalized experience

"Electrotactile stimulation is a good method to provide effective virtual touch for users," Dr. Yu explained. "However, as individuals have different sensitivities, the same feedback strength might be felt differently in different users' hands. So we need to customize the feedback parameters accordingly to provide a universal tool for all users

to eliminate another major bottleneck in the current haptic technology."

The ultra-soft feature of WeTac allows the threshold currents to be easily mapped for individual users to determine the optimized parameters for each part of the hand. Based on the personalized threshold data, electrotactile feedback can be delivered to any part of the hand on demand in a proper intensity range to avoid causing pain or being too weak to be felt. In this way, virtual tactile information, including spatial and temporal sequences, can be faithfully reproduced over the whole hand.



A user touches a virtual tennis ball in VR via WeTac, a skin-integrated wireless electrotactile system. Credit: Dr Yu Xinge's research group / City University of Hong Kong

The WeTac patches are worn on the hands to provide programmable spatio-temporal feedback patterns, with 32 electrotactile stimulation pixels on the palm instead of the fingertips only. The average center-to-center distance between the electrodes is about 13mm, providing wide coverage over the whole hand.

The device has several built-in safety measures to protect users from electric shock, and the temperature of the device is maintained in a relatively low range of 27 to 35.5°C to avoid causing any thermal discomfort during continuous operation.

Wide range of potential applications

WeTac has been successfully integrated into VR and AR scenarios, and synchronized with robotic hands through BLE communication. With the miniature size, wearable and wireless format, and sensitivity-oriented feedback strategy, WeTac makes tactile feedback in the hand much easier and user-friendly. Users can feel virtual objects in different scenarios, such as grasping a tennis ball in sports training, touching a cactus, or feeling a mouse running on the hand in social activities, virtual gaming, etc.

"We believe that this is a powerful tool for providing virtual touching, and is inspiring for the development of the metaverse, human-machine interface (HMI), and other fields," said Dr. Yu.

More information: Kuanming Yao et al, Encoding of tactile information in hand via skin-integrated wireless haptic interface, *Nature Machine Intelligence* (2022). DOI: 10.1038/s42256-022-00543-y

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