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Supplementary Materials for

Super-resolution wearable electrotactile rendering system

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The PDF file includes:

Other Supplementary Material for this manuscript includes the following:

Supplementary Figure:

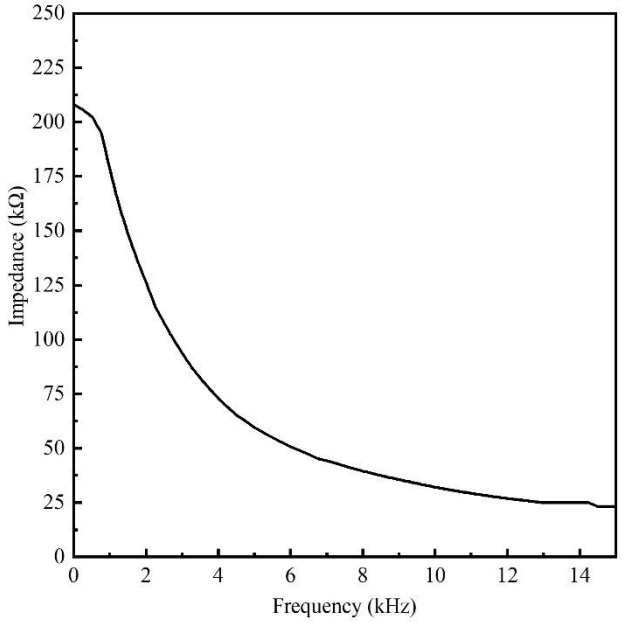

Fig. S1. The impedance of human fingertip skin with stimulation current frequency. The positive electrode is located in the center of the fingertip, and the negative electrode is four adjacent electrodes connecting. The electrode is a half-spherical-shaped bump with 1 mm radius.

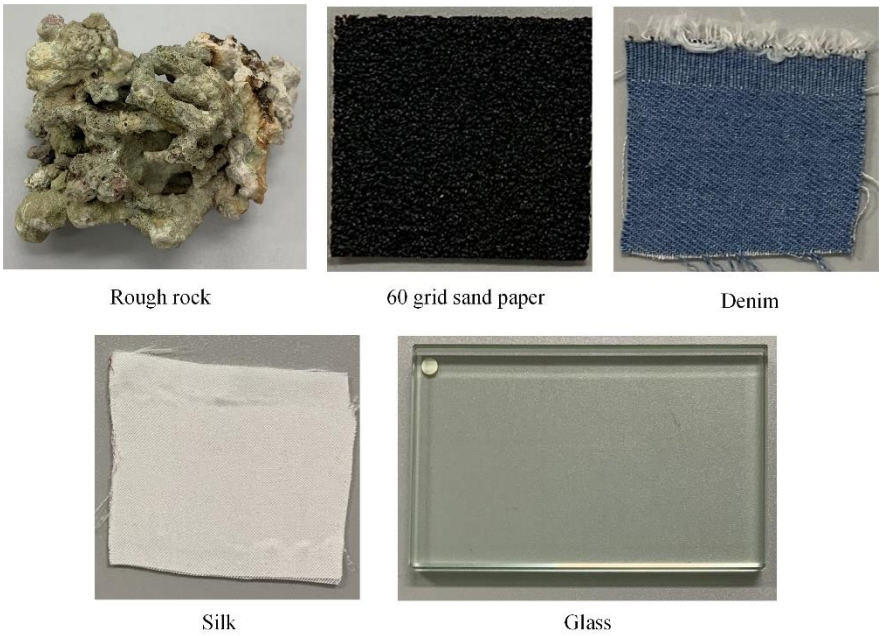

Fig. S2. Five texture surfaces with different roughness.

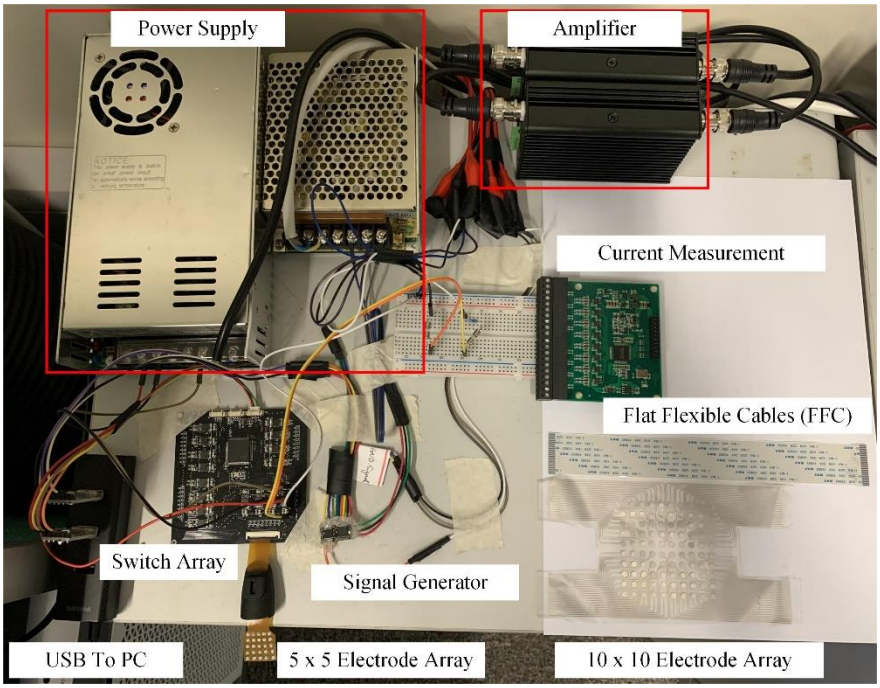

Fig. S3. Optical image of all electro-tactile devices. The signal generator is controlled by the computer software to generate the specified waveform. The signal is amplified by the power amplifier as the input signal of the switch array circuit board. The switch array circuit board is connected to the electrode array through the FFC and independently controls the state of each stimulation electrode. Each device is connected by wires.

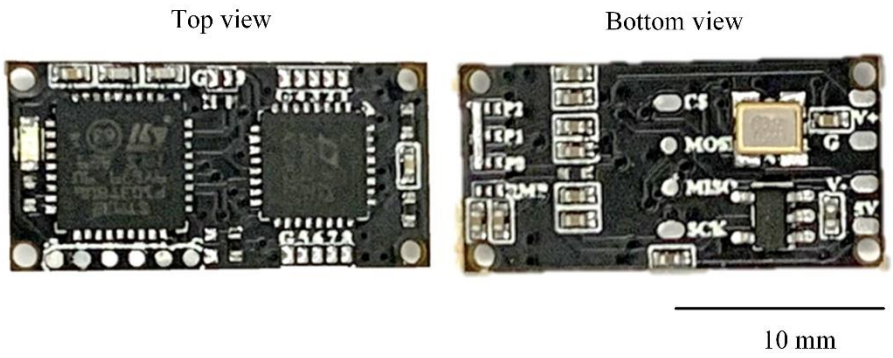

Fig. S4. Optical image of the signal generator circuit board.

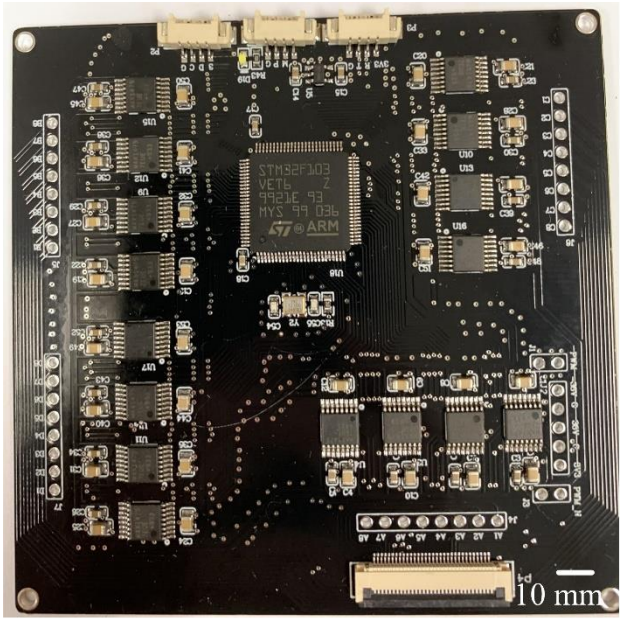

Fig. S5. Optical image of the switch array circuit board.

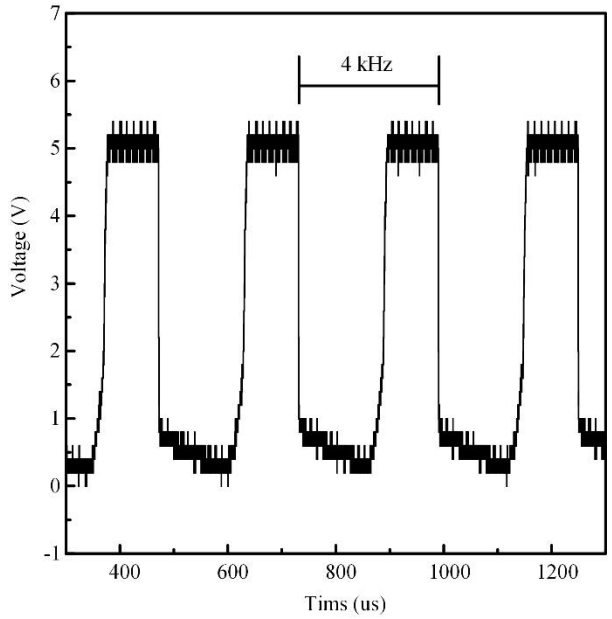

Fig. S6. The refresh rate of stimulating electrode state switching.

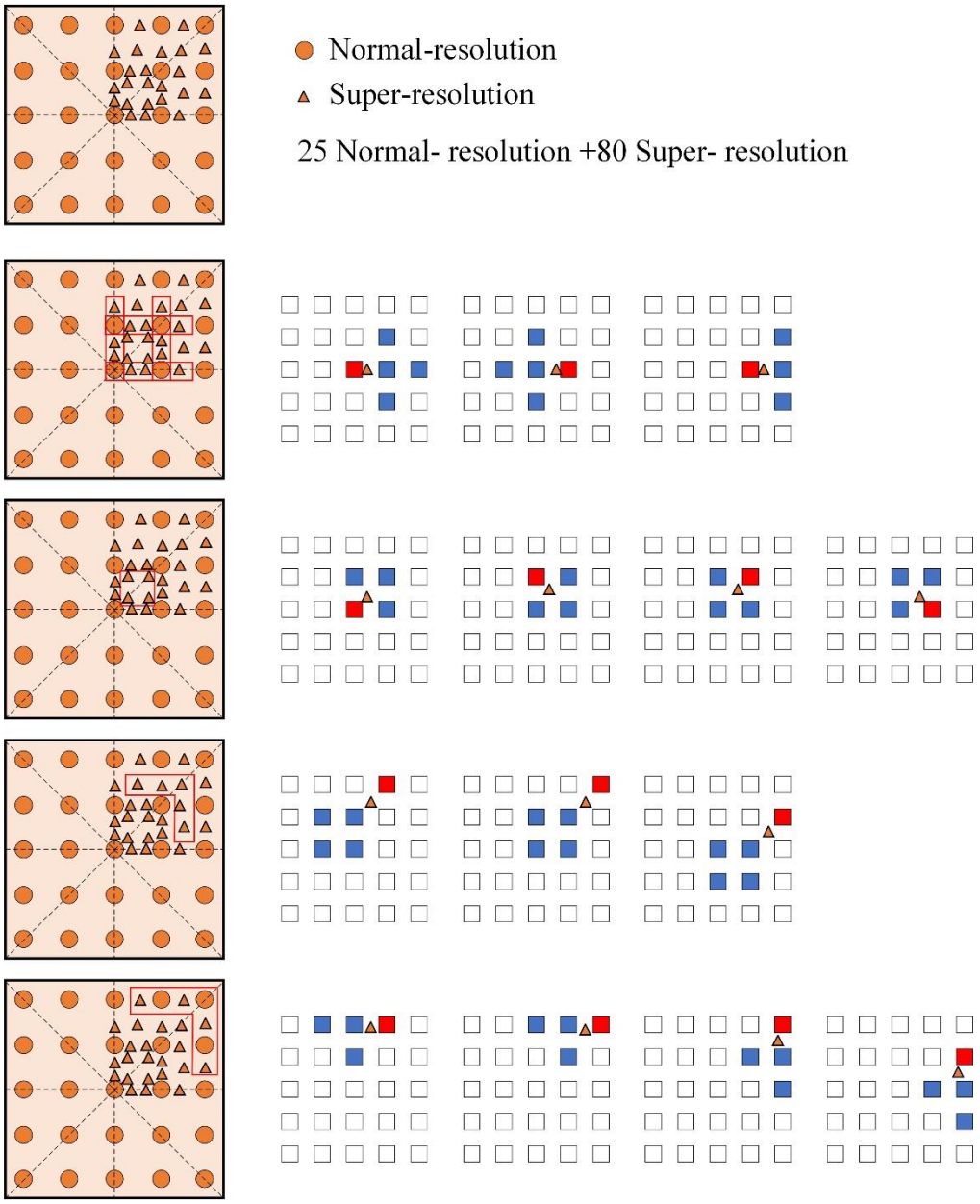

Fig. S7. Render strategy for each super-resolution stimulus point.

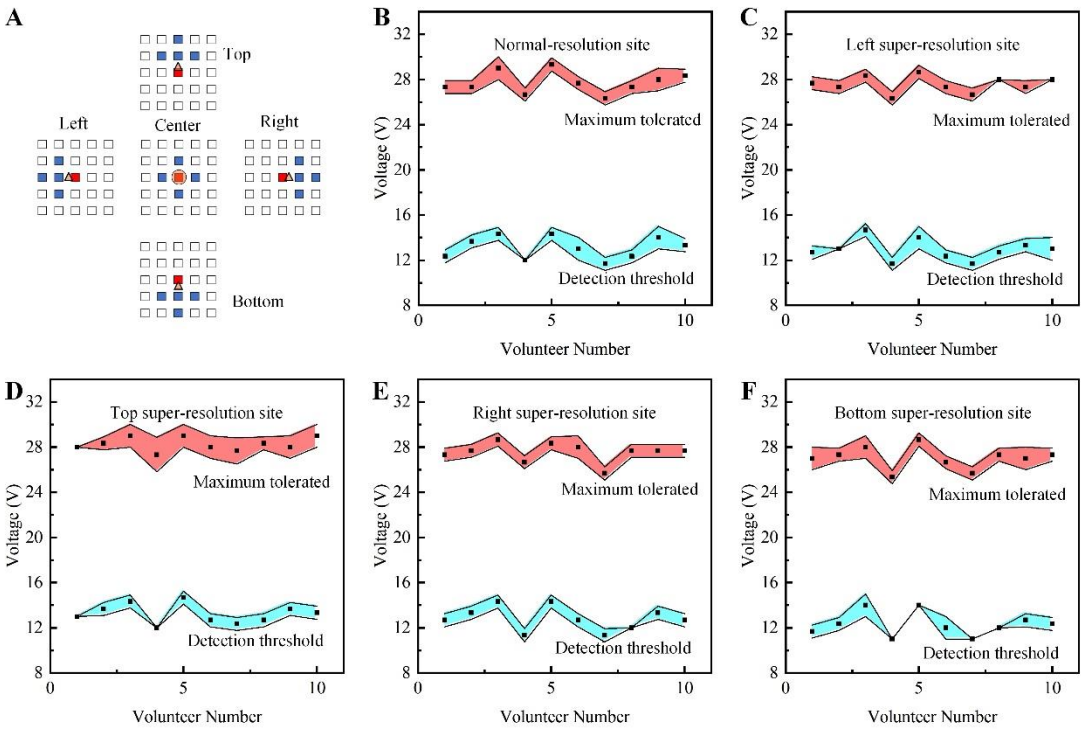

Fig. S8. Intensity test of center normal resolution and super-resolution sites. **(A)** Schematic of the distribution of stimulus electrode states. **(B-F)** The relationship between tactile perception intensity and stimulation voltage for five sites. Error bars indicate the fluctuation of the test results of each volunteer in multiple measurements.

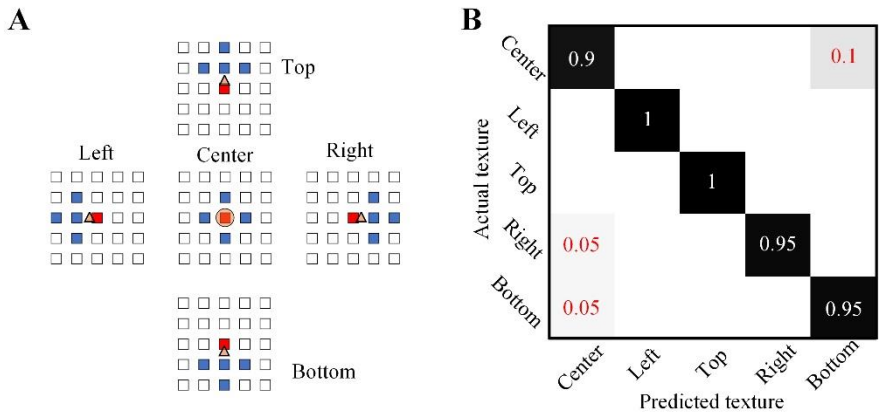

Fig. S9. Recognition test of center normal resolution and super-resolution sites.

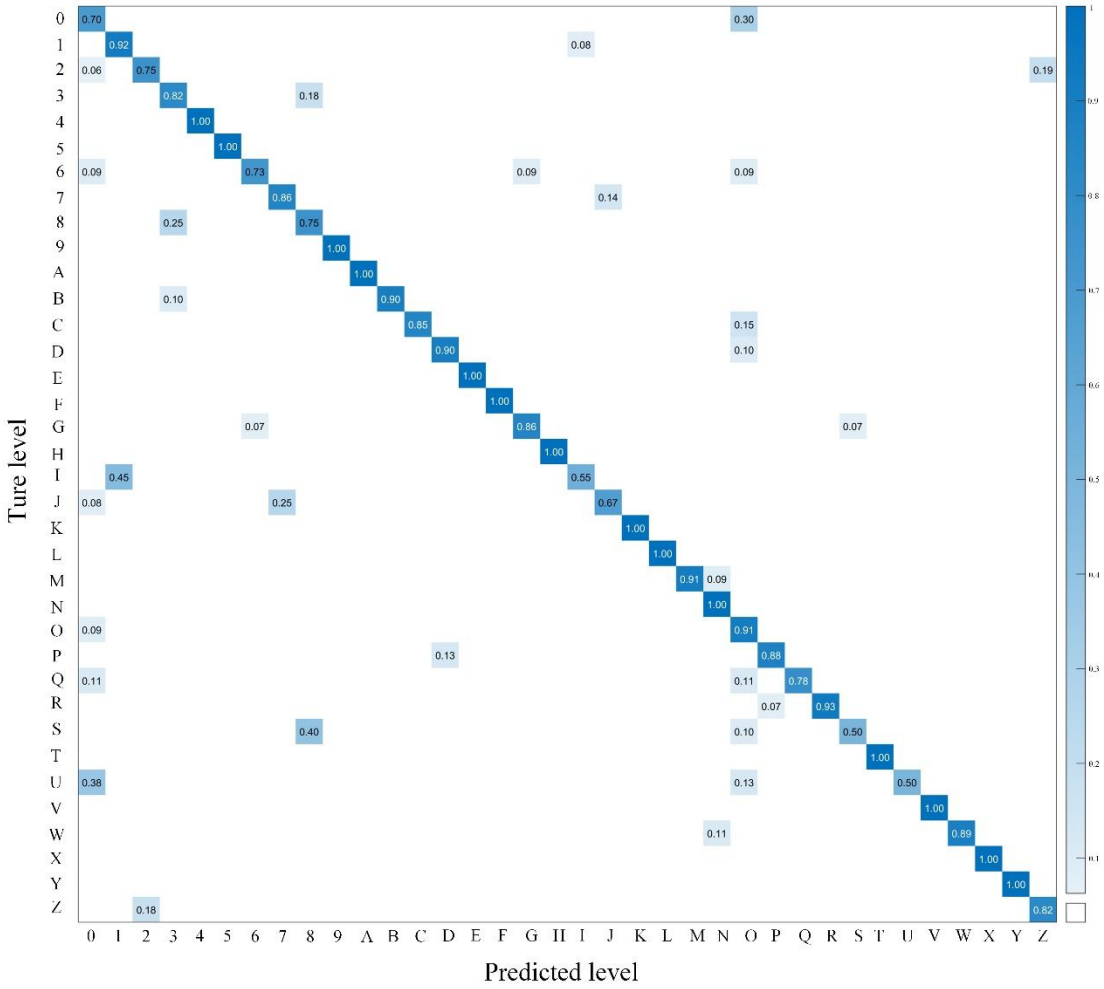

Fig. S10. Detailed data of confusion matrix of 26 letters and 10 numbers.

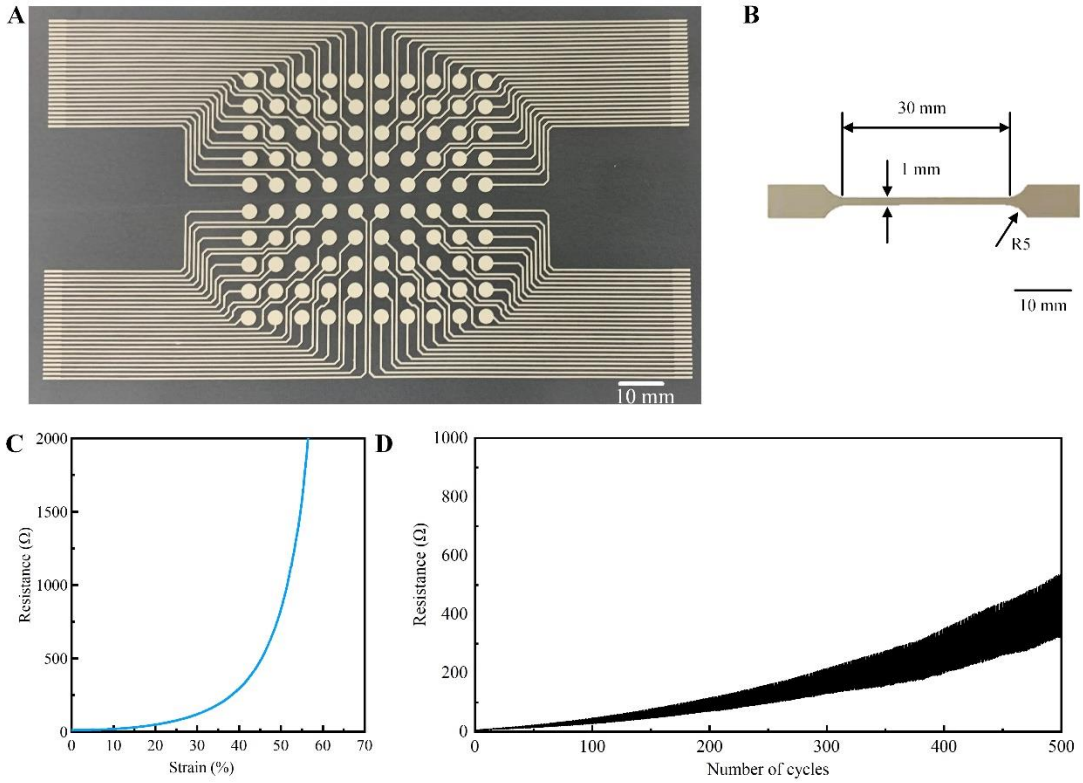

Fig. S11. 10×10 stretchable TPU-based electrode array. (A) The optical image of 10×10 stretchable TPU-based electrode array. **(B)** The optical image of test sample. **(C)** Resistance response of the test sample under the uniaxial tensile strain. **(D)** Cycle tests of the sensor with 500 cycles of repeated stretching to 10% strain.

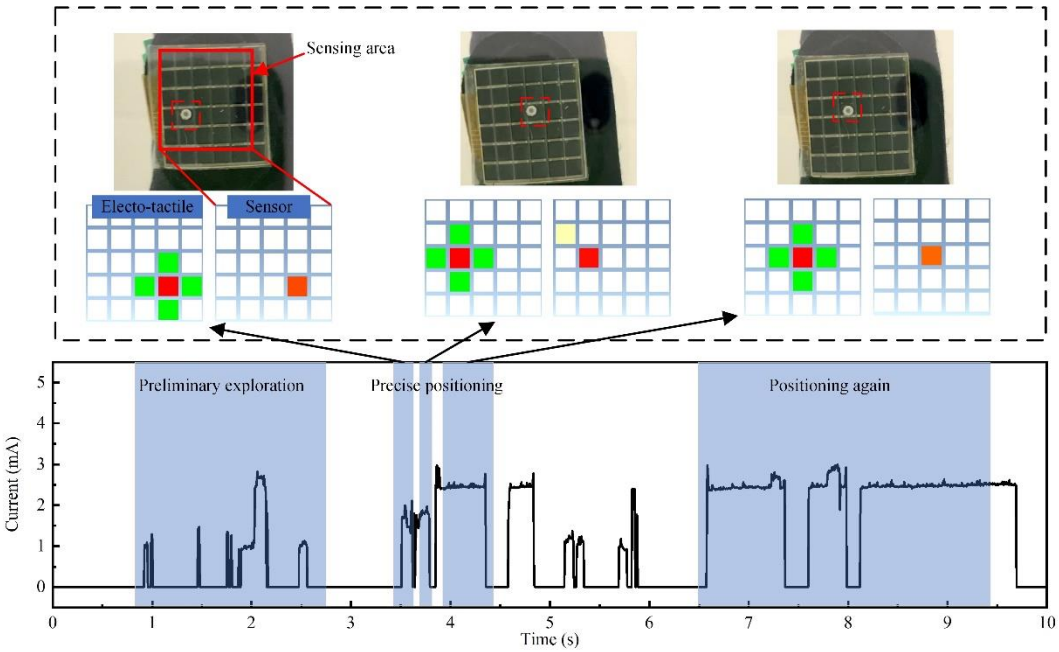

Fig. S12. The real-time signal of the sensor-actuator glove system. After a short preliminary exploration, the volunteer accurately positions the target at the center of the fingertips.

Layer	Electrical conductivity (S/m)	Relative permittivity	Thickness (mm)
Stratum corneum	3.5×10^{-4} (20 Hz) 9.0×10^{-4} (1 kHz) 2.0×10^{-3} (5 kHz) 4.0×10^{-3} (10 kHz)	1.0×10^{5} (20 Hz) 4.0×10^{4} (1 kHz) 3.5×10^{4} (5 kHz) 3.0×10^{4} (10 kHz)	0.04
Epidermis	Diagonal {0.95,0.95,0.15}	7.3×10^{4}	0.06
Dermis	Diagonal {2.57,2.57,1.62}	1.2×10^{6}	1.40
Hypodermis	0.01	2.5×10^{4}	2.00

Table. S1. The electrical properties and thickness of each layer of the finite element model.