Supporting Information

Triboelectric Self-Powered Wearable Flexible Patch as 3D Motion Control Interface for Robotic Manipulator

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S1. Fabrication of carbohydrate-based elastomer.

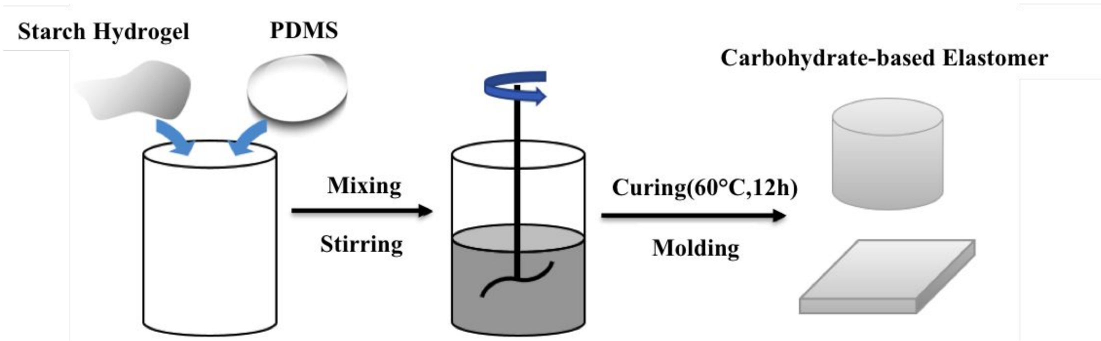

Figure S1. Fabrication of carbohydrate-based elastomer. Liquid PDMS was prepared by mixing silicone elastomer base and cross-linker (Sylgard 184, Dow Corning) at a mass ratio of 10:1. Both starch-based hydrogel and liquid PDMS were degassed in a vacuum chamber to removing gas bubbles in the gel. Then they were mixed together at a volume ratio of 3:1 to obtain the precursor of Carbohydrate-based Elastomer. To remove the bubbles in the precursor, the precursor was centrifuged for 10 min at a speed of 3000 rpm.

S2. Electrical conductivity test of HPE.

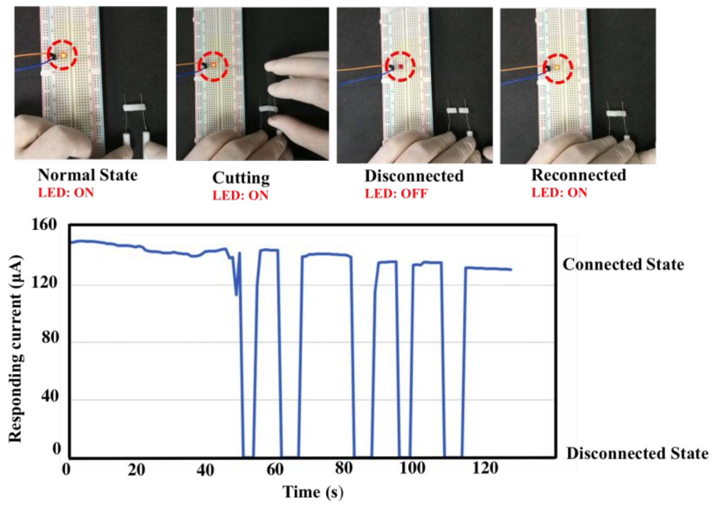

Figure S2. A piece of HPE is applied with a 3 V voltage at both ends. It can be seen that HPE has good conductivity. It is verified by the diode experiment, and the current curve of HPE disconnection and connection process in the circuit is given.

S3. Normalization example.

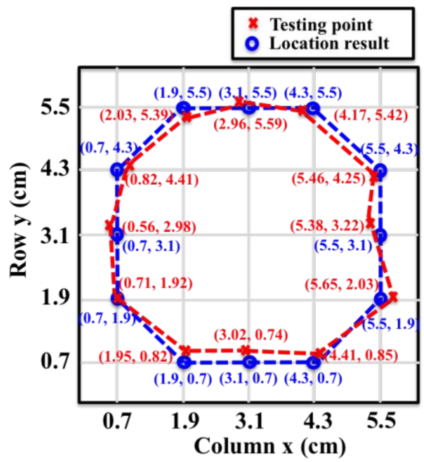

Figure S3. Take the ring location as an example, the normalization of theoretical location results and testing points are illustrated, respectively. After normalization, the path described used the 2D-SFTS patch is regular, avoiding excessive folding points.

S4. The dimensions of the 2D-SFTS patch.

Table S1. Dimensions of the sensor

Parameter Name	Value
Length of device	80 mm
Width of device	80 mm
Length of each electrode	70 mm
Width of each electrode	10 mm
Width of grid line	2 mm
Thickness of grid line	1.5 mm
Side length of each small lattice	10 mm
Thickness of electrode	1.5 mm
Thickness of silicone rubber	2 mm

S5. The voltage ratios of the center of twenty-five lattices.

Table S2. Voltage ratios calculated (R_1).

	$x = 0.7$	$x = 1.9$	$x = 3.1$	$x = 4.3$	$x = 5.5$
$y = 5.5$	12.25	12.11	11.06	10.13	10.69
$y = 4.3$	3.92	3.88	4.26	3.38	3.72
$y = 3.1$	1.26	0.98	0.99	1.37	1.19
$y = 1.9$	0.44	0.50	0.39	0.37	0.35
$y = 0.7$	0.14	0.09	0.11	0.11	0.13

Table S3. Voltage ratios calculated (R_2).

	$x = 0.7$	$x = 1.9$	$x = 3.1$	$x = 4.3$	$x = 5.5$
$y = 5.5$	0.09	0.34	1.02	3.89	13.33
$y = 4.3$	0.12	0.41	0.98	4.37	10.82
$y = 3.1$	0.11	0.32	1.01	4.62	11.29
$y = 1.9$	0.09	0.36	0.91	3.97	12.31
$y = 0.7$	0.08	0.31	0.95	3.83	13.09

S6. Stability tests under different humidity and forces conditions.

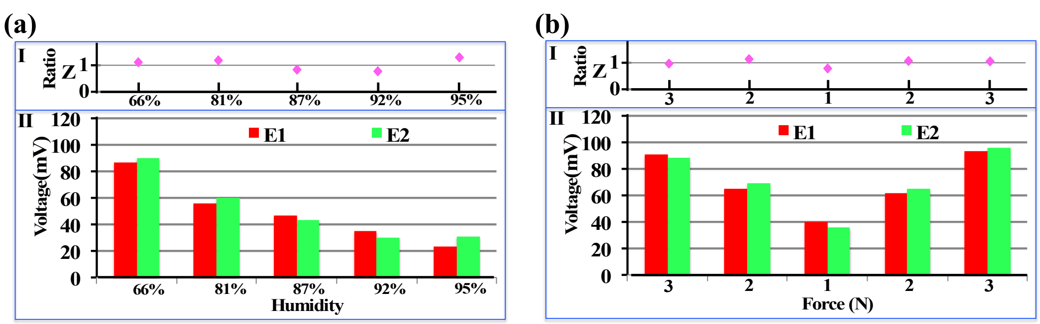

Figure S4. (a) Testing of 1D-SFTS under different humidity. The spray device is used to change the humidity on the surface of the device. Five groups of experiments are carried out under different humidity. The surface humidity of the 5 groups are 66%, 81%, 87%, 92%, 95% respectively. In each group, the voltages of two electrodes are detected by tapping the center point of the 1D-SFTS patch. The average values of electrodes voltages of each group (50 times) are calculated, and shown by the column diagram, as shown in (a-II). The ratios of the tapping point in Z direction are calculated according to the average values, and marked in (a-I). It can be seen that with the increase of humidity, the output voltage of the electrode will decrease significantly, but it does not affect the calculated value of the position point. (b) Testing of 1D-SFTS under different forces. Five groups of experiments are carried out under different forces. Similarly, the magnitude of the force has little effect on the location calculation.

S7. The tests of long-term stability.

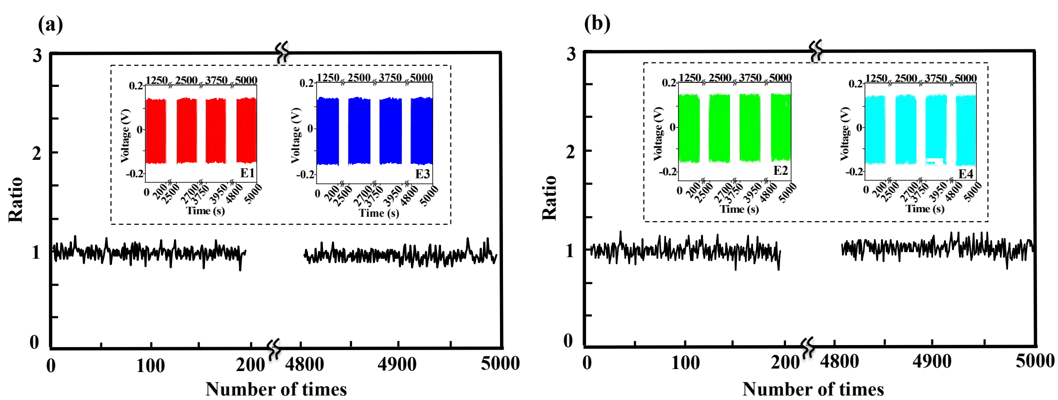

Figure S5. The cycling stability of point (3.1, 3.1) of 2D-SFTS under force of 5 N is tested. The voltages are measured for 5000 cycles, during which 4 groups of 200 cycles are recorded as shown in the figures inserted in (a) and (b). The voltages of electrodes can be maintained after 5000 cycles. And the ratio of opposite electrodes maintains a relatively stable value, implying long working lifetime and reliability of device. (a) The ratios of V_{E3}/V_{E1} corresponding to the first and the last 200 cycles. (b) The ratios of V_{E4}/V_{E2} corresponding to the first and the last 200 cycles.