Electronic Supplementary Material (ESI) for Nanoscale.

Supplementary Information

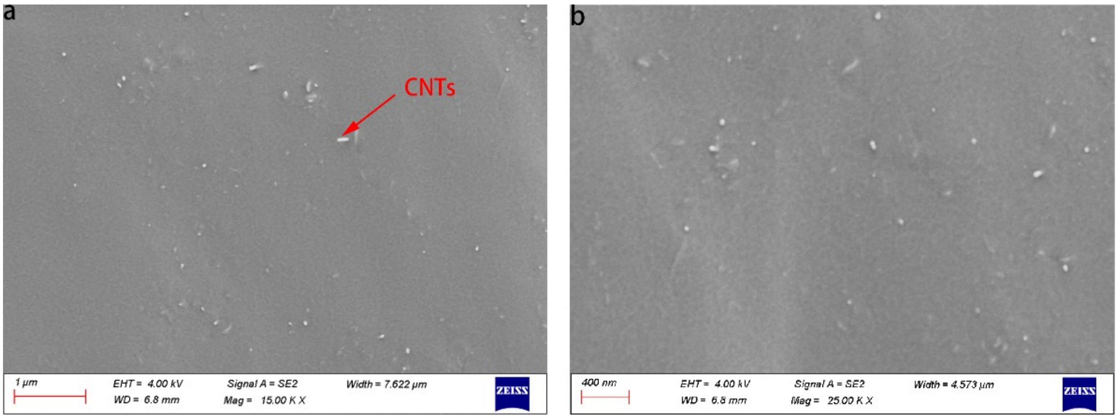

Figure S1 SEM images of CNTs/PDMS composite containing 1.5% CNTs with the magnification of 15k and 25k.

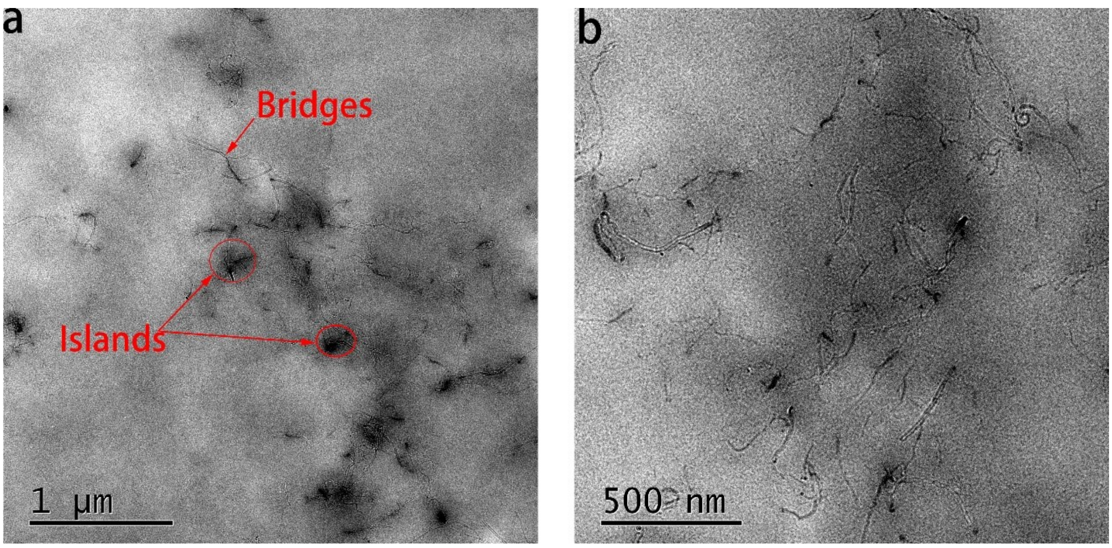

Figure S2 TEM images of CNTs/PDMS composite containing 1.5% CNTs

The CNTs are evenly dispersed in the PDMS matrix, forming a loose network which is like the distribution of islands and bridges marked in Figure S2a.

Table S1 The Young's Modulus of the composites with different CNTs and pure PDMS.

Type / No.	PDMS (MPa)	0.5 wt% CNTs (MPa)	1 wt% CNTs (MPa)	1.5 wt% CNTs (MPa)	2 wt % CNTs (MPa)
Sample 1	1.72	4.28	4.54	5.48	3.78
Sample 2	1.32	4.65	4.98	5.62	4.26
Sample 3	1.33	4.27	5.1	5.42	4.18
Sample 4	1.26	4.83	4.56	5.77	3.95
Average	1.41	4.51	4.8	5.57	4.04

It can be seen that with the increase of CNTs content, the Young's Modulus would increase initially. The composite containing 1.5 wt% CNTs has the best Young's Modulus. However, more CNTs would yield larger Van der Waals force, so more agglomeration of CNTs would be formed, leading to the reduction of the Young's Modulus. This can explain that why the Young's Modulus of the composite with 2 wt% CNTs is slightly less than that of 0.5 wt% CNTs.

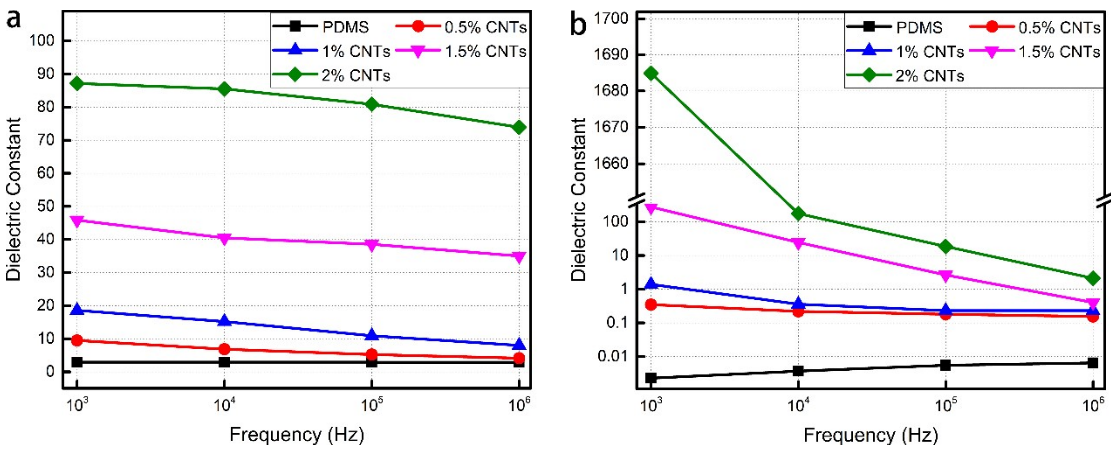

Figure S3 (a) Dielectric constant and (b) dielectric loss of CNTs/PDMS composites as a function of CNTs content.

The figures depicting the dielectric constant and dielectric loss as a function of CNTs content have been added and displayed in Figure S3. There are four composites with different contents of CNTs (0.5 wt%, 1 wt%, 1.5 wt%, and 2 wt%) and pure PDMS. In parallel, four types of frequency were applied, ranging from 1kHz to 1MHz. With the increase of contents of CNTs, the dielectric constant and dielectric loss would increase. When the frequency is sped up, the dielectric constant and dielectric loss would decrease.

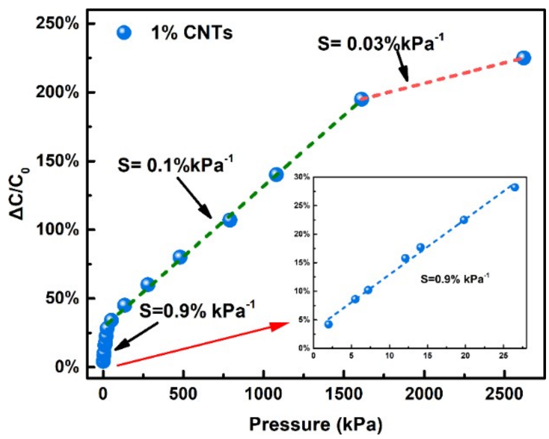

Figure S4. The relative change in capacitance ($\Delta C/C_0$) of the sensor with 1% CNTs as a function of pressure in the range of 0~2.55 MPa.

The sensitivity is 0.9% kPa^{-1} for the low-pressure working range (<27 kPa), 0.1% kPa^{-1} for the middle-pressure (27 kPa~ 1.5 MPa) and only 0.03% kPa^{-1} for the high-pressure (> 1.5 MPa).

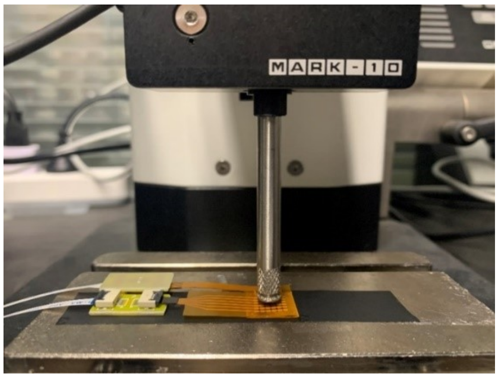

Figure S5 Photograph of the tactile sensor mounted on the force tester.

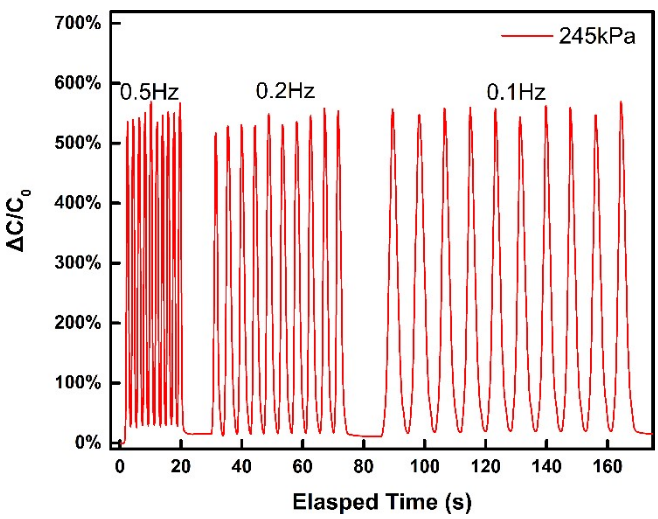

Figure S6 Capacitance response of the sensor under 245 kPa pressure with different loading frequencies (0.5 Hz, 0.2 Hz and 0.1 Hz)

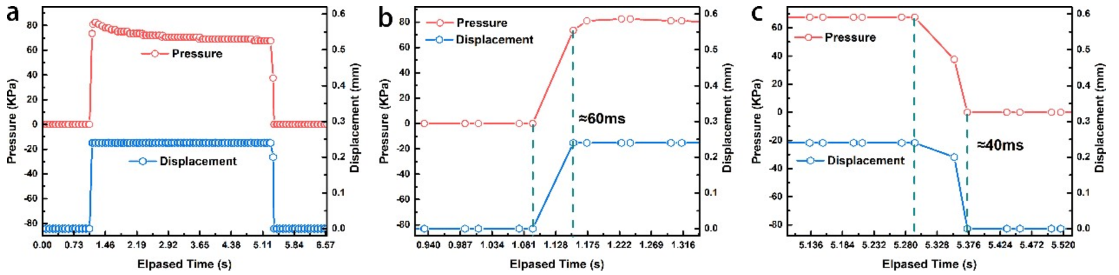

Figure S7 Loading/unloading time of the pressure and displacement.

The loading time is about 60 ms, and the unloading time is around 40 ms, as depicted in Figures S4b and S4c.

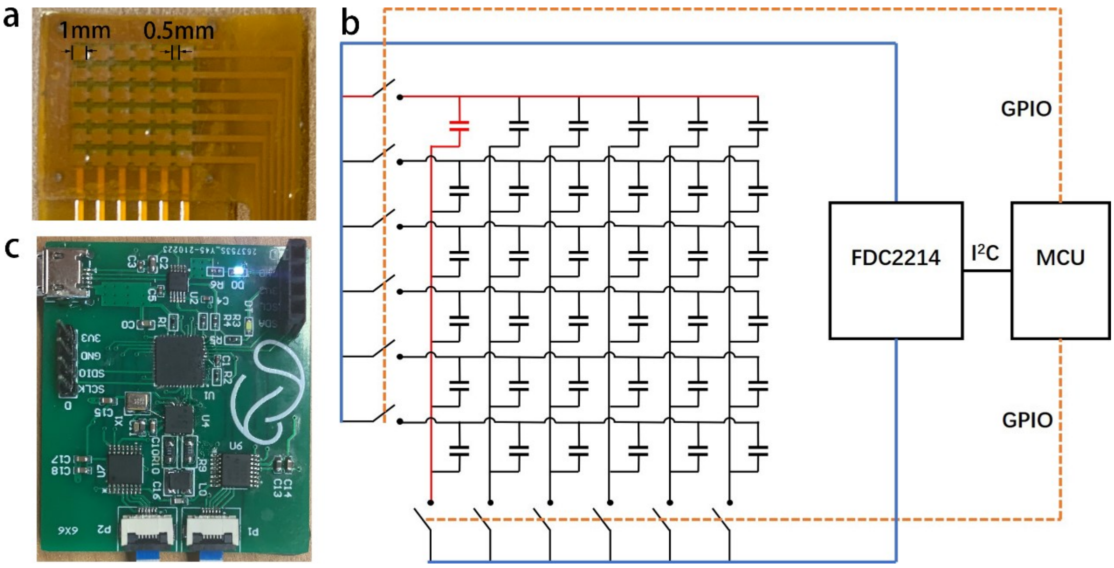

Figure S8 a) Photograph and dimension of the tactile sensor array. b) Schematic diagram of the Custom data acquisition (DAQ) board and the capacitive sensor array. c) Photograph of the custom DAQ board.

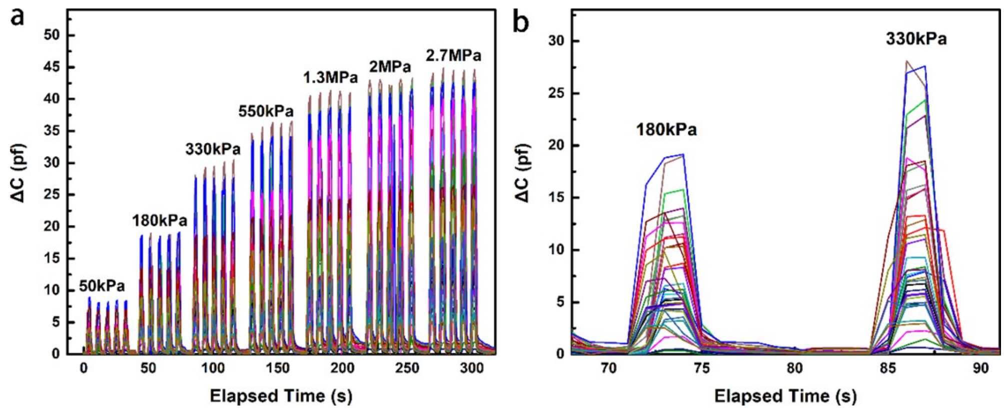

Figure S9 a) The capacitance response of the 36 sensing channels detected by the DAQ board under various applied pressures. b) The magnified view of the capacitance response of 36 sensing channels under 180kPa and 330kPa.

The result reveals the correlation between capacitance change and pressure. Hence, as the unknown force is applied, the rough value of pressure can be inferred according to Figure S6a.

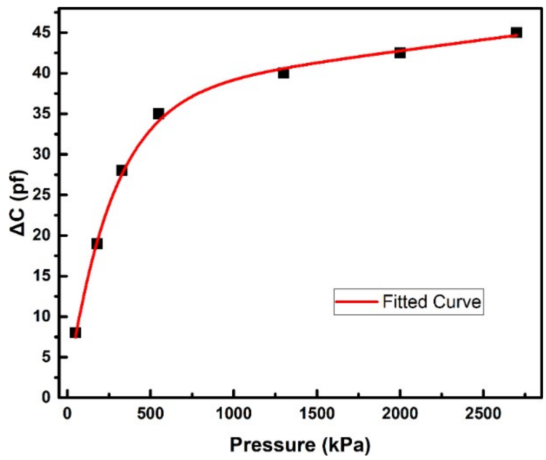

Figure S10 The capacitance change ΔC of the sensor with 1.5% CNTs as a function of pressure in the range of 0~2.7 MPa.

$$y = A1 * exp(-x/t1) + A2 * exp(-x/t2) + y0 \qquad \text{Eq. S1}$$

The expression is obtained through nonlinear fit. x is the pressure, and y represents the capacitance change.

Table S2 The parameters in Eq. S1

Parameters	Value
$y0$	556762.47986
$A1$	-36.09554
$t1$	270.72885
$A2$	-556725.12012
$t2$	2.05334E8

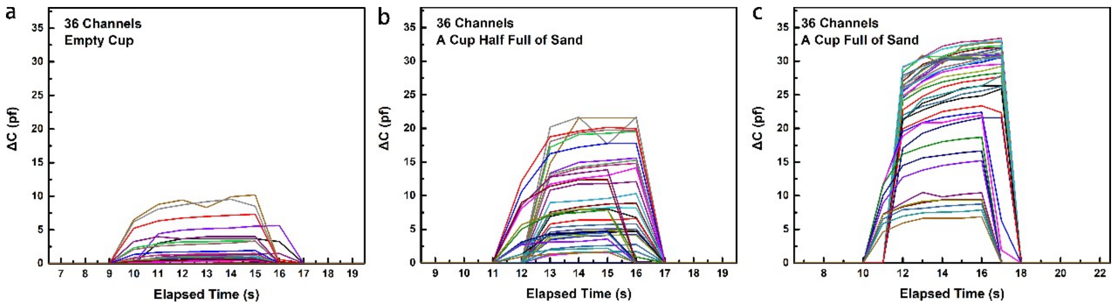

Figure S11 a) The capacitance change of 36 sensing channels when the robotic hand grasped the empty cup. b) The capacitance change of 36 sensing channels when the robotic hand grasped the cup half full of sand. c) The capacitance change of 36 sensing channels when the robotic hand grasped the cup full of sand.

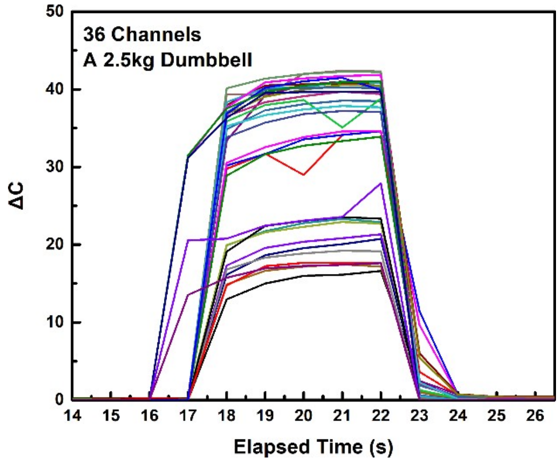

Figure S12 The capacitance change of 36 sensing channels when the robotic hand grasped the 2.5kg dumbbell.