Multifunctional Soft Anti-Swelling Hydrogels-Based Sensor Reinforced with Carboxylated-MWCNTs and CMC for Human Motion Detection and Air-Underwater Communication

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Table S1 Comparative analysis of reported studies and the present work

Materials	Composition	Gauge Factor	Swelling %	Conductivity S/m	Stretchability %	Ref
A1H1M Hydrogel	CNT-based sensor	0.7	31	6.40	1134	[1]
PGCC Hydrogel	F-CNT & CMC	5.06	-	0.273	961	[2]
Cpam-cnt	CNT & CMC	19	-	31.9	637	[3]
PAAM-P(B2F1)	CNT-PAAm	7.9	99	4.94	560	[4]
PSG-Zr-CNT	CNT	2	30	0.42	623	[5]
PVA-CNT-S Hydrogel	PVA-CNT	1.7	0.8	0.11	200	[6]
Ni-LM@CNT	CNTs	20	-	0.5	400	[7]
ALT Hydrogel	A-MWCNTs)	9.2	-	1.85	500	[8]
G-CNTs hydrogel	CNT	9.45	-	0.142	1000	[9]
G3-Hydrogel	COO-MWCNTs & CMC	17	20	82	1254	Current study

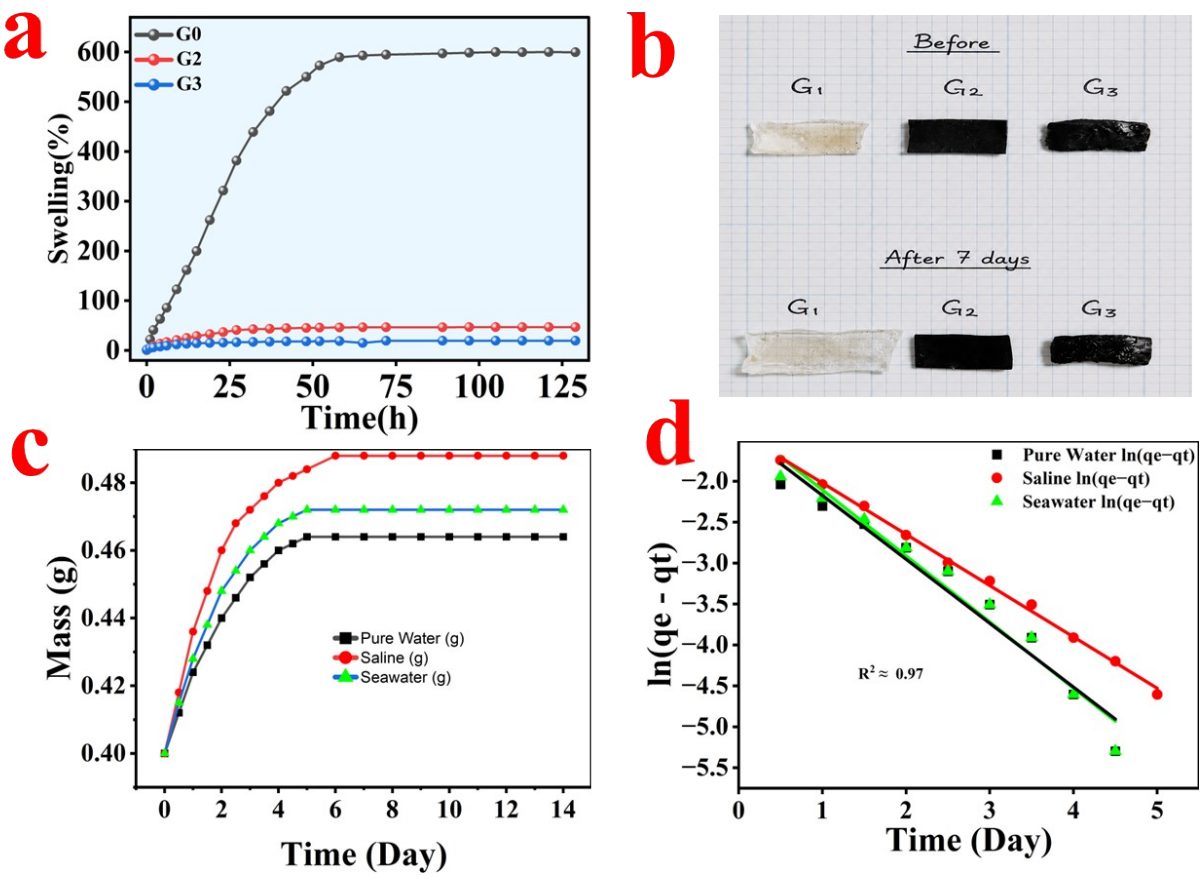

Fig S1 (a) Swelling percentage of G1, G2, and G3 hydrogels. (b) Photographs of G1, G2, and G3 after 7 days of immersion. (c) Swelling behavior of G3 in pure water, saline, and seawater. (d) Pseudo-first-order kinetic fitting of G3 swelling in different media.

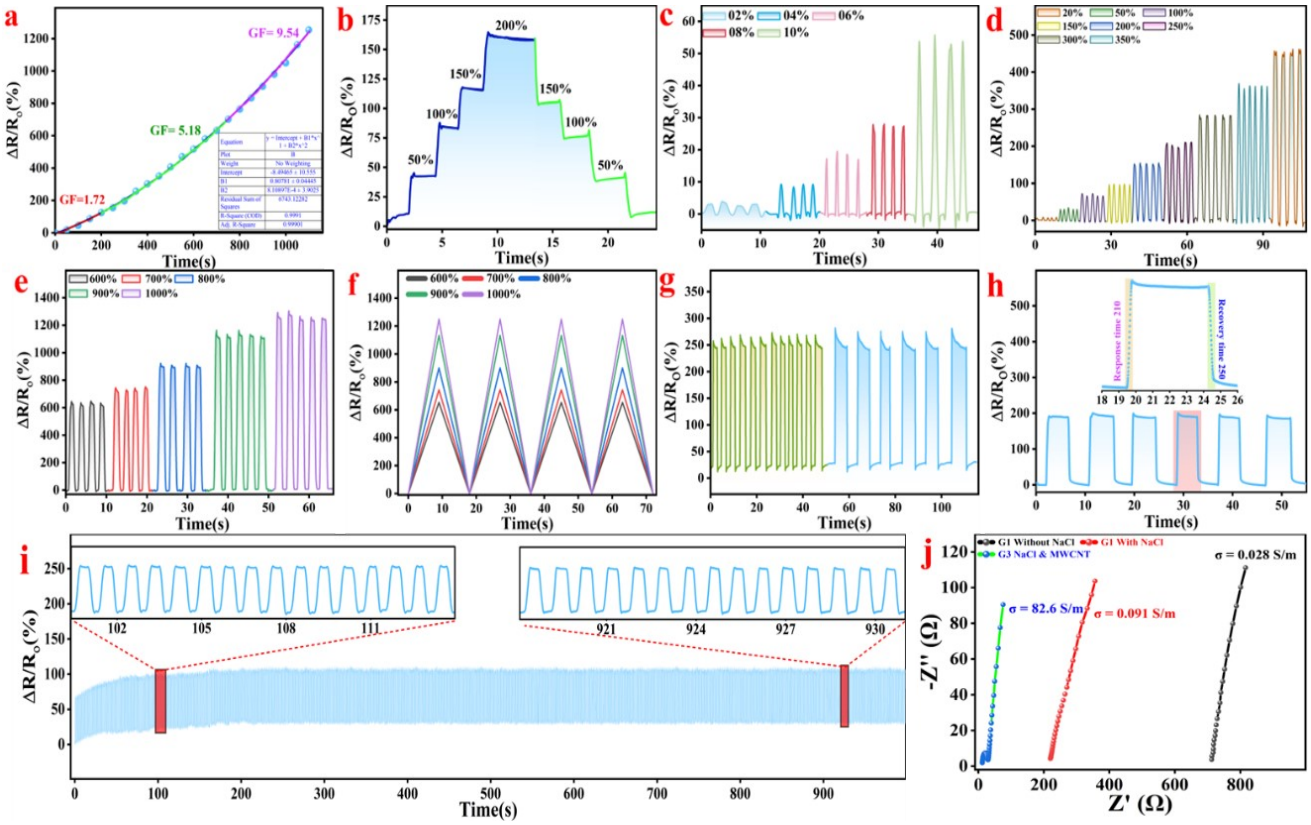

Fig. S2 Electromechanical behavior of the hydrogel in water. (a) Gauge factor (GF), (b) stepwise response to increasing strain from 0% to 200%, (c-e) detailed responses at low (c), moderate (d), and high (e) strain levels, (f) stability of the hydrogel under cyclic loading at different strains, (g) response under fast and slow stretching, (h) recovery and response times of hydrogel, (i) performance over repeated multiple cycles at 200% strain, (j) conductivity of the hydrogel measured by electrochemical impedance spectroscopy (EIS) Comparison of electrical conductivity of G1 hydrogel with and without NaCl, and for demonstrating enhanced ionic-assisted charge transport after salt incorporation

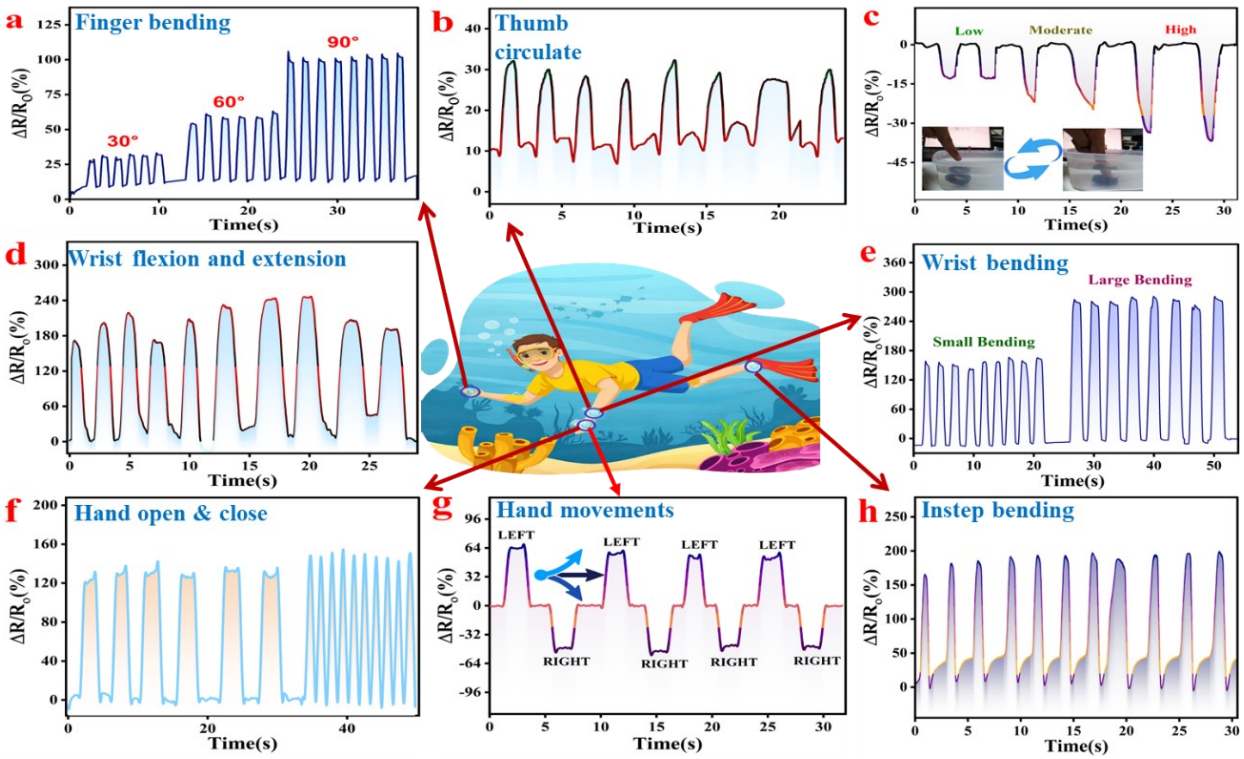

Fig. S3 Demonstration of the hydrogel sensor operating in water for real-time tracking of body movements: (a) finger bending at three different angles, (b) circular movement of the thumb, (c) response to light and strong pressing, (d) wrist bending and straightening, (e) small and large wrist movements, (f) hand opening and closing, (g) side-to-side hand motion, (h) bending of the instep.

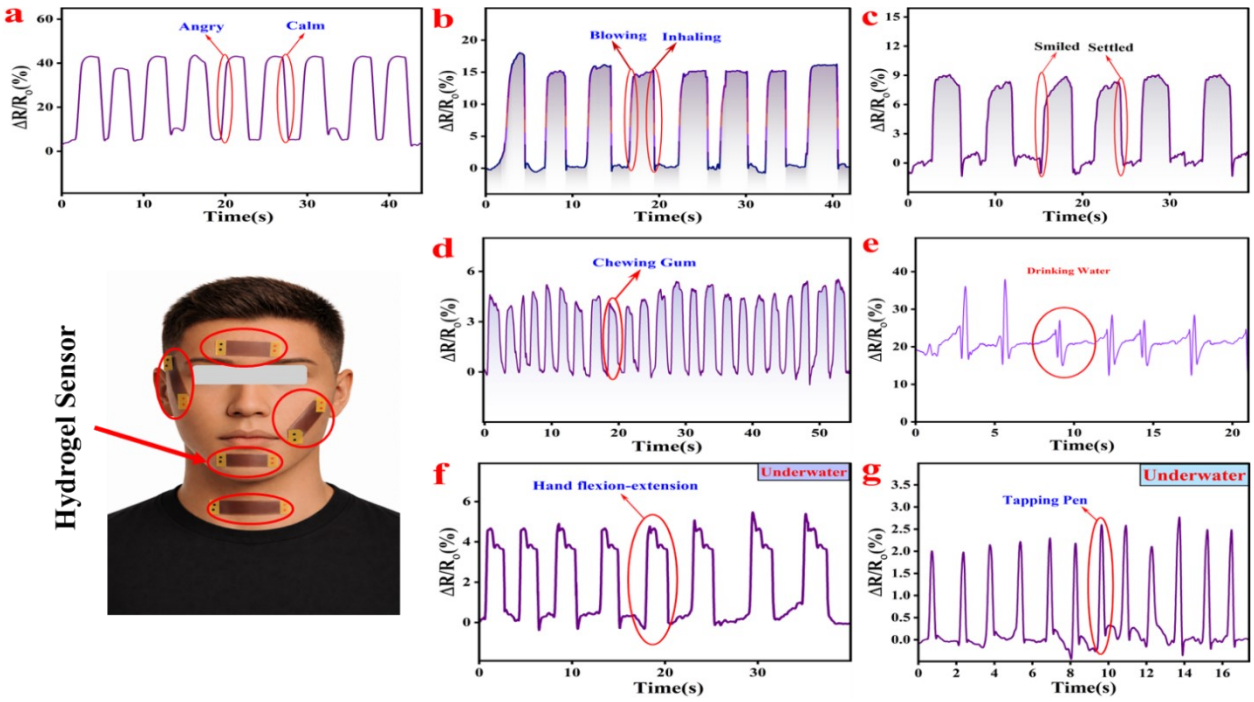

Fig. S4 Detection of subtle human activities using the hydrogel sensor: (a) facial expression changes between angry and calm states, (b) breathing behavior during blowing and inhaling, (c) smile and settled facial expression, (d) chewing motion while chewing gum, (e) signal response during drinking water; and underwater physiological movements such as (f) muscle movement of hand flexion-extension and (g) pen tapping on hydrogel.

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