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Ultraflexible polyurethane yarn-based wearable strain sensor with polydimethylsiloxane infiltrated multilayer sheath for smart textiles†

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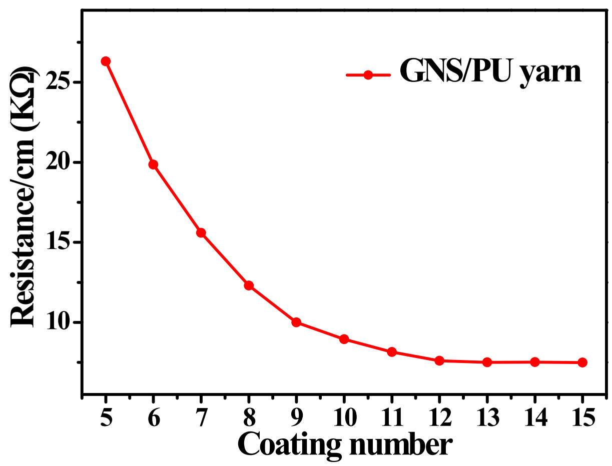

Fig. S1 Resistance changes of GNS/ PU yarn with different number of GNS coating. The electrical resistance of GNS/PU yarn decreases with the increase of number of GNS coating (from 5 to 12) until it reaches to a stable condition (from 12 to 15). That is say, when the number of GNS coating increased to 12, the GNS layer has been achieved to a highly conductive and stable state, and thereby enabling the electro-mechanical properties reach to a stable state.

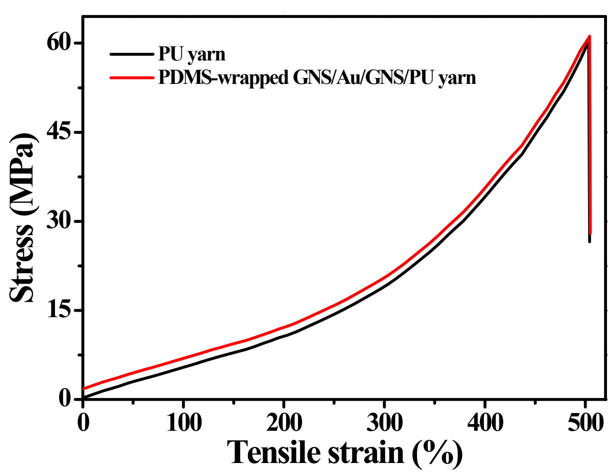

Fig. S2 Tensile properties of PU yarn and the resultant PDMS-wrapped GNS/Au/GNS/PU yarn. It compares the stress-strain curves of the PU yarn and the resultant strain sensor. The PU yarn and the resultant strain sensor can be stretched to approximately 500% until breakage, which indicates that the multilayer sheath and PDMS wrapping layer had no apparent influence on the inherent outstanding mechanical property.

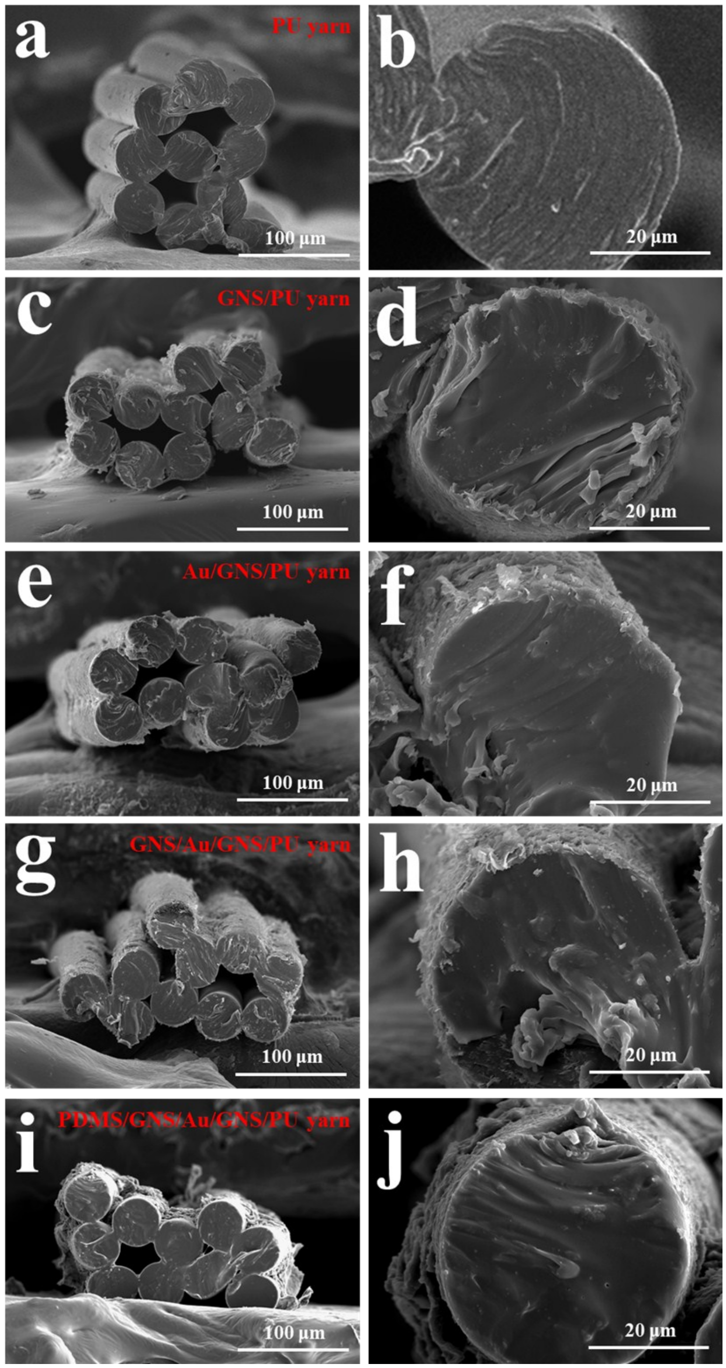

Fig. S3 The cross-sectional FESEM images of (a, b) PU yarn, (c, d) GNS/PU yarn, (e, f) Au/GNS/PU yarn, (g, h) GNS/Au/GNS/PU yarn, and (i, j) PDMS-wrapped GNS/Au/GNS/PU yarn. The PU yarn is consisted of a group of monofilaments with average diameters of approximately 40 μm.

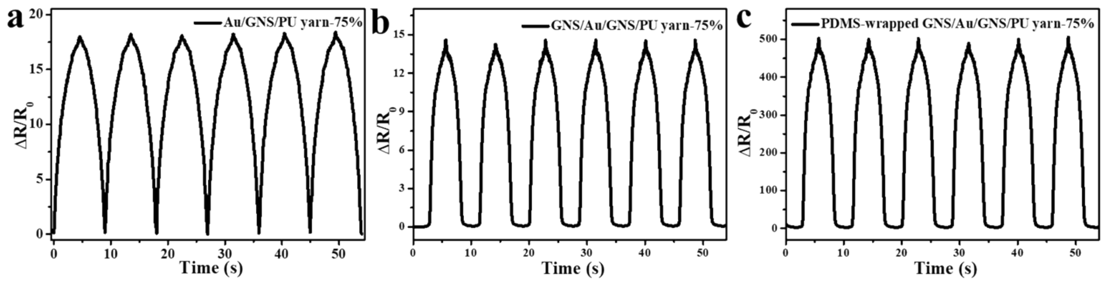

Fig. S4 Resistance-time relationships under six stretching/releasing cycles with an applied strain of 75%: (a) Au/GNS/PU yarn (GF: 23.96), (b) GNS/Au/GNS/PU yarn (GF: 19.55), (c) PDMS-wrapped GNS/Au/GNS/PU yarn (GF: 668.33).

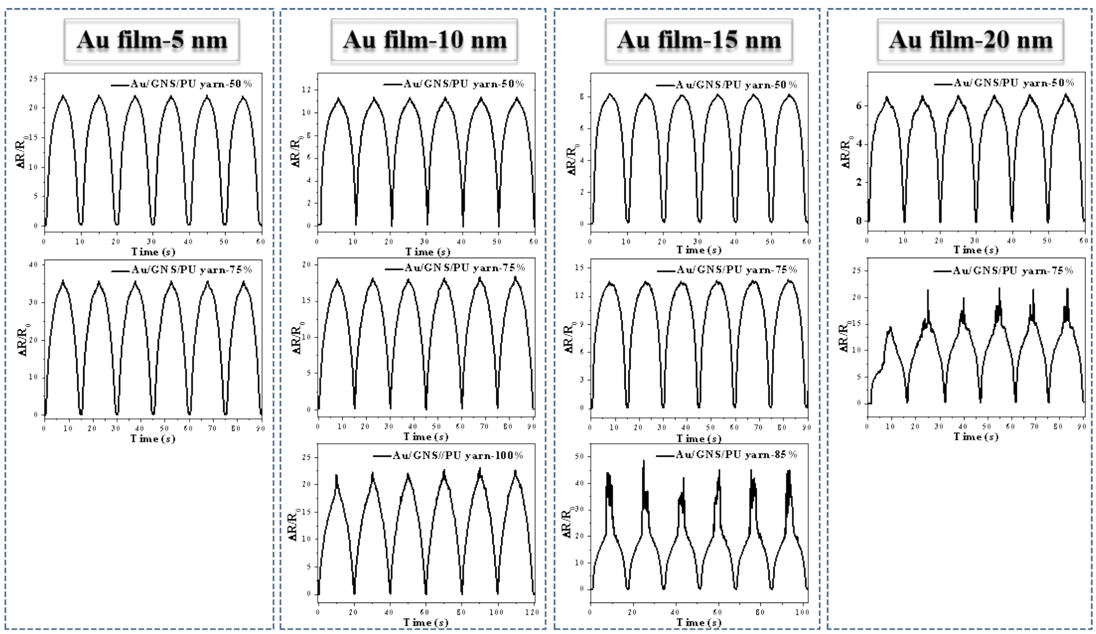

Fig. S5 Electro-mechanical properties of Au/GNS/PU yarn with different thicknesses of Au films. Comparing with the GNS/PU yarns coated with 5 nm, 15 nm, and 20 nm Au films, the GNS/PU yarn coated with 10 nm Au film possesses a wider and more stable working (strain-sensing) range (up to 100%), therefore, in this manuscript, we chose the 10 nm Au film as the inter layer.

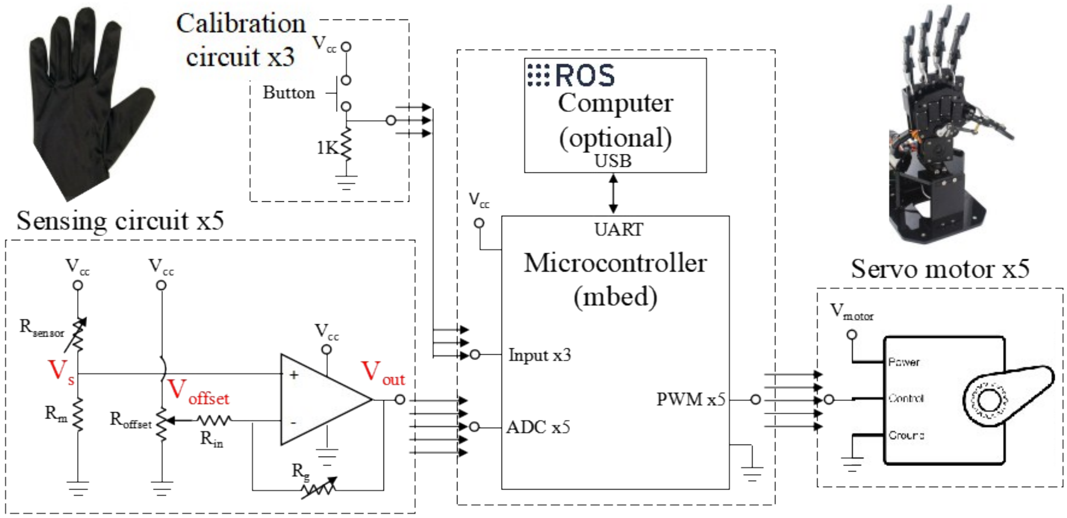

Fig. S6 Schematic diagram of the wearable sensor platform for human-machine interface. Each strain sensor in the glove was connected to a sensing circuit and microcontroller to map the normalized signal voltage value into rotation angle of the servo motor on the corresponding finger of the robotic hand. A separate calibration circuit provides personalized tuning for the voltage mapping of the fingers. Optionally, the signals can be displayed on computer that runs Robot Operating System.

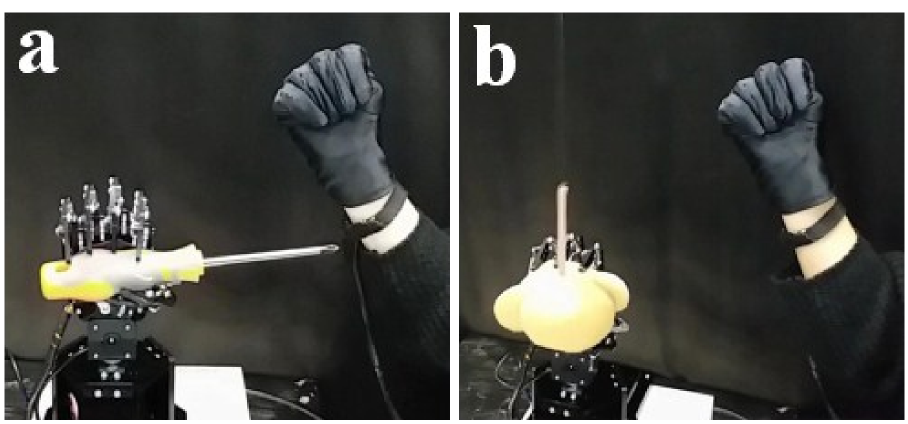

Fig. S7 Photographs showing the smart glove control a hand robot to (a) hold still object and (b) grasp a moving toy.