MULTIMODAL TACTILE SENSOR AIMING AT SMART SPACE EXTRAVEHICULAR MULTI-FINGER OPERATIONS BASED ON FINGER TRIBOLOGY

Kaixuan Kong[a,b]*, Linfeng Wang[a,b], Haodong Wu[a], Zhengxiang Le[a], Zhiwei Yu[a,b], Zhouyi Wang[a,b], Jing Tao[b] , Zhendong Dai[a,b]

*Corresponding author: kongkx@nuaa.edu.cn

[a] Jiangsu Provincial Key Laboratory of Bionic Functional Materials, College of Mechanical and Electrical Engineering, Nanjing University of Aeronautics and Astronautics,

29 Yudao, Nanjing 210016, China

[b] State Key Laboratory of Mechanics and Control for Aerospace Structures, Nanjing University of Aeronautics and Astronautics,

29 Yudao, Nanjing 210016, China

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ABSTRACT

Tactile sensing of skin, an important component of biotribology, shapes the interactions between hand and the surrounding world, owing to the remarkable natural sensory system. But for astronauts, tactile feedback cannot be obtained biologically due to the very thick protective gloves, which seriously hinders the flexibility of the extravehicular activity. In this work, inspired by human skin, we develop a biomimetic multi-layer tactile sensor (BMLTS) that can work like the fast adaptive and slow adaptive receptors of fingertip to achieve the multimodal tactile perception based on the fusion of thermosensitive, piezoelectric, triboelectric and piezoresistive materials. Based on the BMLTS, the tactile perception for temperature, surface roughness discrimination and smart object grasping is successfully achieved by the tribological behavior between BMLTS and surrounding world. Furthermore, by the combination of BMLTS and deep learning, a biomimetic intelligent perception system (BIPS) that can make decisions is constructed. Intelligent real-time object material identification, writing and recording are conducted using BIPS, reaching the recognition accuracy rate higher than 95%. This work lays the foundation for the systematization and integration of tactile sensors, and paves the way for the development of dexterous tactile perception for extravehicular activities of astronauts.

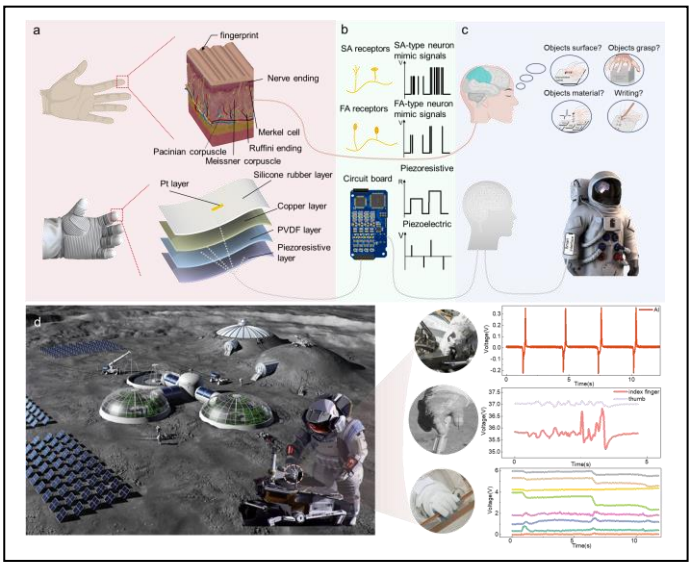

Fig.1 Inspiration and design of BMLTS and BIPS. The BMLTS is composed of five layers including Pt layer, silicone rubber layer, copper layer, PVDF layer and piezoresistive layer, intimating the human fingertip skin mechanoreceptors such as Merkel cell and Ruffini ending for static pressure, Meissner and Pacinian corpuscles for dynamic forces or vibrations and nerve ending for temperature. The tactile signals are generated by the tribological behavior between the BMLTS and surrounding world including one finger, two fingers and multi fingers.

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