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Artificial-Intelligence in 3D-Printed-Hybrid-Triboelectric/Piezoelectric-nanogenerators multifunctional-self-powered sensing and actuation systems for intelligent-robots

The challenges of robotics involved the exploration of new materials and fabrication schemes, and power and energy harvesting schemes that require self-powered sensing and actuation fusion mechanisms, which challenges the physical limitations of traditional mechatronic systems, opening a range of options for developing a new generation of intelligent robots. The requirement of self-powered multifunctional sensing and actuation, as flexible sensors, and soft actuators to enable a high degree of autonomy, adaptability, and reliability for intelligent robots can be addressed using triboelectric (TENG) and piezoelectric (PENG) nanogenerators that convert mechanical energy into electricity using the triboelectric and piezoelectric effects. Nanogenerators provide the opportunity to develop multifunctional self-powered sensing and actuation systems exploiting their unique energy harvesting mechanisms, large open-circuit voltages, ease of fabrication and high conversion efficiency. This research will focus on merging the triboelectric and piezoelectric effects for the design and fabrication of innovative Hybrid Triboelectric/Piezoelectric nanogenerators to fully utilize their advantages and eliminate possible limitations to achieve more efficient self-powered sensing and actuation exploiting their energy harvesting capabilities for intelligent robotic systems, oriented in find solutions to the challenges of robotics integrating the hybrid nanogenerators. Firstly, an Artificial intelligence (AI) algorithm based on deep neural networks technique will be used to predict, establish, and improve the tuning of the electromechanical output performance, conversion efficiency and achieve an optimal design under various structures, materials, and conditions of the complex mechanism of hybrid TENG/PENG devices with further physical experimental data comparison. Secondly, utilizing advanced 3D printing manufacturing technology approach, which offers ease of fabrication, rapid implementation, higher adaptability, lower-cost, better productivity to fabricate complex structures and integrate soft materials. The fabrication and development of functional novel self-powered 3D-printed hybrid TENG/PENG flexible, robust and reliable devices such as sensors and actuators will be performed following the AI algorithm outputs and analysis. Finally, the hybrid devices will be integrated and tested working as self-powered multifunctional sensing and actuation mechanisms in intelligent robots used for real-world deployment human-robot applications. Focus on demonstrating their proper operation, adaptability and stability adapted to create innovative mobile soft robot-human interfaces tested in real-world environment conditions without sacrificing performance.