Development of 3D Printed Soft Origami-Inspired AI-driven Millirobot for Biomedical Applications

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To tackle the challenges of targeted drug delivery, we created three different milli-robotic approaches. To improve overall locomotion efficiency and load bearing capabilities during delivery, a multi-legged millirobot (15 x 5 x 1.5mm) was designed and implemented with both leg extrusions and a crater texture. The PDMS-based body and magnetic limbs were found to be successful as the locomotion speed relative to the lower limb of the milli-robot was 106% more efficient than the next highest specimen. In order to achieve a quasi-soft, adaptable architecture, the design of actuated origami-inspired structures is presented. The structures were 3D-printed as individual "islands" then threaded with shape-memory alloy wires for a full assembly. The wires have a pre-trained memorized shape corresponding to an "unfolded" stage and are deformed to the "folded" stage upon exposure to the activation temperature. The structures were able to transition from folded and unfolded stages with a discrepancy below 0.7mm. Towards achieving autonomous navigation, a soft origami-inspired SCPAM-driven robot was also developed. An origami bellow was fabricated by a 3D printer and an autonomous AI control system was implemented. The robot successfully recognized, located, and delivered solid drugs to a mock disease site in a simulated human organ at a speed of 10 mm/minute and an accuracy of near 100%. Future development of more miniaturized technologies means that more functionalities can be added, such as blood vessel insertion, and current on-board technologies can be made more effective and more efficient.