

What types of motion can the artificial muscles presented in the paper achieve? How can these motions be combined to produce more complex behaviors?

Artificial muscles are a long-sought class of actuators for applications in industrial robots, wearable devices, and medical instruments. Numerous transduction methods have been proposed, including the use of thermal energy, electric fields, and pressurized fluids. Most artificial muscles are made from fluid-driven actuators due to their simplicity, large actuation stress and deformation, high energy efficiency, and low cost. Each muscle has its own distinct motion along with it which carries out a series of tasks. For example, actuators such as pouch motors and Peano muscle have a simple planar architecture. These artificial muscles can generate both linear contraction and torsional motion at relatively low air pressures. Planar linear contraction and torsional motion can be generated by VAMPs through the buckling of their elastomeric beams caused by negative pressure. The fluid-driven origami-inspired artificial muscles allows programming for a multiaxial motion. These fluid-driven muscles are fast, energy efficient, and powerful. Additionally, they can be operated at a low cost while being high quality. Voids with different hinge stiffnesses can be used to achieve differential contractions. This principle can generate asymmetrical out-of-plane motions. For example, a 2D Miura-ori origami skeleton with some hinges weakened can produce a complex motion that combines both torsion and contraction. Furthermore, if the hinge or connection stiffnesses are significantly distinct, then a controllable pseudo sequential motion can be generated by the artificial muscle. In a second example, a pneumatically driven robotic arm can first grip an object, then lift and twist the gripped object. This pseudo sequential multiaxial manipulation is achieved by a single control pressure. In this case, the gripper's plastic skeleton is much more compliant than the metal skeleton in the "arm". These examples show how the addition of different motions can open up additional capabilities of the artificial muscle. As a result, artificial muscles through the process of soft robotics and wearables is definitely a part of our future. Through more research, this can open us up to major advances in biology and anatomy as a whole.