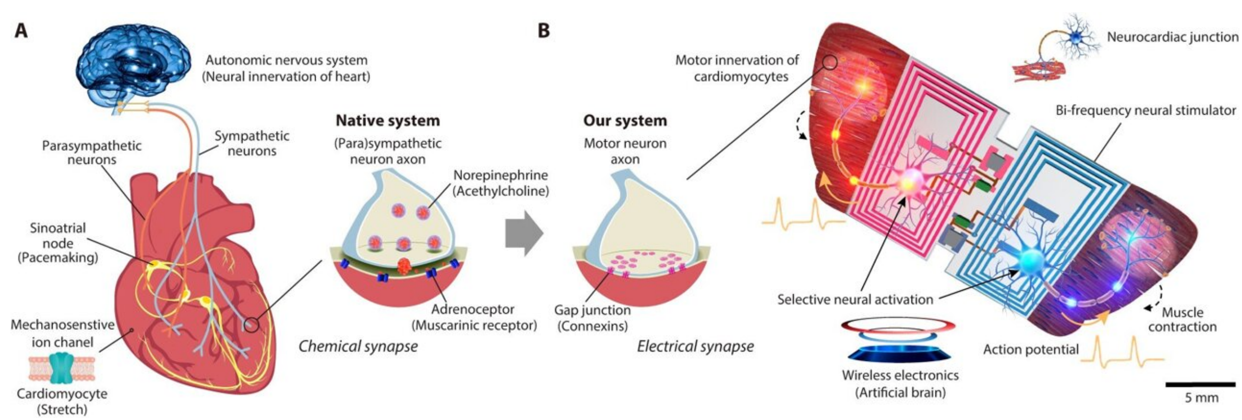
Biohybrid swimming robot uses motor neurons and cardiomyocytes to emulate muscle tissue

October 1 2024, by Bob Yirka



Wirelessly controllable bioelectronic neuromuscular robots for steering actuation behavior. (A) Dynamic control of the heart via the neural innervation of cardiomyocytes (CMs). (B) Schematic of a bioelectronic neuromuscular robot with selective motor innervation of CMs driven by a wireless frequency multiplexing bioelectronic device. Credit: Hiroyuki Tetsuka

A combined team of bio researchers and roboticists from Brigham and Women's Hospital, in the U.S., and the iPrint Institute, in Switzerland, has developed a tiny swimming robot using human motor neurons and cardiomyocytes grown to emulate muscle tissue.

Their paper is published in the journal *Science Robotics*. Nicole Xu, a mechanical engineer at the University of Colorado Boulder, has published a Focus piece in the same journal issue outlining ongoing work to create bioinspired robots using animal tissue.

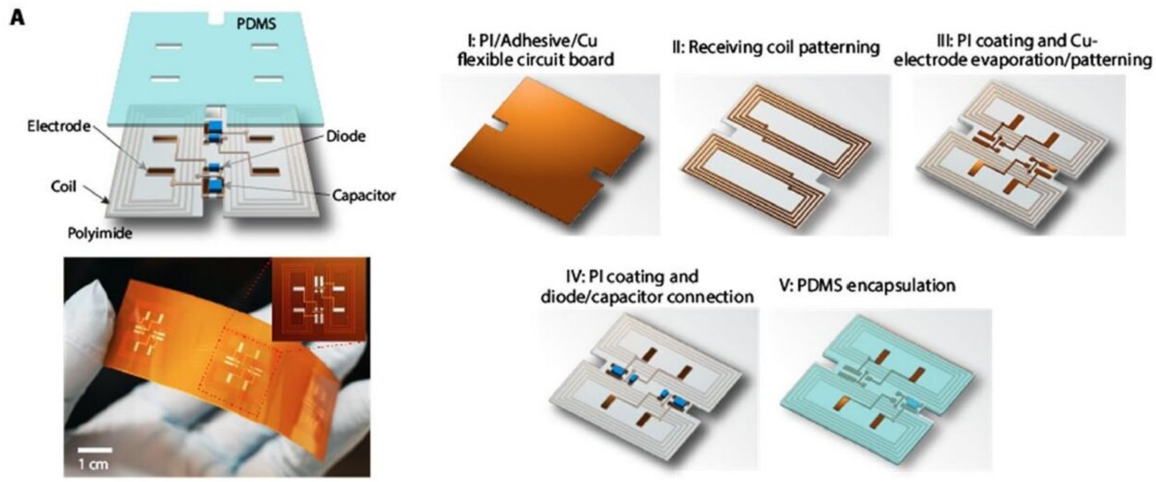
For many years, science fiction writers and movie makers have used the idea of combining electronics, computers and animal tissue to create robots with unique and sometimes terrifying attributes. In the real world, Xu describes such work as ongoing.

Animals, including humans, have abilities that far surpass anything robots can do. Doing laundry, for example, requires a myriad of skills, including sorting dirty clothes, choosing washer and dryer settings, and folding or hanging clothes.

Such activities require both dexterity and mental processing. Because of that, roboticists are exploring the development of biohybrid robots. The research team created a ray-like swimming robot with a computer brain that controls human muscle cells activated by human motor neurons.

To create the robot, the researchers cultured both motor neurons and cardiomyocytes that were produced using human pluripotent stem cells. The cardiomyocytes were programmed to grow into muscle cell tissue on a scaffolding that resembled ray fins in a way that allowed them to junction with the motor neurons.

This allowed for the creation of electrical synapses. Some of the motor neurons were then connected to an electronic processor that served as the robot's brain. It housed Wi-Fi circuitry that transferred signals from human controllers to either the left or right fin, or both.



Fabrication process for the flexible PCB-based wireless bi-frequency bioelectronic device. Credit: Hiroyuki Tetsuka

In this way, the researchers were able to control the movement of their robot, eventually giving it the ability to swim.

Over time, the research team found they could maneuver the robot with precision, including making sharp turns. They also found they could make it swim at speeds of up to 0.52 ± 0.22 mm/s.

More information: Hiroyuki Tetsuka et al, Wirelessly steerable bioelectronic neuromuscular robots adapting neurocardiac junctions, *Science Robotics* (2024). DOI: 10.1126/scirobotics.ado0051

Nicole W. Xu, Float like a butterfly, swim like a biohybrid neuromuscular robot, *Science Robotics* (2024). DOI: 10.1126/scirobotics.ads4127