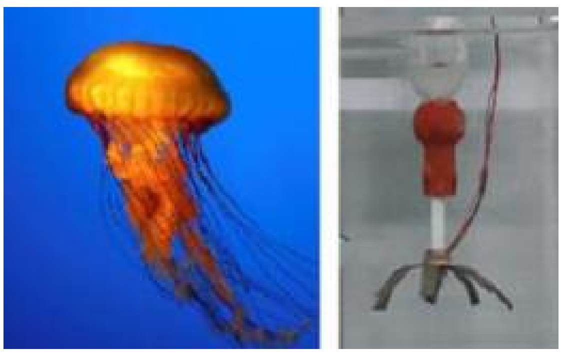
Jellyfish Robot Swims Like its Biological Counterpart

June 26 2009, By Lisa Zyga



(Left) A living jellyfish and (right) a jellyfish robot made of electro-active polymer artificial muscle. Both jellyfish move by contracting the bell to generate a pulsating motion. Image: Yeom and Oh.

(PhysOrg.com) -- "Jellyfish are one of the most awesome marine animals, doing a spectacular and psychedelic dance in water," explain engineers Sung-Weon Yeom and Il-Kwon Oh from Chonnam National University in the Republic of Korea. Recently, Yeom and Oh have built a jellyfish robot that imitates the curved shape and unique locomotive behavior of the living jellyfish.

As the researchers explain, advances in electro-active polymers (EAP) enabled them to achieve this biomimetic swimming behavior in a robot. One specific type of EAP, ionic polymer metal composites (IMPC), can be used to make actuators that behave like biological muscles, exhibiting large bending under a low applied voltage. The muscle material has several advantages for biomimetic robots, such as compactness, high power efficiency, controllable steering, and quiet locomotion. In this study, the researchers used this material, permanently bending it to mimic the living jellyfish's bell (the hemispherical top part).

"This is the first jellyfish robot based on the electro-active polymer artificial muscle," Oh told *PhysOrg.com*. "They could be used as entertainment robots, micro/nano-robots, and biomedical robots in the near future."

Living jellyfish, the authors note, can vary in size from a few inches up to seven feet in diameter. Yet all jellyfish use a similar, simple swimming mechanism. By contracting its bell, the animal reduces the space underneath it, forcing water out through a lower opening near its mouth and tentacles. This pulsating motion allows the jellyfish to partially control its vertical movement. This ability is important, since jellyfish are photosensitive and prefer deeper water at brighter times of day. Although living jellyfish can move vertically, they passively depend on ocean current, tides, and wind for horizontal movement.

Previous research on the locomotion of living jellyfish has found that, if the animal's muscles force the bell to contract at its resonant frequency, less energy is required for movement. In their study, the researchers mimicked the natural pulse and recovery processes of the living jellyfish. They found that the bio-inspired periodic input signal enables the jellyfish robot to obtain a large floating velocity upward; in comparison, harmonic sinusoidal signals do not push the robot upward.

Overall, their study has shown that the curved shape of the IPMC actuator can be used to build a jellyfish robot that successfully mimics the locomotion of living jellyfish. Oh added that, in the future, he plans to develop artificial biomimetic jellyfish robots that have integrated selfpowered actuators and sensors, as well as an automatic steering system.

More information: Sung-Weon Yeom and Il-Kwon Oh. “A biomimetic jellyfish robot based on ionic polymer metal composite actuators.” *Smart Mater. Struct.* 18 (2009) 085002 (10pp).