Alan Pierce
pierceaj@optonline.net

Artificial Muscles

Biomimetics is the name given to technologies that have been inspired by observing living organisms. This area of technology has led to research in many areas including hearing, vision, artificial intelligence, and artificial muscles.

The photo at right shows a computer-controlled "power suit" that was developed by Keijiro Yamamoto, an engineering professor at Japan's Kanagawa Institute of Technology. Yamamoto's suit enhances a person's own body strength through the use of pneumatic muscles. A built-in computer controls the suit's artificial muscles. Each artificial muscle group receives its activation signal from the computer, which constantly measures the working load of the wearer's own muscles.

Dr. Keijiro Yamamoto, Kanagawa Institute of Technology

The power suit is an exoskeleton that can determine a wearer's need for assistance when lifting or carrying a particular load. The suit joins a person and a machine to maximize physical strength so a nurse or first responder can lift or move people or materials that could previously not be lifted by one person.

In the U.S., the Defense Advanced Research Projects Agency (DARPA) is funding the development of soft power suits. While these suits would not enhance strength to the same degree as Yamamoto's, DARPA hopes to develop a less bulky pneumatic suit that could assist in the lifting and carrying process to lessen the fatigue of a soldier or first responder. The suit could also increase the mobility of people who have certain disabling conditions.

The holy grail of artificial muscle technology is to build an exoskeleton suit that wouldn't be as bulky as suits that are powered by pneumatic systems. Electroactive polymers (EAPs) change shape when they are electrically stimulated and return to their designed shape when the electricity is turned off. The Achilles heel in the development of EAP artificial muscles arises from the fact that polymers tend to be physically weak.

At the First International Conference on Electroactive Polymers, Yoseph Bar-Cohen challenged the engineering community to develop an electroactive polymer strong enough to power an artificial arm in a person vs. machine arm-wrestling contest. (See photo at right.) Bar-Cohen made this challenge on March 1, 1999, expecting his challenge to stand for decades. However, advances in this field have come rapidly, and Bar-Cohen's challenge should be met at the EAP Actuators & Devices Conference in March 2005. SRI International is building the EAP artificial muscle combatant. The human side of the challenge will be handled by a straight-A high school student from San Diego, CA.

For more material from Yamamoto and a list of web sites from Bar-Cohen, visit www.technologytoday.us and follow the link to "artificial muscles."

Recalling the Facts

1. What is the relationship between the natural world and biomimetics?
2. What provides the muscle power in Keijiro Yamamoto's power suit?
3. How will the DARPA-funded soft suit differ from Yamamoto's power suit?
4. How do electroactive polymer muscles differ from the other muscle-powered systems discussed in this article?

NASA Jet Propulsion Laboratory

Alan Pierce, Ed.D., CSIT, is a technology education consultant, technical writer, and public speaker on technology issues.