

News

First armwrestling match between an EAP actuated robotic arm and a human

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On 7 March 2005, the International Society for Optical Engineering (SPIE) hosted a groundbreaking event for the field of electroactive polymers (EAP) with the first armwrestling match of EAP robotic arm against human (AMERAH). The event was held during the Electroactive Polymer Actuators and Devices (EAPAD) Conference at SPIE's Smart Structures and Materials Symposium in San Diego, California, USA.

Three organizations entered the competition each with a novel EAP driven robotic arm: Environmental Robots Inc. (ERI), Swiss Federal Laboratories for Materials Testing and Research (EMPA), and a group of students from Virginia Tech's Engineering and Mechanics Department. These three participating teams competed against the human opponent, Panna Felsen, a robotics hobbyist and straight-A 17-year old high school student from the San Diego School District. This first AMERAH was coordinated with the United States ArmSports and its rules were based on the rules for human wrestling matches as defined in the United States ArmSports rules and regulations.

The number one priority of the competition was the safety of the human wrestler and thus measures were taken to ensure that Ms Felsen was not subjected to any hazardous conditions. With this as the governing rule for the robotic arms, none were able to defeat its human opponent.

The longest match lasted 24 s by the EWA-2 robotic arm manufactured by ERI of New Mexico. The total EWA-2 arm system weighed 3 kg. The body of the arm was produced of polypropylene and Derlin and was driven by two groups of artificial muscle. One group consisted of dielectric elastomeric resilient type that was used to maintain an equilibrium force, and the second was composed of ionic polymer metal composites (IPMC) type strips

that flexed to increase or decrease the main resilient force (Plate 1).

The arms from Virginia Tech and the Swiss Federal Laboratories for Materials Testing and Research each yielded to the female opponent in less than 5 s. The EAP actuator built by three senior students from Virginia Tech's Engineering Science and Mechanics Department contained batches of PAN gel fibers encased in an electrochemical cell that responded to changes in pH by contracting like a human muscle does. The skeleton of the arm utilized a structure consisting of composite material attached to an aluminum base (Plate 2).

EMPA, part of the Switzerland Federal Institutes of Technology, developed a robotic arm that was driven by dielectric elastomer multi-

layered scrolled actuators that were organized into four groups. Using electronic control, these actuators operated similar to human muscles, in which two of the groups acted as antagonists and the other two operated as antagonists. The arm's fiberglass outer shell shielded the electric section. The arm structure was a composite of fiberglass and carbon fibers (Plate 3).

This inaugural EAP arm wrestling event was founded by Dr Yoseph Bar-Cohen, a Senior Research Scientist at Jet Propulsion Laboratory (JPL) in Pasadena, California. Bar-Cohen first came up with the idea for a human/robot arm wrestling competition in 1999 as a means to promote the advances towards making EAP actuators used in prosthetics and other

Plate 1 Arm wrestling world champion Allen Fisher advises Panna Felsen in her first competition against ERI's patented EWA-2 robotic arm



Plate 2 The human opponent studies her chemically activated muscle competitor from Virginia Tech



Plate 3 A member of the Swiss Federal Laboratories team performs safety checks prior to arm wrestling match



devices that are superior to the performance of human muscles, and to increase the worldwide visibility and recognition of EAP materials. At the time, Bar-Cohen thought it would take 20 years – not 6 – before the technology developed.

Commented Bar-Cohen after the event, “Even though these arms did not win against the human opponent, we have accomplished a major milestone for the field of EAP with this historic event. We are now at the dawn of a new era for the field of EAP and we can get prospective to this accomplishment when we remember that the first flight lasted only 12 s”.

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