Researchers present a new method of wirelessly recharging medical device batteries with ultrasound

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Human beings don't come with power sockets, but a growing numbers of us have medical implants that run off electricity. To keep our bionic body parts from powering down, a group of Arizona researchers is developing a safe, noninvasive, and efficient means of wireless power transmission through body tissue. The team presents their findings at the 166th meeting of the Acoustical Society of America, held Dec. 2 – 6 in San Francisco, Calif.

Medical implants treat a variety of conditions such as chronic pain, Parkinson's disease, deep brain tremors, heart rhythm disturbances, and nerve and muscle disorders. If the batteries in the devices lose their charge, minor surgery is needed to replace them, causing discomfort, introducing the risk of infection, and increasing the cost of treatment.

This is a scenario the Arizona researchers are aiming to change.

Their novel wireless power approach is based on piezoelectric generation of ultrasound. The Greek root, "piezo", means "squeeze." In piezoelectrical systems, materials are squeezed or stressed to produce a voltage. In turn, applied voltages can cause compression or extension. Piezoelectric materials have specific crystalline structures. The team's piezoelectric system has been tested in animal tissue with encouraging results.

"The goal of this approach is wireless power transmission to human implantable power generators (IPGs)," explained lead researcher Leon J. Radziemski of Tucson-based Piezo Energy Technologies. "Charging experiments were performed on 4.1 Volt medical-grade lithium-ion batteries. Currents of 300 milliamperes (mA) have been delivered across tissue depths of up to 1.5 centimeters. At depths of 5 centimeters, 20 mA were delivered. Currents such as these can service most medical-grade rechargeable batteries."

With Dr. Inder Makin, an experienced ultrasound researcher, the team has tested the device in pigs to demonstrate safe charging over several hours of ultrasound exposure. The system works like this: A source such as a wall plug or battery powers the transmitter. Ultrasound passes from the transmitter through the intervening tissue to the implanted IPG housing the piezoelectric receiver. After positioning the transmitter, the patient can control the procedure from a hand-held device that communicates with the implant. When charging is complete, the implant signals this and turns off the transmitter.

Wireless recharging transmission has been tried before using a different technology, electromagnetic recharging. Given the proliferation of battery-powered medical implanted therapies, the Radziemski team sees an emerging and expanding need for increased rechargeable power options.

"Ultrasound rechargeable batteries can extend the time between replacements considerably, reducing health care costs and patient concerns," Radziemski said. The next step involves further testing and development in hopes of commercializing the technology within two to five years.

More information: Presentation 3pBA5, "An ultrasound technique for wireless power transmission through tissue to implanted medical devices," will take place on Wednesday, Dec. 4, 2013, at 2:00 p.m. PST. The abstract describing this work can be found here: asa2013.abstractcentral.com/planner.jsp

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