Washington University in St. Louis
Office of Technology Management

SELF-CAPACITANCE POWER TRANSFER FOR EFFICIENT WIRELESS CHARGING OF SMALL WEARABLES

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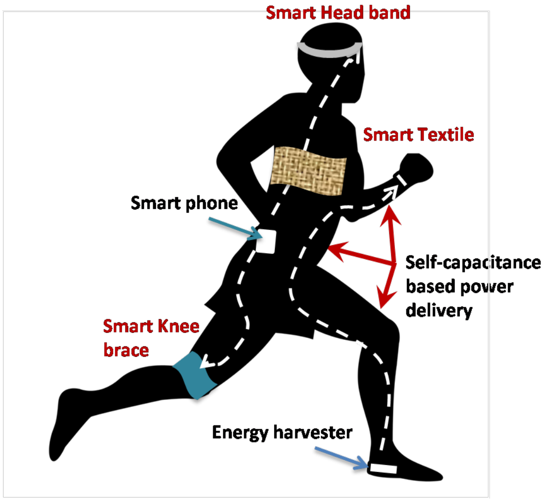
T-018759

Technology Description

Engineers in Prof. Shantanu Chakrabartty's laboratory have developed a convenient, wireless power transfer system that exploits the body's self-capacitance to charge small, low power, wearable and minimally-invasive devices.

Wearable devices traditionally rely on bulky rechargeable batteries to supply the power needed for their sensors and other functions. Therefore, the devices must be large enough to integrate the battery and the user is periodically inconvenienced by recharging the battery. This is not practical for semi-invasive wearables like oral cavity sensors, smart contact lenses and miniature sensors stitched into clothing/textiles. This new self-capacitance technology can solve these problems by remotely transferring the power to the wearable or hard-to-reach areas of the body. The system utilizes the self-capacitance of the person's body to wirelessly transfer power from portions of the body that have access to higher power density to energy-constrained wearable devices. Self-capacitance provides high efficiency power transfer that scales linearly with the size of the transducer and enables charging over distances that are not possible with traditional wireless charging technologies (e.g., induction, ultrasound). This invention could enable the next generation of wearable devices to be even smaller and more convenient with end-user applications for animal monitoring, medical devices or consumer electronics.



Self-capacitance system for wireless power transfer

Stage of Research

- **Human studies** – The inventors have developed a prototype self-capacitance based wearable and a battery-based power source and validated its operation using human subjects. They have also verified that the power transfer

mechanism is functional under different environmental and subject ambulatory conditions.
- **Animal studies** - The inventors developed models for self-capacitance charging and demonstrated its efficiency (>90% for distances greater than 10cm) for delivering a microwatt-scale charge in a prototype "smart cage" for monitoring laboratory animals. They verified the system in an experimental cadaver mouse model.

Applications

- **Wireless charging** of millimeter scale wearables in the power range of ~10mW, with end-user applications such as:
    - Hard-to-reach wearable technology (e.g., smart contact lenses, mouth guards)
    - Smart textiles and stitched sensors (e.g., sports performance monitors, flexible electronics/wearables)
    - veterinary and laboratory animals (e.g., livestock monitors, smart cages for remote monitoring)

Key Advantages

- **Convenient, efficient charging:**
    - devices can receive power with >90% efficiency, outperforming energy transfer compared to conventional wireless charging (e.g., RF, inductive, ultrasound)
    - devices can be charged while being worn, which could increase compliance in health monitoring etc.
    - devices can be powered over a distance and do not need directly contact the charger
- **Compact, scalable devices:**
    - wearable devices can be miniaturized because they do not require large batteries
    - improves aesthetics and wearability
    - harvestable power scales linearly with the dimensions of the components
    - robust to transducer alignment artifacts and energy fluctuations

Publications - Alazzawi, Y., Aono, K., Scheller, E. L., & Chakrabartty, S. (2019). Exploiting Self-Capacitances for Wireless Power Transfer. *IEEE transactions on biomedical circuits and systems*, 13(2), 425-434.

Patents – Methods and apparatus for wireless power delivery and remote sensing using self-capacitances (US 11,128,168)

Website -Adaptive Integrated Microsystems (AIM) Lab