WiseSkin for tactile prosthetics

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Problem: Amputation of a hand or limb is a catastrophic event resulting in significant disability with major consequences for amputees in terms of daily activities and quality of life. Although functional myoelectric prostheses are available today (e.g. hand), their use remains limited due, in part, to a lack of sensory function in the prostheses. At the same time, as the world’s population is growing and aging, the number of people living with disabilities, including lost limbs due to trauma, diabetes or cancer is increasing. A sense of tactility is needed to provide feedback for control of prosthetic limbs and to perceive the prosthesis as a real part of the body; a sense of “body owner ship”.

Today, there is no solution for restoration of a natural sense of touch for persons using prosthetic limbs

Solution: WiseSkin provides a solution for restoration of the sensation of touch. It embeds tactile sensors into the cosmetic silicone coating of prostheses, which acts like a sensory “skin” providing the sensation of touch, enabling improved gripping, manipulation of objects and mobility (walking) for amputees. Flexibility, freedom of movement and comfort demand unobtrusive, highly miniaturized, ultra-low power (ULP) sensing capabilities built into the “skin”, which is then integrated with a sensory feedback system. The focus is on non-invasive (external actuation) sensory feedback mechanisms. The main elements of the project are:

- flexible, skin-like, material embedded with tactility sensors
- miniature, flexible, soft-MEMS based sensors (e.g. pressure, shear)
- ULP, event driven wireless communication (radio and protocol) between the sensors and processing / control module
- a conformal, stretchable powering system based on a metallic mesh grid
- use of the metallization layers as a waveguide (e.g. gold, liquid metal)
- a system for sensory feedback based on a tactile display (i.e., on the amputation stump or the back) using miniature actuators
- Proof-of-Concept demonstrator (i.e., tested on volunteers) combined with brain imaging to investigate neural mechanisms of tactile perception.

Key innovations:

- Wireless and sensor technology
  - Scalable routing, adaptable MAC, robust, event driven, new solutions for High Density Wireless Sensor Network (HD-WSN)
  - Reliable, miniature, soft-MEMS sensors (e.g. pressure)
  - Conformal power distribution system
  - Stretchable power distribution and signal transmission layers
  - Electro-mechanical-sensor integration and miniature flexible antenna
  - Tactile sensory perception and human-electronics interface (HEI)
  - Study and test of a non-invasive HEI on real patients
  - Multi-sensory perception, MRI brain imaging analysis (e.g. phantom finger somatotopy)
  - WiseSkin system and technology integration
    - A flexible, stretchable artificial skin / smart material that is relatively easy to manufacture
    - Restore a natural sensation of touch, ease of sensor placement and coverage of large areas

WiseSkin provides a natural sense of touch