Scalable networks of wearable bioelectronics for treating sensory impairments

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Abstract:

Just as our eyes perceive red, green, and blue as the basis for color vision, our skin perceives pressure, stretch, vibration, and temperature as the basis for understanding our physical surroundings. Skin-mediated perception is central to our everyday lives; for example, our feet provide the first point of contact with our environment during walking, and patients with conditions such as stroke and spinal cord injury, who have lost the ability to perceive this contact, often face major challenges with balance and mobility. Here, we introduce a wireless network of skin-conformable, multimodal haptic arrays that deliver high-density thermal and vibrotactile patterns anywhere on the body. These haptic arrays form the receivers in a sensory substitution system that delivers patterns of vibrotactile stimulation to mirror the distribution of pressure recorded from an insole-based array of pressure sensors. Exploratory case studies in individuals with spinal cord injury and stroke demonstrate feasibility and suggest improved performance during standing balance and walking tests. Altogether, this work highlights the potential of information-rich cutaneous interfaces to substitute plantar sensation, expanding the scope of somatosensory engagement for rehabilitation, entertainment, and education.