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On-Skin Interfaces

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The convergence of advances in electrical engineering and material science has opened up new opportunities for using the skin as an interactive device. This theme issue presents two articles focusing on emerging input capabilities and design.

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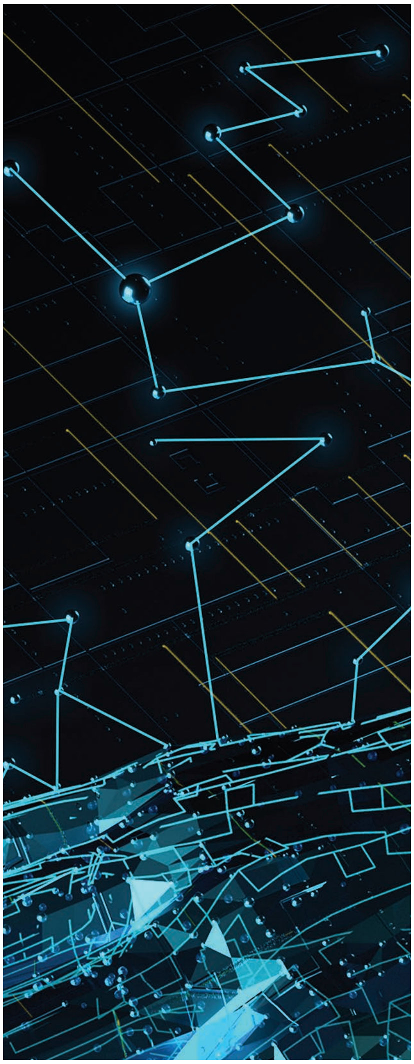
The personal computer's dramatic transformation—from terminal to desktop, and from laptop to handheld—shows no sign of ending. In fact, as computing interfaces shift into everyday "things," they are increasingly embedded into objects and clothing, and can be used in entirely new ways. This theme issue looks at a possible—and certainly extreme!—next step: using the human skin as a user interface.

With a surge in exciting prototypes recently published in the field of human–computer interaction, we are seeing the convergence of two rapidly advancing areas: electrical engineering and material science. One well-known example is Skinput,[1] which embeds a bio-acoustic sensing array into an armband that can detect vibrations on the arm produced by tapping. Taps on the arm and hand can be localized. In another line of work, electromyography (EMS)-based sensing was used to recognize hand postures as sources of input.[2] In addition, new slim, deformable materials can be engineered for capacitive sensing to be worn on the skin. iSkin, for example, introduces bandage-like patches based on carbon-filled PDMS (a polymeric organosilicon compound).[3] The semi-transparent patches are perforated for air transmission and decorated with black ink. A music player, for instance, can be operated by touching different parts of an iSkin patch, which has decorations that function as buttons on the forearm. This category of input devices is emerging as "interactive tattoos."

Further explorations for expressive input capability have led to other types of on-skin inputs. Capacitive sensing for pressure and multitouch,



for example, were used in a prototype called SenSkin,[4] which featured photo-reflective sensor arrays on the forearm that tracked skin deformations. Continuous input was provided by pushing or pulling the skin with the tip of a finger. On the output side, projectors, thin displays, vibrotactile actuators,[5] and more have been investigated. Moreover, using wireless communications, we could recruit nearby displays or smartwatches for output as well.

Perhaps the most obvious benefit to these technologies is immediacy. A command can be given faster, as there is no need to retrieve a device from a purse or a pocket. Another is eyes-free interaction: a tap on the forearm is registered by the computer, but also sensed by the skin itself. No other feedback would be needed to confirm the input event. There could also be social benefits: we could control a social media application by tapping or sliding the tip of thumb along the shaft of the index finger, which could be done without others in the vicinity noticing. Finally, the malleability of sensing and the immediacy it provides open up new possibilities for people in challenging conditions or who might have sensory or mobility impairment.

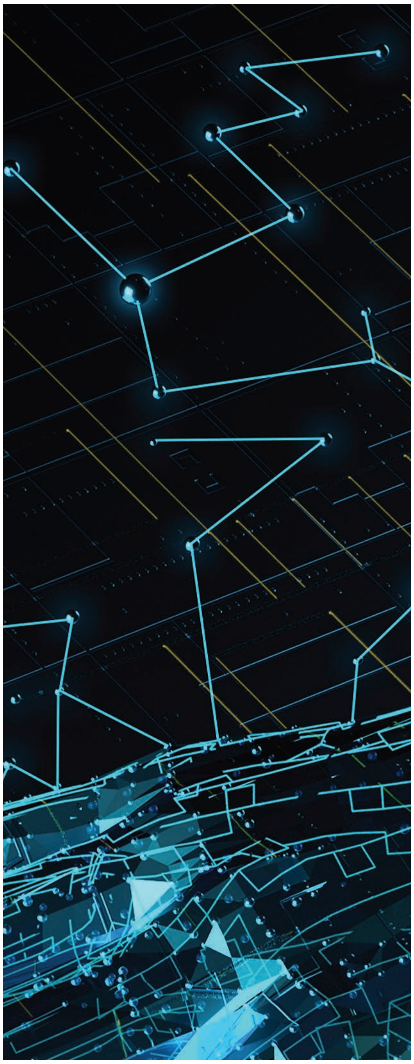
On-skin interaction might not be science fiction in a few years' time. Realistically, though, many challenges still exist for these technologies. Perhaps the most immediate technical obstacles are recognition accuracy and energy efficiency. When sensing devices are on the body, they are susceptible to false positives caused by unintended contact. The materials and devices worn on skin should also be safe and comfortable for regular use. The skin is an organ, after all, and is necessary for sensing and protection. Improvements in breathability of the materials worn on the skin are therefore necessary, and damage and wear to biological tissues should be minimized to ensure the skin's ability to function. Presently, rigid objects are still required for I/O, microcontrollers, energy supply, and communications.

IN THIS ISSUE

This theme issue explores two exciting vistas in this space. In "On-Skin Interaction Using Body Landmarks," Jürgen Steimle, Joanna Bergstrom-Lehtovirta, Martin Weigel, Aditya Shekhar Nittala, Sebastian Boring, Alex Olwal, and Kasper Hornbæk discuss the design of interactions for on-skin technology. The design of skin-based interfaces is radically different from, say, the design of GUIs. Consider wrinkles, knuckles, and other natural features associated with skin. The authors use body landmarks to help design more efficient and memorable means of interaction.

In "Interactive Systems Based on Electrical Muscle Stimulation," Pedro Lopes and Patrick Baudisch look at an emerging opportunity to "actuate people." Here, on-skin electrodes are used to contract muscles involuntarily but in a coordinated fashion. Feedback and subtle information can be provided to the user. More radically, gross movements can be controlled with muscle stimulation. This creates completely new opportunities in joint human–computer control of movement.

The two articles neatly illustrate that the most important open questions for on-skin interfaces are not technical. Will it ever be "natural" to adopt skin as an interactive surface, given its vital biological functions? Will it be socially acceptable to interact with a computer without others being able to observe it? Will we surrender more of our privacy and leisure time to computers when they are not held but worn around the clock? With actuation techniques like electrical muscle stimulation, will other people and algorithms take control of our bodies? And, looking into the future, what will happen when our bodies become part of the Internet?



REFERENCES

1. C. Harrison, D. Tan, and D. Morris, "Skinput: Appropriating the Body as an Input Surface," *Proc. SIGCHI Conf. Human Factors in Computing Systems* (CHI 10), 2010, pp. 453–462.
2. T.S. Saponas et al., "Enabling Always-Available Input with Muscle–Computer Interfaces," *Proc. 22nd ACM Symp. User Interface Software Technology* (UIST 09), 2009, pp. 167–176.
3. M. Weigel et al., "iSkin: Flexible, Stretchable and Visually Customizable On-Body Touch Sensors for Mobile Computing," *Proc. 33rd ACM Conf. Human Factors in Computing Systems* (CHI 15), 2015, pp. 2991–3000.
4. M. Ogata et al., "SenSkin: Adapting Skin as a Soft Interface," *Proc. 26th ACM Symp. User Interface Software Technology* (UIST 13), 2013, pp. 539–544.
5. V. Lehtinen et al., "Dynamic Tactile Guidance for Visual Search Tasks," *Proc. ACM Symp. User Interface Software Technology* (UIST 12), 2012, pp. 445–452.

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