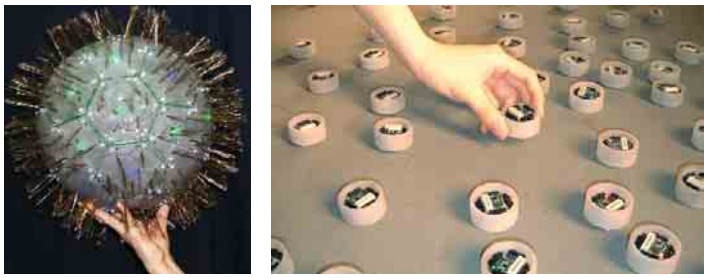
Sensate Media

The ability to blend diverse sensors in close proximity promises to usher in a new generation of electronic skins that hold the potential for revolutionary applications.

BY **Joseph A. Paradiso**

COMPUTERS ARE DISAPPEARING INTO OUR environments through many different avenues. Several of these routes, such as teleconferencing being subsumed into smart rooms, burglar alarms transforming into infrastructures for smart homes, and mobile devices diffusing into wearable computing, are related to initiatives highlighted elsewhere in this section. A different and more extreme axis of this evolution is the absorption of computer networks into electronic skins. Sensate media [1] is a surface tiled by an extremely dense sensor network, taking basic inspiration from biological skin, where signals from a concentrated array of multimodal receptors that sense proximity, vibration, pressure, shear force, tactile flow, temperature, and pain are conditioned and processed (for example, adapted, inhibited, or enhanced) as they are routed to the brain by the nervous system.



Sensate media hardware test beds at the MIT Media Lab: The Tribble (right) and The Pushpin computer (left).

Today's typical sensor network feature nodes placed many meters apart, spanning buildings, rainforests, or battlefields. Sensate media, however, anticipates a node spacing of under a centimeter. In order to avoid complexity in wiring and data transmission when scaling to large areas, each processor manages its own array of sensors, communicating with its neighbors to reduce data locally across the physical footprint of a stimulus, then route higher-level paramaterizations off the sensate surface (or collectively manage embedded actuators for a local reflex response). Such a construct aspires to blur the boundary between the fabricated and the animate and spur new innovations in applications like robotics, telemedicine, and prosthetics.

This approach has a legacy in earlier programs, such as the "Smart Matter" initiative at Xerox PARC and the Amorphous and Paintable Computing projects at MIT. Advances in semiconductor capacity have recently made hardware implementations more feasible, as researchers begin to microfabricate very high-density multimodal microsensor arrays onto flexible substrates and ever more capable and power-efficient microcomputer systems-on-a-chip are available in shrinking footprints.

At the MIT Media Lab, we have recently developed a series of test beds to explore information processing in sensate media. The Pushpin computer is an easily configurable array of over 100 sensor nodes that can be placed anywhere on a tabletop-sized conductive-sandwich backplane from which they draw their power. Communicating with other nodes in their neighborhood via IR, they collectively process sensor stimuli garnered from a transducer suite that currently features optical, audio, and ultrasound sensors.

The Tribble (Tactile Reactive Interface Built By Linked Elements) is a research platform for the application of decentralized control and distributed sensor processing to human-computer interaction. It resembles a soccer ball, but is covered with a multimodal sensate skin consisting of 32 networked tiles supporting 516 sensor channels. Every tile measures pressure at three locations, local temperature, local sound and illumination, and dynamic tactile stimulation with up to 12 channels of protruding, touch-sensitive piezoelectric "whiskers." Each tile can also respond with a small audio speaker, a pager vibrator, and a bright RGB LED. There is no central processor—each tile talks to its neighbors through conductors in the frame. C

Reference

1. Paradiso, J., Lifton, J., and Broxton, M. Sensate media—Multimodal electronic skins as dense sensor networks. *BT Technology J. 22*, 4 (Oct. 2004), 32–44.

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