UnderWare: Aesthetic, Expressive, and Functional On-Skin Technologies

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Abstract
Emerging technologies allow for novel classes of interactive wearable devices that can be worn directly on skin, nails and hair. This one-day workshop explores, discusses and envisions the future of these on-skin technologies. The workshop addresses three important themes: *aesthetic* design to investigate the combination of interactive technology with personalized fashion elements and beauty products, *expressive* and multi-modal interactions for mobile scenarios, and *technical function*, including novel fabrication methods, technologies and their applications. The goal of this workshop is to bring together researchers and practitioners from diverse disciplines to rethink the boundaries of technology on the body and to generate an agenda for future research and technology.

On-Skin Technologies
For centuries, the body surface has been accessorized with body art and cosmetics. An emerging research stream in UbiComp/ISWC and HCI proposes skin and its appendages (e.g., hair, nails) as the next surface for wearable computing. These surfaces have been shown to be promising for novel wearable form factors [5,13—15] presenting new challenges and opportunities for wearable devices and interactions. They blur the line between technology and fashion (aesthetic), and allow for novel multi-modal and highly expressive

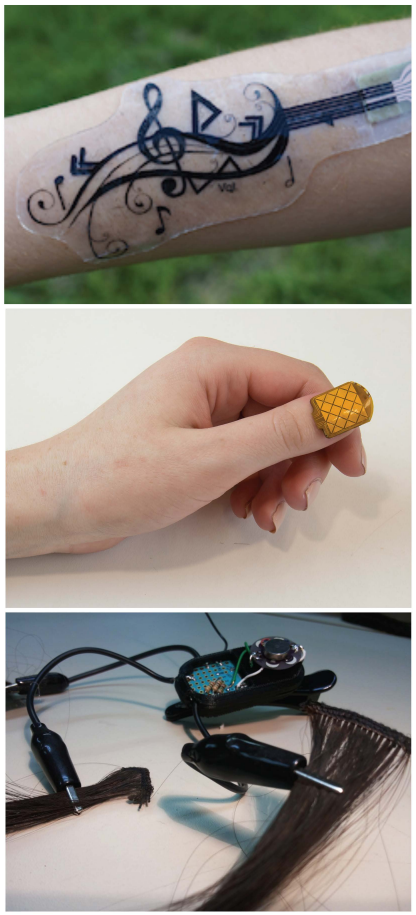

Figure 1: On-skin technology examples. (a) iSkin [15], a flexible, visually customizable skin-overlay for touch input. (b) NailO [6], a fingernail trackpad. (c) HairWare [13], touch-sensitive hair extension.

interactions on the body (expressive). Finally, they require thin, flexible and biocompatible interaction surfaces and fabrication methods that ease personalization (technical function). Together, on-skin devices have the potential to improve a wide range of application scenarios, from interaction, communication, wellbeing, to cosmetics and beyond.

Workshop Goals and Themes

This one-day workshop aims to broaden research horizons and form a research community around on-skin technologies. Potential participants include Ubicomp and HCI researchers, fashion and interaction designers, material and medical sciences researchers to form an interdisciplinary discussion. Attendees are invited to submit position papers that extend the current status of on-skin technologies. The range of contributions includes, but is not limited to:

Aesthetics: Visually Customizable On-Skin Technology and Interactive Body Art

Since on-skin devices are worn on the body, there is a desire to *personalize* its appearance to reflect identity and style. This includes wearables which are visually customizable to enable personal aesthetic [5,15].

Traditional body art practices integrated with technology present unique aesthetics and fashion statements [13,14]. Examples include decorative displays, light embellishments and interactive performances. Conceptual videos that speculate the future of these technologies are also invited.

Expression: On-skin Interaction and Sensing

The skin can become an expressive user interface [12,15]. On-skin sensors appropriate the skin as an *input* surface, and connect to devices for always-available mobile interaction. iSkin [15], Hairware [13] and NailO [5] are examples of direct input on the body. In addition, the skin can serve as *output* through LEDs, visual displays, and haptic feedback. Affective states such as electrodermal activity [2], vital signals [6,11], and vocal quality [4,8] can also be measured though the skin's physical properties.

Function: Technical Innovation and Applications

In UbiComp and HCI, novel materials, fabrication processes, and miniaturized electronics expand the technical development of on-skin technologies.

In material science, nanotechnology, microfabrication and advanced materials enable fully integrated electronics with soft, stretchable forms, as in Epidermal Electronics [7].

Medical applications can measure the chemical composition, optical characteristics, and mechanical properties of human skin and its appendages to develop point-of-care wearable devices and drug delivery technologies. Discussions about continuous, real-time monitoring of analytics in sweat, interstitial fluid, and tear are also welcomed.

Workshop Format

There are four sessions in the one-day workshop. The introduction session will welcome participants and describe the agenda. In the second session, participants will briefly present their position papers (3 minutes per pitch), followed by plenary discussions. The presentation timeline will be adjusted based on the number of accepted papers per theme. Participants will then have the chance to live-demo their projects. In

the third session, participants will split up into three groups, one for each theme, depending on their preferences. This provides room for in-depth discussion of opportunities and challenges of the respective theme. The goal is to work together on creating an account of important open questions and derive a prioritized agenda for future research. To support idea generation and discussion, we will provide prototyping material for creating low-fidelity conceptual prototypes. In the closing session each group reports their results back to the plenary. Finally, the workshop will be concluded with reflective discussion and planning of follow-up activities.

Workshop Timing (6 hours)

- Introduction Session (15 min)
- Theme 1. *Presentation and discussion* (25+20min)
- Theme 2. *Presentation and discussion* (25+20min)
- Theme 3. *Presentation and discussion* (25+20min)
- Lunch break
- Group work based on themes (2h)
- Mid-Afternoon break
- Reporting results back (45 min)
- Closing session (30 min)

Pre-workshop. A website will be created for publicity and sharing through social media. We will also spread the word through mailing lists and other targeted outreach efforts.

Post-workshop. We plan to form a sub-group of interested workshop participants who consolidate and extend the outcomes of the workshop, resulting in a report covering the state-of-the-art of on-skin research and an agenda for future research. We plan to invite workshop participants to expand their submission for a special issue of a journal.

Soliciting Participants

The workshop committee will accept manuscript submissions in the form of position papers via e-mail. For early acceptance (June 7), the workshop committee will directly contact and invite submissions from researchers and practitioners of on-skin technologies. The public call for participation will be open until the final submission deadline.

Organizers

MIT Media Lab

Joseph Paradiso is a professor at MIT Media Lab. He directs the Responsive Environments Group, which explores how sensor networks augment and mediate human experience, interaction and perception.

Chris Schmandt is a principal research scientist at MIT Media Lab. He directs the Living Mobile Group, which explores novel mobile and wearable interactions.

Katia Vega is a postdoc at the MIT Media Lab. She proposes Beauty Technology [14]: a novel way to move from traditional to interactive cosmetics that transform the body into an interactive platform.

Cindy Hsin-Liu Kao is a PhD student at MIT Media Lab. Her work focues around on-skin electronics which are expressive and culturally-designed.

Rébecca Kleinberger is a PhD student at the Media Lab. She works on ways to connect people with themselves and others by playing with mental, physiological and physical perception including affective skin responses.

Xin Liu is a master student at the MIT Media Lab. She has worked on interactive clothing including Google Jacquard and hosted the Body as Interface workshop in Eyebeam this year [1].

Jie Qi is a PhD candidate at the MIT Media Lab and creative director of Chibitronics. Her research blends electronics with nontraditional media to create expressive electronics and engage new communities in making technology.

Microsoft Research
Asta Roseway is a Principal Research Designer at Microsoft Research. Her work focuses around HCI, Affective Computing, and wearable technologies.

Harvard Medicial School
Ali K. Yetisen is the Tosteson postdoctoral fellow at Harvard Medical School and Massachusetts General Hospital. He researches nanotechnology, photonics, wearables, and arts.

Saarland University
Jürgen Steimle is a professor of computer science at Saarland University. His focus areas include flexible displays and sensor surfaces, on-body interaction, embedded user interfaces, and personal fabrication.

Martin Weigel is a PhD candidate at Saarland University and the Max Planck Institute for Informatics. His research focuses on novel body-worn devices and expressive on-skin interactions.

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