Personalized Interactive Surfaces with Printed Electronics

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Abstract
Recent advances in printed electronics have enabled the design and fabrication of thin, flexible and customizable interactive surfaces. These interfaces create opportunities for a variety of novel interactions leveraging on the unique form factor, flexibility and customization options. Previous research has demonstrated the possibility of customizable multi-touch sensors, conformal on-skin interfaces and printable shape changing displays. The aim of this tutorial is to acquire basic conceptual and practical skills in developing interactive surfaces with printed electronics.

Author Keywords
Printed Sensors and Actuators; On-body Interfaces; Digital Fabrication

ACM Classification Keywords
H.5.2 [Information interfaces and presentation (e.g., HCI)]: User Interfaces; Input devices and strategies [Prototyping]: Interaction styles

Introduction
Interactive surfaces have evolved from classical touch-screen based computing devices to a wider variety of domains, such as interactive tangible objects [4] and on-body user interfaces [6, 7]. Such interactive surfaces should effectively blend in with the potentially demanding geometries of those

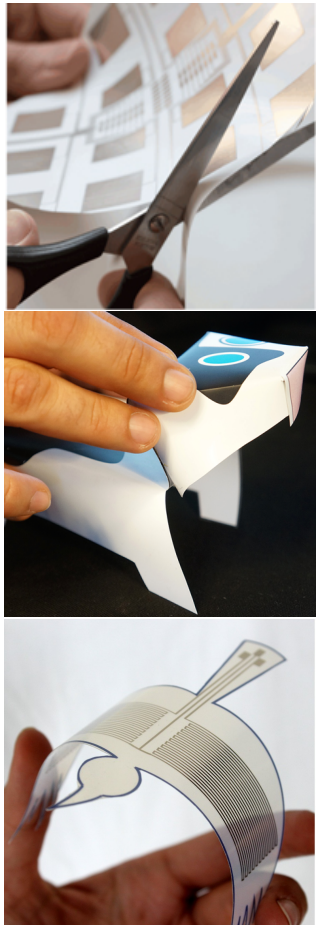

Figure 1. Previous research has demonstrated the possibility of customizable multi-touch sensors (top) [3], fold sensors and actuators (middle) [4], and flex sensors (bottom) [5] using printed electronics.

devices, satisfy personal user preferences, and be aesthetically pleasing while functioning efficiently. Therefore, such interfaces tend to require a much higher degree of customization to the personal and contextual needs than a general purpose interactive surface.

Recent advances in printed electronics have enabled the design and fabrication of thin and flexible computing components that capture user input and provide output [2]. The majority of these components can be digitally designed in a computer so that they can be easily customized and personalized [3, 4]. Rapid prototyping of such designs becomes possible with low cost fabrication methods such as conductive inkjet printing [1]. This enables iterative design and evaluation of user interfaces with thin, flexible, and highly customized form factors.

Printed Interactive Surfaces

Printed electronics can be used to fabricate interactive surfaces using different underlying technologies. Multi-layered printed electronics can be used to detect touch and pressure with resistance or impedance changes [6]; single-layer printed electrodes can detect touch, multi-touch and proximity with loading mode capacitive sensing [3]. Furthermore, elastic properties of printed electronics have been shown to allow for sensing the deformation of a surface [5].

Olberding et. al. demonstrated a variety of interactive and customizable interfaces with printed electronics. These comprise multi-touch, proximity and bend sensors for input, while electroluminescent displays and thin-film actuators are used for output [4]. Furthermore, previous research has shown the capability of physical customization of printed electronics after they are fabricated, such as a cuttable multi-touch sensor [3]. These interfaces have enabled a variety of interaction modalities such as touch, shear, fold,

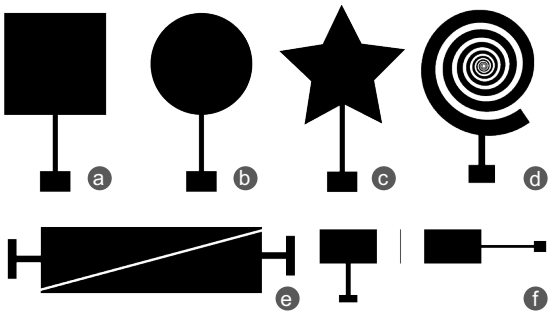

Figure 2. Sample shapes and arrangements of printable electrodes for loading mode capacitive sensing. a-d) custom shaped electrodes for proximity (hover) and touch sensing, e) two electrode arrangement to implement a slider, f) two electrode arrangement to sense fold.

and rotation sensing with custom shaped displays and fold actuators. Figure 2 shows a few example shapes and arrangements of printable electrodes that can be used to sense different modalities using loading mode capacitive sensing.

Planned Activities

The goal of this tutorial is to acquire basic conceptual and practical skills in developing personalized interactive surfaces with printed electronics. Topics and learning outcomes of the tutorial include:

- Personalized digital design of printed electronics.
- Basics of different sensor types and actuators (touch sensing, proximity sensing, RFID, EL displays, etc.).
- Rapid prototyping of printed circuits with conductive inkjet printing.

- Hardware interfacing and data communication with Arduino.
- Sample application scenarios with printed sensors and actuators.
- Introduction to high fidelity printed electronics with screen printing.

Presenter Biographies

Anusha Withana is a postdoctoral research fellow at the Human-Computer Interaction Lab at Saarland University and the Max Planck Institute for Informatics, Germany. His primary research focus is in ubiquitous and wearable multimodal interfaces. Prior to joining Saarland University, he was a Postdoctoral Research Fellow in the International Design Center at Singapore University of Technology and Design. He completed his PhD (2014) and Masters in Media Design (2010) at Keio University, Japan.

Jürgen Steimle is a professor of computer science at Saarland University and a senior researcher at the Max Planck Institute for Informatics. His research interests include embodied and tangible interaction, interactive surfaces, new materials, and personal fabrication. Prior to joining Saarland University he was a visiting assistant professor at the MIT Media Lab. He received a PhD in computer science from Darmstadt University of Technology.

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