Printed Electronics for Human-Computer Interaction

A very brief introduction

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Agenda

- What is Printed Electronics?
- Potential for HCI
- Outlook
Printed Electronics

Printed electronics is a set of printing methods used to create electrical devices on various substrates. (Wikipedia)

- Organic electronics (inks contain carbon atoms)
- Plastic electronics
- Paper electronics
Graphic Printing: Traditional Art

- Patterned deposition process of color on a thin film substrate
- Multi-layers for color images
From Graphic Printing to Functional Printing

Use of established **printing methods**
- Inkjet printing
- Screen printing
- Offset printing
- ...

... and established printable **substrates**
- Paper, Foils, Textiles, ...

...with novel **inks**
- Printable conductors and semi-conductors (e.g., silver nanoparticles, conductive polymers, graphene...)
- Dielectric
- Insulators

...enables **printing of electrical devices**
Functional Printing

- RFID and Smart Labels
- Flexible OLED lighting and displays
- Biosensors
- Printed photovoltaics
- Batteries
- Memory
- Transistors -> simple logic circuits
- ...
1st Integrated Printed Electronics System

Continuously monitors temperature

- Temperature sensor (PST sensors)
- Organic logic circuitry (PARC)
- Rewritable memory (Thinfilm)
- Electrochromic display (ACREO)

Source: Thin Film Electronics ASA
From Heiko Kempa, Institute of Print and Media Technology, Chemnitz University of Technology

**Printed Electronics**
- long switching times
- low integration density
- large areas
- flexible substrates
- simple fabrication
- extremely low fabrication costs

**Conventional Electronics**
- extremely short switching times
- extremely high integration density
- small areas
- rigid substrates
- sophisticated fabrication
- high fabrication costs

**low cost**

**high cost**

**low end**

**high end**
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- What is Printed Electronics?
- **Potential for HCI**
  - **Basic approaches**
  - Sensors
  - Displays, speakers, actuators
  - Prototyping toolkits
- Outlook
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Potential for HCl: Input and Output

- Touch sensors
- Multimodal sensor surfaces
- Displays
- Speakers
- Actuators

- New form factors: thin, flexible, large-surface
- Easy, fast, and inexpensive fabrication
Typical Approach in HCI

- Only the **I/O surface is printed**
- The other components are still “conventional”:
  - I/O surface connected to rigid controller board
  - Reads out sensor data, Signal processing, Energy supply
  - Tethered or wireless connection to a computing device
Typical Printing Techniques in HCI

- **Conductive inkjet printing** with silver nanoparticle ink
- **Screen printing** with various commercial inks
Inkjet Printing

+ Digital process
  - No printing plates
  - Perfect for low volume, customized solutions, prototypes and demonstrators

+ Quite high resolution and high precise registration

+ Commodity hardware (!)

- Single layer printing on commodity printers
- Slow speed
- Nozzles block
Screen Printing

+ Most used production technique
+ Large variety of substrates
+ Large variety of inks
+ Multi-layer printing

- Requires print mask
- Slow speed

± Inexpensive tools, but manual process
± Semi-automatic and automatic printers available, but expensive

From Gunther Hübner, HdM
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Conductive Inkjet Printing

- Off-the-shelf inkjet printer
- Silver nano particle-based conductive ink
- Realize circuits, resistors, capacitors, antennae
- Single-layer printing


Multimodal Touch Sensor: PrintSense

- Thin-film, flexible sensor surface
- Captures multi-modal input
  - Multi-Touch
  - Pressure
  - Proximity
  - Deformation
- Custom shape
- Single layer print

Large Surface: Sensor Floor

Cuttable Multi-Touch Sensor

Pressure Sensor: PyzoFlex

Deformation Sensor: FlexSense

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User-printed Displays: PrintScreen

Paper Speakers

By Jess Rowland

http://www.instructables.com/id/Paper-Speakers-1
Thin-Film Actuators: Self-folding hinges

Energy Harvesting: Paper Generators

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Prototyping Platform: Circuit Stickers

Available at https://www.crowdsupply.com/chibitronics/circuit-stickers

Figure 2: Circuit stickers. From left: generic 0805, piezo sounder, LED, coin-cell battery holder, 555 timer, hall-effect sensor, accelerometer, push button.

Prototyping Platform: Printoo

- Modular approach
- Core module
- Various sensor modules
- Electrochromic display
- Soft battery
- ...
- Available at [www.printoo.pt](http://www.printoo.pt)
Prototyping Platform: Fingies

A set of printed circuit cards is used to attach different sensors and actors to the "fingies" platform.

The electronic contact is established with the super magnets.
Prototyping: Printing Methods

- Ask us for conductive inkjet printing and for screen printing / display printing
- We’re happy to help you get started with these technologies
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Outlook

3D printed electronics
*Voxel8 printer*

New materials:
- Elastic form factors
- Printable textiles
Thank you.