

Interaction with Touch-Sensitive Knitted Fabrics: User Perceptions and Everyday Use Experiments



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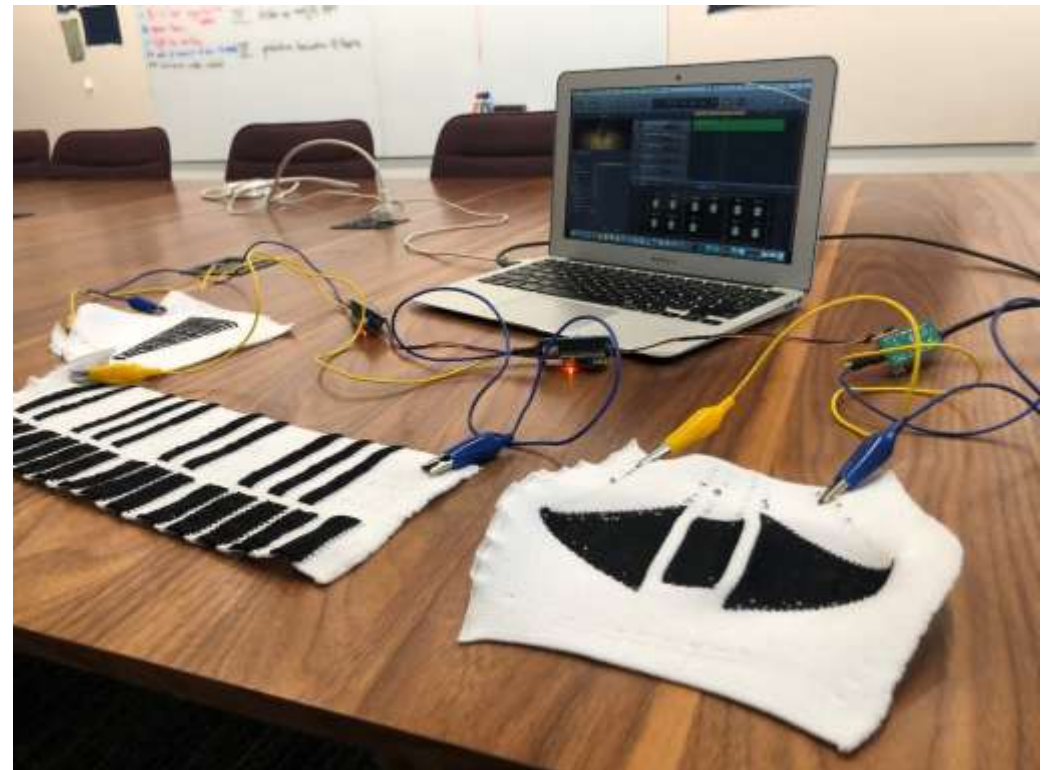
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Touch-Sensitive Knitted Fabrics

- ▶ Capacitive Touch Sensing
- ▶ Digital Weft-Knitting
- ▶ Single Conducting Yarn
- ▶ Two external connection points
- ▶ Different prototypes



Textile Capacitive Touch Sensor Demonstrations

Contributions

- ▶ Results from a qualitative study investigating user perceptions of this technology
- ▶ Design guidelines for potential applications
- ▶ Investigating the feasibility of simple gesture recognition
- ▶ Results from everyday use experiments

Study Overview

- ▶ Objectives:
 - ▶ To understand users' views and experiences
 - ▶ To explore application areas
 - ▶ To identify potential concerns
 - ▶ To generate design guidelines
- ▶ Structure and Subjects:
 - ▶ 8 focus groups of 2-5 participants each
 - ▶ A total of 32 participants
 - ▶ 20 male, 11 female and 1 of non-binary gender.

Study Procedure

Phase 1

- Design ideas and perceptions



Phase 2

- Usability of application prototypes



Phase 3

- Reflections on technology and suggestions



Data Interpretation

- Thematic Analysis



Formative Study Results

General Perceptions

- ❖ Fabric Texture
- ❖ Comfort and Approachability
- ❖ Robustness
- ❖ Affordability
- ❖ Portability

Application Areas

- ❖ Wearables
- ❖ Smart Environments
- ❖ Education
- ❖ Art and Entertainment
- ❖ Assistive, Medical Technologies and Ergonomics
- ❖ Monitoring and Activity Recognition

User Concerns

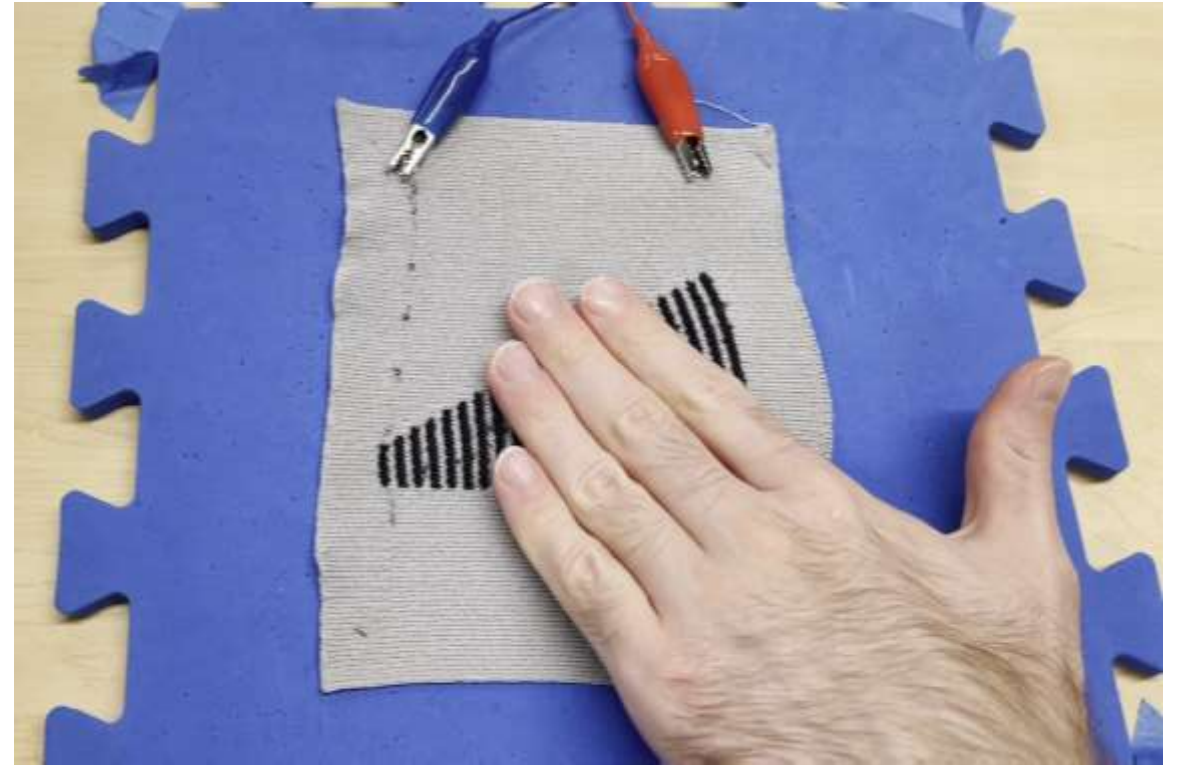
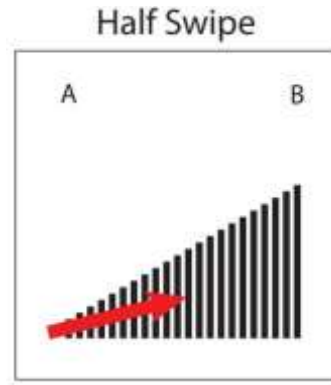
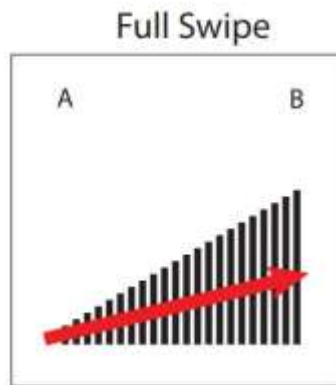
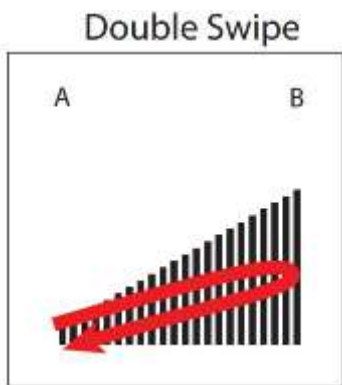
- ❖ Damage and Safety Concerns
- ❖ Washing and Drying
- ❖ Stretching
- ❖ Exposure to outside conditions

Interaction Design Guidelines

- ▶ Sensation generated by continuous contact with the interactive components
- ▶ Availability of various choices regarding colors, sizes and patterns
- ▶ Comfortable environments from psychologically inviting fabric
- ▶ Discreet interactions using the low-profile sensors
- ▶ Potential applications emulating existing ones for use in different scenarios
- ▶ Areas of interest are VR/AR and groups to design for children and the elderly

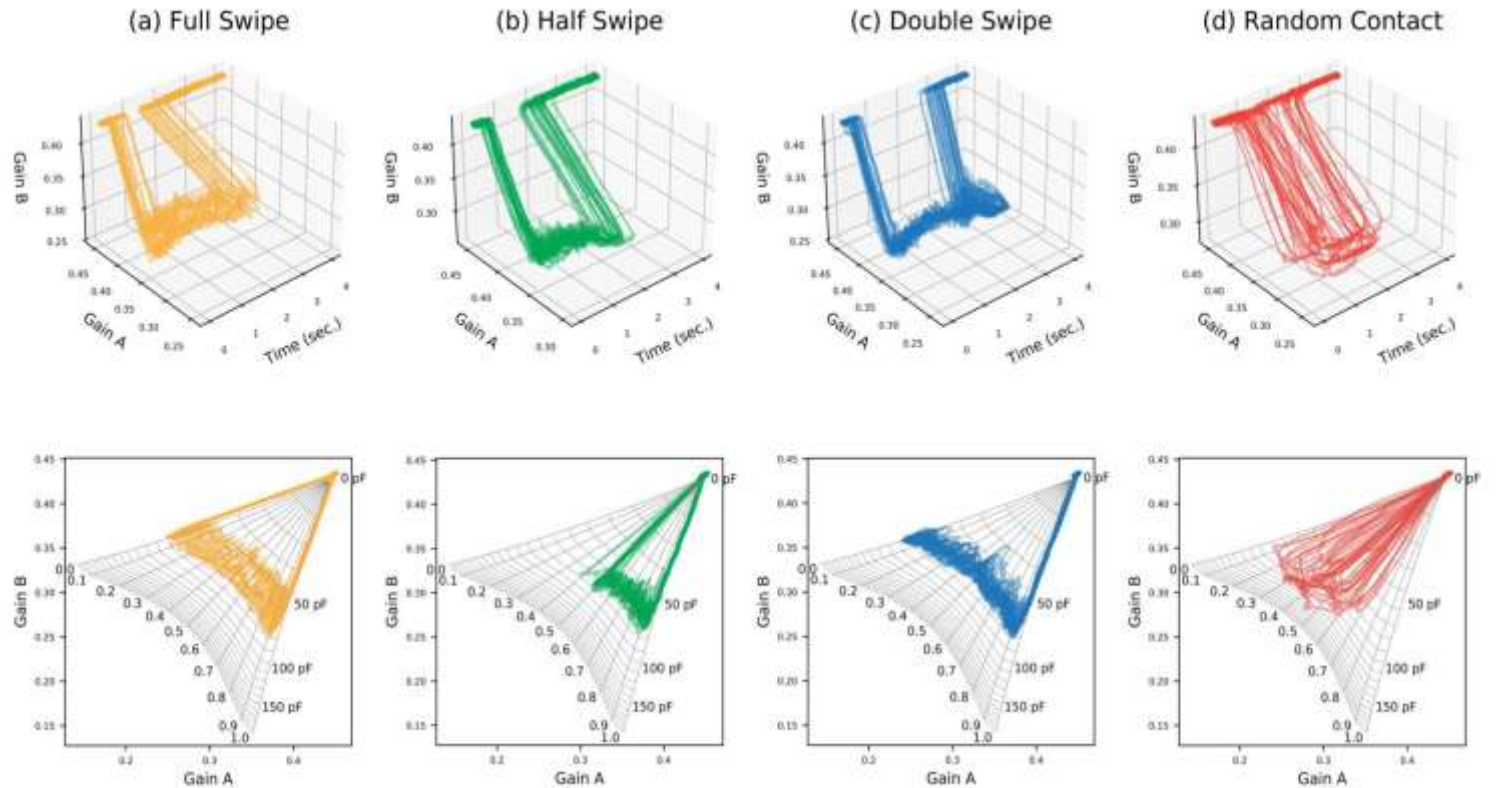
Simple Gesture Representation

- ▶ Double Swipe
- ▶ Full Swipe
- ▶ Half Swipe
- ▶ Accidental Touch Events



Gesture Representation

- ▶ Different signal response for different swipe gestures and accidental touch events
- ▶ Similar signal response for samples of the same gesture types



Results

Two groups investigated:

- ▶ The distances between same-type samples, encoded in the heatmap diagonal.
- ▶ The distances between different-type samples, encoded in the rest of the heatmap.

$f - stat$	p_f	$z - score$	p_z
231.81	0.00	-15.23	0.00

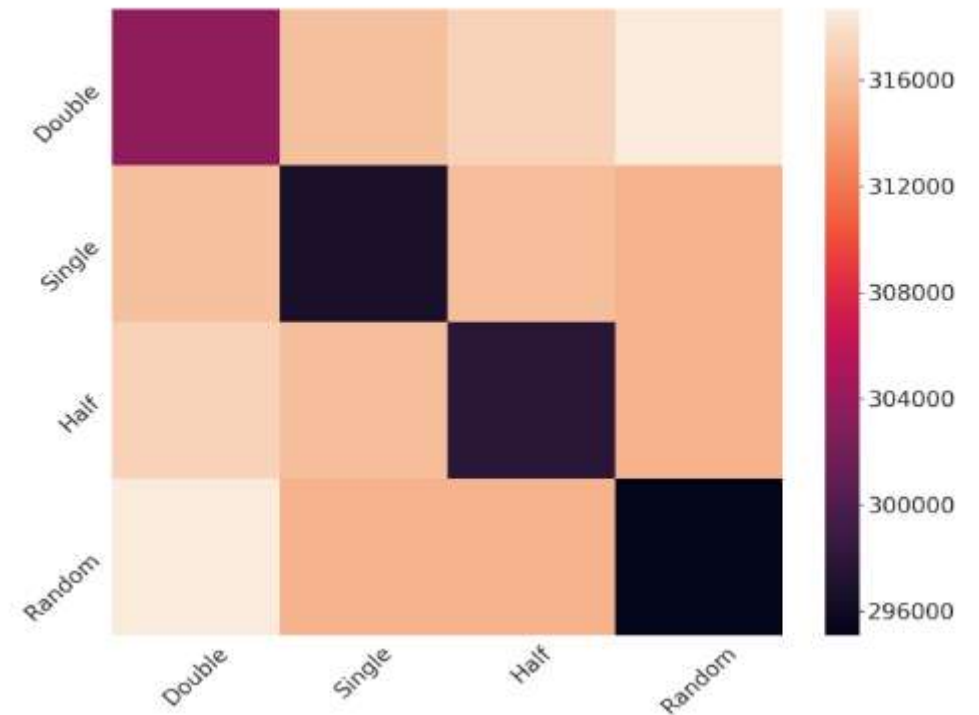


Fig 1: Gesture similarity matrix

Washing and Drying Tests

- ▶ Three different sensors
- ▶ Five cycles of washing and drying
- ▶ Calculate change in resistance between baseline and each cycle
 - ▶ Within 7%



Fig 1: Tested sensors.

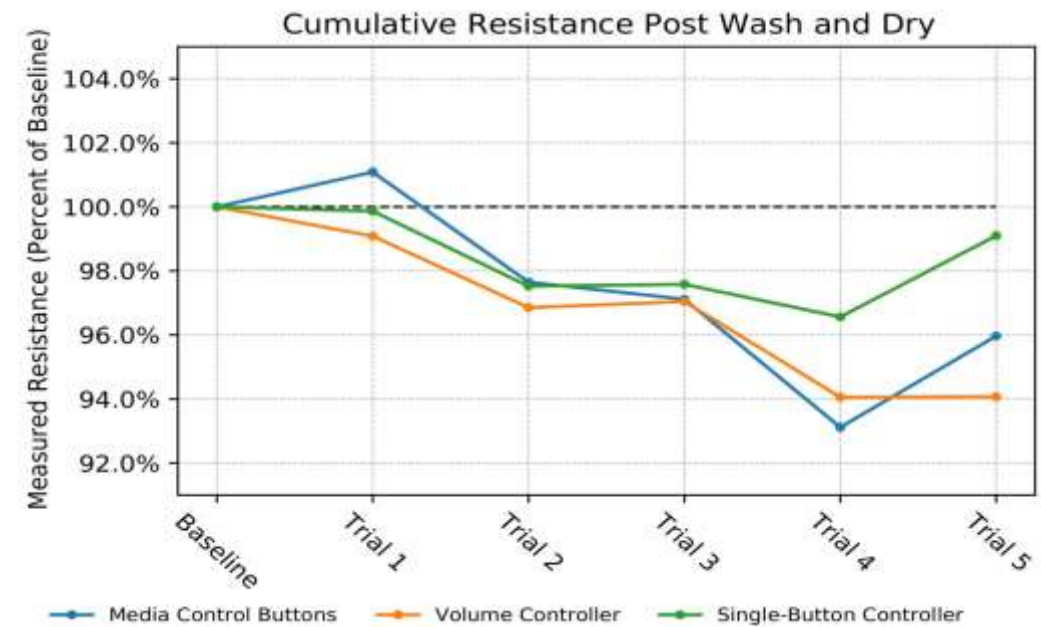


Fig 2: Resistance change from washing and drying.

Stretching Tests

- ▶ Three different sensors
- ▶ Continuous horizontal and vertical stretching
- ▶ Calculate change in resistance with baseline
 - ▶ Variable by sensor structure

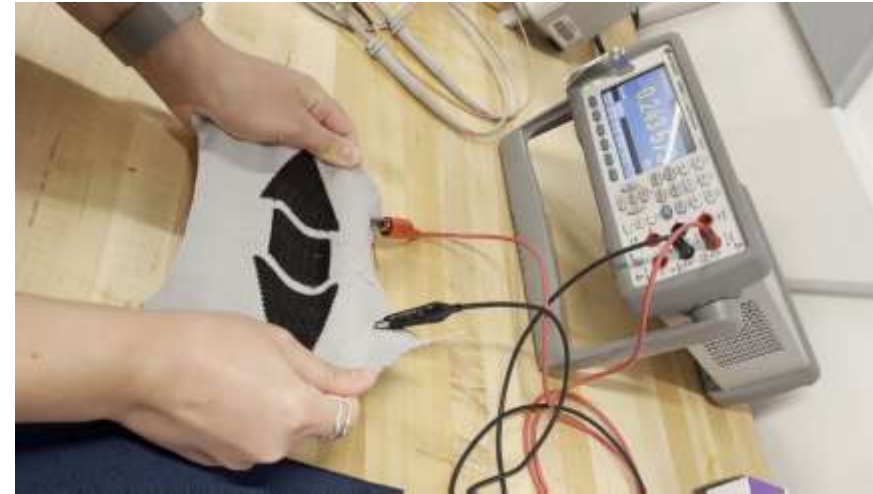


Fig 1: Stretching Illustration.

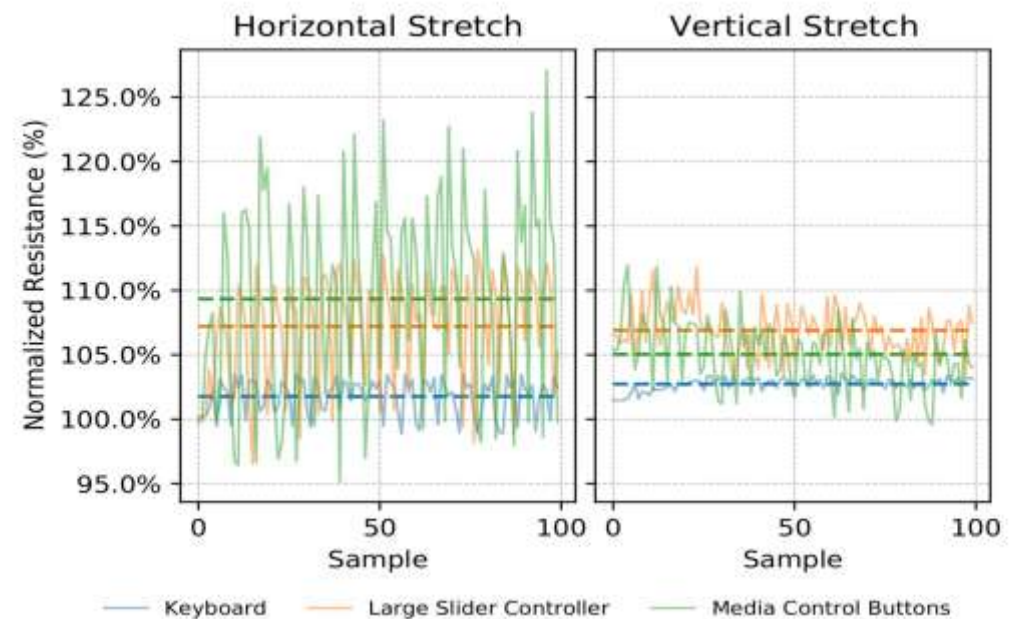


Fig 2: Resistance change from stretching.

Thank You!

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- ▶ Formative study to investigate user perceptions
- ▶ Gesture representation
- ▶ Everyday use experiments
 - ▶ Stretching
 - ▶ Laundering

