Gardeene! Textile Controls for the Home Environment

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Abstract

Textile controls so far, have mostly been envisioned to be integrated to clothing. In our environment, however, much more textile interaction surfaces are available. In this paper, we present a capacitive textile sensor, seamlessly integrated into a motorized curtain. While the basic functionality is simply to open and close the curtain, its design allows a much richer gestural interaction.

1 Introduction

Textile materials are a ubiquitous component of our everyday environment, not only in clothing, but also part of the floors, the furniture, and the decoration present in a room. So far, when thinking about interaction with textiles, the use of clothing as interaction surface was most prominent. For this paper, we decided to take a closer look at textile interfaces for the home environment, more specifically, the curtains. Curtains are very important for the visual impression of the room, but also serve the practical purpose of controlling lighting conditions in the room and occluding the view from the outside. In the context of smart homes, opening and closing the curtains is performed automatically, by a remote control, or via an electric switch. Pushing and potentially holding a button, however, is far from how we open and close a classical curtain. We integrated capacitive sensing into a curtain using conductive thread and use it to provide gestural input to control the motorized opening and closing of the curtain in a similar fashion as one would open a non-motorized curtain.

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2 Related Work

Capacitive sensing on clothing is subject to a series of challenges. Searching for a capacitive button can only happen visually since activation is triggered when the finger reaches it, the sensors are subject to constant deformation and movement, and, very important, the body capacitance makes it very difficult to place a sensor directly above the skin. Holleis et al. (2008) provide a detailed overview over the area and some applications like capacitive touch areas on gloves, a bike helmet, an apron, and a phone bag. Further examples of embroidered sensors can be found in (Zeagler et al. 2012). Sergio et al. (2002) present a capacitive textile pressure sensor, and Project Jacquard (Poupyrev et al. 2016) investigates mass production of capacitive sensors in clothing.

Using the large surface of a curtain as interaction surface has, so far, been prototyped using image-based technologies. (Laschke et al. 2011) demonstrate the use of a shower curtain as ambient display to visualize water consumption by different members of a home. A calendar based view allows an easy comparison but is not really interactive, as the visualization only takes into account the water flow and does not provide any other input mechanisms.

Funk et al. (2012) present a shower curtain that senses touch input using a thermal camera. This allows to select between different applications, such as weather information or controlling a music player.

3 Interaction

Figure 1: Possible ways of interacting with an augmented curtain. The gestures on the left and on the right are taken from traditional curtains, whereas the middle one relates more to vertical persian blinds. In this paper, we built on the interaction on the right.

The interaction is designed similarly to how you would draw a curtain open in the morning, with a large swipe from the center to the outside (see Figure 1). As motorized curtains are usually installed on large windows, the user cannot cover the entire surface of the curtain with one gesture. Furthermore, it should be possible to open the curtain at different granularities. We designed a sensing pattern that allows both coarse and fine input.

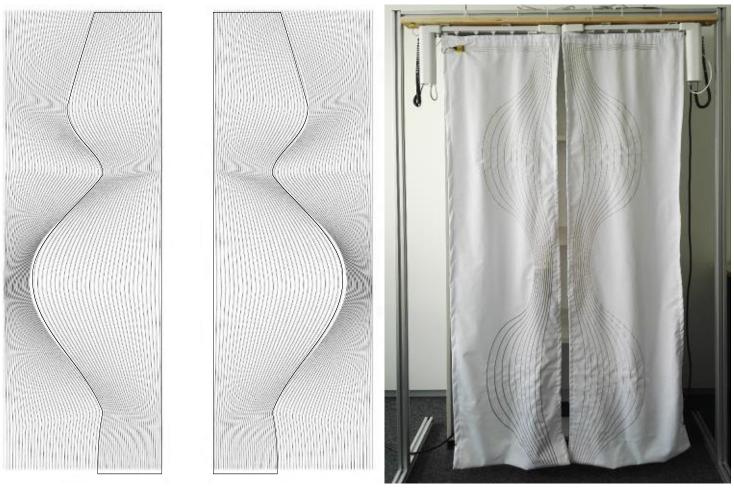

Figure 2: Left: The sensor pattern. Conductive thread is embroidered in a waved shape with variable spacing. In the areas with small spacing, only small gestures are required to open the curtain completely. In areas with large spacing, the recognition is more fine-grained, thus, more precise commands can be issued. The sensor area is highlighted in blue. Right: our prototype with the embroidered sensing threads.

4 Technical Implementation

The pattern is embroidered onto a cotton fabric using Shieldex 235/34 conductive thread. Our first prototype only used 10 sensor threads of the total pattern, which are connected to a TI MSP430 microcontroller, which performs the capacitive sensing, detects swipes in both direction, and communicates the appropriate commands to the motor controller. The curtain hangs on a rail with two motors for symmetric operation.

5 Summary and Future Work

We presented a prototype of a capacitive sensing curtain as an initial step for smart textiles in the home environment. The interaction is designed similarly to the traditional one. The sensor pattern allows small gestures for coarse control and large gestures for more fine grained input. The visual appearance of the pattern is designed to afford this variable granularity.

In the near future, we plan to evaluate the general usability and acceptance of such an input mechanism. Especially, the textile design of the sensor pattern offers a wide variety of options. As motorized curtains are not yet widespread, the interaction might not be as obvious as we intended. Preliminary results suggest that the intention to use this innovative input device for domestic environments is high. All participants interacted with the curtain easily and intuitively. The intention to use the device is shaped by the perceived pragmatic value, the hedonic quality, and the attractiveness as measured by the AttrakDiff questionnaire (Hassenzahl et al. 2003). Possible barriers for an adoption are rooted in the integrated electronics of the curtain, as some participants with lower technical expertise feared safety hazards through electric shocks and inflammability. Overall, people with lower technical expertise showed a lower intention to use the curtain. This indicates that user diversity plays an important role in the acceptance of smart fabrics in the habitat. Consequently, this needs to be addressed in future designs and evaluations.

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