Shade Pixel: Interactive Skin for Ambient Information Displays

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CHI 2009, April 4 – April 9, 2009, Boston, MA, USA
ACM 978-1-60558-247-4/08/04.

Abstract
This paper discusses *Interactive skin*: a surface with a merged control or display. By merging a control or display into the surface, an interactive skin brings simplicity to the appearance of objects. Furthermore, *Shade Pixel*, an interactive skin for an ambient information display is presented. Unlike typical light-emitting displays, Shade Pixel uses shade to visualize information, as its name implies. Its non-luminescent nature and simple appearance reduce visual noise and provide sensorial and hence emotional comfort to users. For its flexibility to fit any form and to accommodate motion, Shade Pixel impeccably fits the concept of a display for Organic User Interfaces.

Keywords
Interactive skin, Shape display, Ambient display, Organic User Interfaces

Introduction
Skin is the plane of contact between people and things. Traditionally, the skins of objects are passive and static. They were simply dead outer surfaces. However, recent advances in technology have made them more active and dynamic. The skins of products, buildings, and clothes today respond to input from users and the environment. They emit colorful lights, make sounds,

or even change their physical shape dynamically to communicate with users. These *interactive skins* are embedded seamlessly into everyday objects or into the environment, making them more interactive.

This paper presents *Shade Pixel* – an *interactive skin* applicable to the surfaces of everyday products or to the environment as an ambient information display. Before this device is described in greater detail, the concept of interactive skin is briefly explored in the next section.

Interactive skin

Interactive skin is a surface with a merged control or display. Accordingly, input or output, or precisely interaction between users takes place on the interactive skin. By merging a control or a display into the surface, an interactive skin brings simplicity to the appearance of objects. Notably, the visual complexity of objects is minimized when they are not in use.

The use of smart materials enables interactive skin to be realized. The History Tablecloth [1], made using electroluminescent ink printed onto a flexible substrate, draws the flow of objects over a surface. By mixing thermochromic ink with concrete, Chronos Chromos Concrete [2] displays information dynamically in concrete surfaces. Using actuation brings kinetic elements to interactive skin. Mechanical mirrors [3] attract a user's attention by combining kinetic movements with intriguing materials that are not considered in typical displays. Textural interfaces such as Super Cilia Skin [4] and Sprout I/O [5] are good examples of types of interactive skin

Shade Pixel

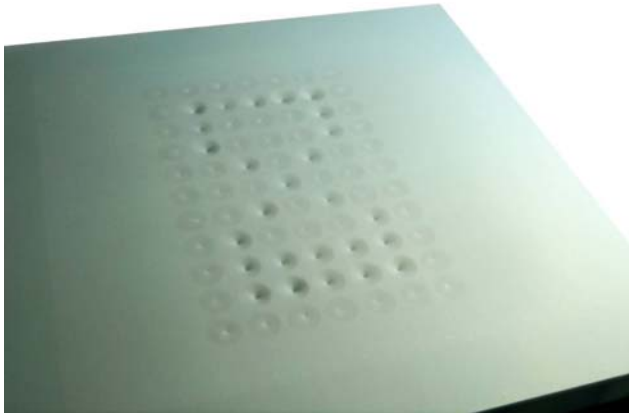

Figure 1 Shade Pixel

Shade Pixel is an interactive skin applicable to the surfaces of everyday products or to the environment (Fig 1). Shade Pixel, just as the name implies, uses shade to visualize information in a manner similar to Cuneiform or Sunken relief. This evokes primitive naturalness and provides sensorial and hence emotional comfort to users. In addition, its non-luminescent nature and simple appearance reduce unnecessary visual noise, especially when it is not in use.

The Shade Pixel prototype is a 7 ×11 pixel screen that consists of two main parts: a skeleton and a skin. The skeleton is made up of a dot-matrix array of 77 solenoids and a frame with 77 holes. Various actuators such as electromagnets, piezo actuators or shape-memory alloy can be used in place of the solenoids. For the skin, Spandex, whose exceptional elasticity is suitable to achieve a deformable skin, was used.

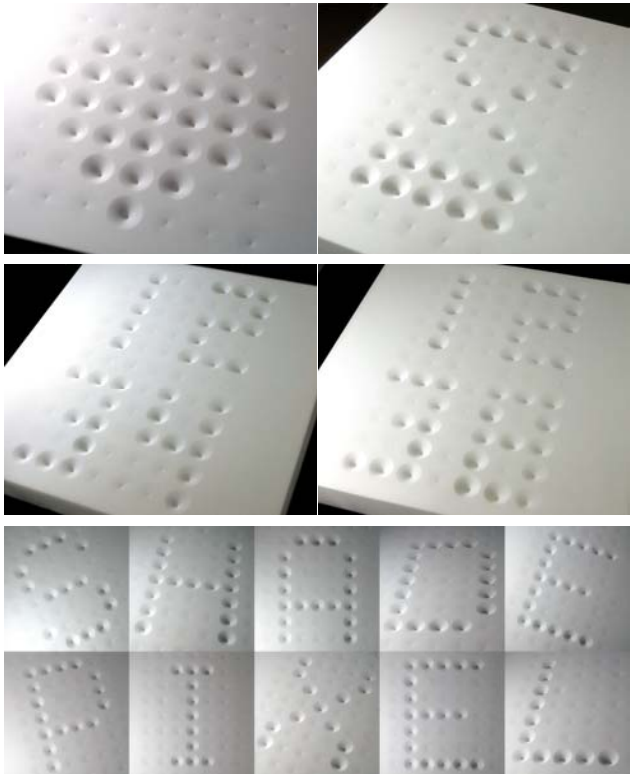

Figure 2 Representing (Top) Images, (Middle) Numbers, (Bottom) Text with Shade Pixel

Figure 3 shows a schematic diagram of Shade Pixel. When sent the proper signals, the solenoids move in and out to create patterns, numbers and text (Fig 4). To minimize the sound of the solenoids, a dampener is positioned at the bottom of each solenoid core. Thus, unlike other shape displays that use actuators, Shade Pixel does not make much noise. In addition, the skin is detachable from the frame; thus, users can replace the skin according to their preferences or requirements. Moreover, the frame can be transformed into a curved shape, making Shade Pixel applicable for curved surfaces as well as flat surfaces (Fig 5). This allows Shade Pixel to be embedded into the surfaces of products or other aspects of the environment as an ambient information display. A short video clip of Shade Pixel in use is available on the web [6]. The aesthetic appeal and the use of shadows cast by the deforming skin are indeed enjoyable to watch.

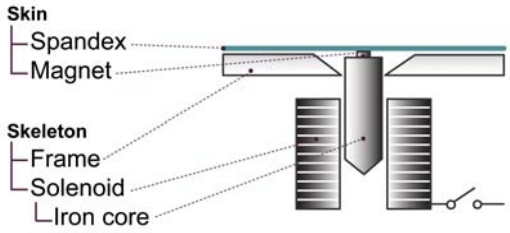

Figure 3 Schematic diagram of Shade Pixel

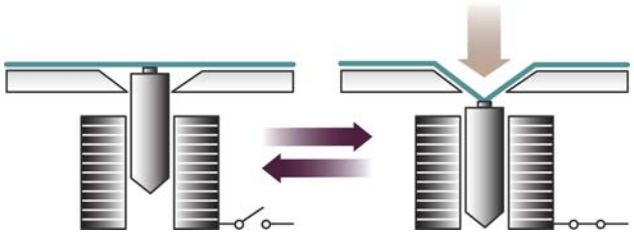

Figure 4 Iron core pulls the fabric to make a concave surface, which creates shade

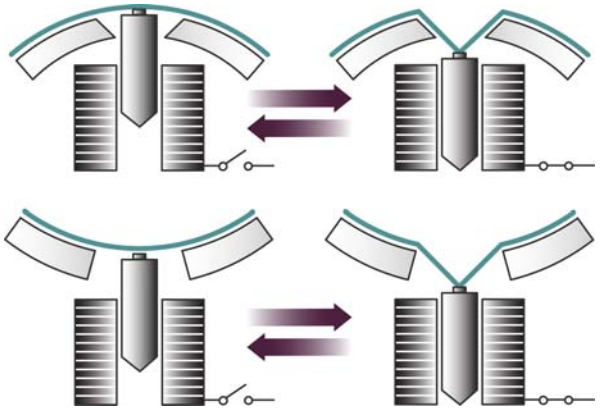

Figure 5 Shade Pixel is applicable for curved surfaces; (Top) Convex surface (Bottom) Concave surface

Conclusion

It is expected that Shade Pixel will become an ambient information display in the form of the interactive skin of everyday products or environments. To achieve this, the current prototype requires technical improvements regarding its thickness. The present thickness of the prototype is approximately 40mm; however, if small actuators are used instead of solenoids, the size and thickness will be reduced significantly. Moreover, although the current prototype has relatively low resolution, it is easy to imagine a much higher resolution version of Shade Pixel.

In future versions, various applications of this technology will be explored. One example is a display with an organic shape of a type that is at present difficult to consider using traditional displays or physical displays. For its flexibility to fit any form and to accommodate motion, Shade Pixel impeccably fits the concept of a display for Organic User Interfaces [7].

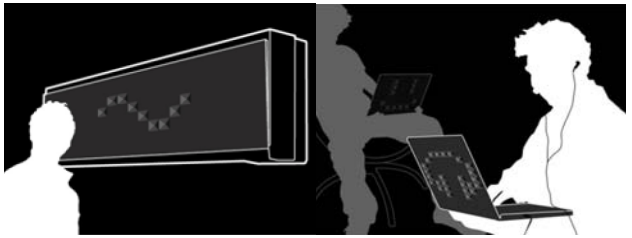

Figure 6 Shade Pixel in the form of the interactive skin of everyday products

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