Towards deformable objects providing physical qualities to display experience

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Abstract
Deformable displays offer opportunities to extend planar rigid formats with surface attributes i.e. primitive and programmable shapes, deformation and texture properties to facilitate a compelling interactive user experience. Non-planar flexible shapes have the potential for new applications tapping into multi-sensory experiences for display interaction. A craft-based metaphor for deformable displays includes physical attributes in information processing of interactions.

Author Keywords
Deformable displays; craft-based metaphor; surface interaction; prototyping future displays

Workshop themes
Current Knowledge and Visions for the Future, Prototyping and Implementation, Interaction and Experience Design.

Introduction
In the foreseeable future printed OLED technology will be capable of delivering inexpensive displays. Various OLED substrate materials will augment objects that we use daily e.g. milk cartons, newspapers, magazines and clothing. A significant advantage of the display technology is that it leverages the flexible and

deformable nature of materials. This facilitates new multisensory experiences with everyday objects. In the following, we describe our relevant works, in which we investigated novel deformable interfaces and 3d display technologies, which may be applied to deformable displays.

Our current works

Here, we introduce three of our works relevant for deformable displays. Our malleable surface touch interface [1] demonstrates a deformable input surface, whereby the physical state is tracked with image processing algorithms in order to provide a whole-hand interface. This interface exhibits many attributes of conventional touch interfaces, such as multi-point and pressure sensitivity, while offering additional passive haptic feedback suitable for applications e.g. sculpting or massage. This design offers a cost effective solution to prototype displays via front or back projection. This platform allows the evaluation of different mechanical and texture properties of deformable surfaces, crucial for sensory rich user experiences (demo possible).

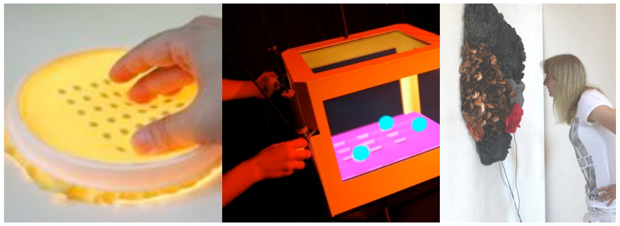

Figure 1. Three interfaces: malleable surface, Cubee display, and emotion sensitive active surface.

Our Cubee interface [2] demonstrates a 3d display that encloses a defined virtual space within a rigid display cube. The appropriate single person 3d view is facilitated by perspective rendering and head/display tracking. A further suspension of the display with pulleys and counter weights allows the manipulation of the display and provides movement resistance. Cubee's applications include static 3d model viewing and physics simulations boundary condition manipulation (move and tilt), both providing strong object presence. An important lesson learned using this interface is how to maintain a consistent display and manipulation space, to unify the real and virtual experience (video demo possible).

Our most recent work demonstrates active robotic fabric surfaces [3], which engage users by demonstrating abstract behaviors. The surface design, including texture, form of expression and dynamics, is a result of an iterative design process involving interdisciplinary participants. In one of our demonstrations, the interface senses emotions by facial video analysis. The device is implemented as an actuated surface that expresses emotions by changing its physical attributes. This change is triggered by sensed emotions via behavioral mapping (video demo and exposé possible).

Vision and future direction

Developing deformable displays beyond today's rigid planar displays opens opportunities to enrich the interaction experience by using diverse shape, texture and deformation properties. These properties may statically mimic real object characteristics or dynamically alter, in order to represent different objects. One potential application constitutes a product design display, which facilitates dynamic rapid prototyping. This display is important since significant efforts in product development are devoted to finding suitable shape and texture properties to provide novel experiences. A further reaching theme for the next generation of deformable interfaces, which we propose here, is to move from paper-based metaphors of interaction to crafts-based metaphors, where the manipulation of physical properties and shapes of objects play a central role (empower the builder). This direction provides a more organic quality of interaction with multi-sensatory information processing in interfaces. While established paper-based interface metaphors are minimal and abstract, craft-based metaphors may emphasize human's strength of parallel modal processing e.g. in human-human communication, where emotion processing plays a significant role.

Possible example applications include:

1) A motorbike handle, which is a deformable display that senses pressure, rotation and torque of the grip, while providing gear and break information to the user,

2) A transport cabin prototyping system where deformable displays provide shape and haptic experiences for passengers, and

3) A display sheet for medical applications that when wrapped around a patient's body displays vital information to medical staff on the patient's anatomical area of interest.

In order to realize this vision and build the outlined applications, several challenges need to be addressed:

1) How should future deformable displays be designed to differentiate from current technology? Which interaction patterns bring added value to products? How can rich experiences be displayed to users and provide USPs?

2) Can suitable interaction metaphors for the upcoming deformable technology generation be found in order to provide new user experiences?

3) What flexible functional prototyping methods can be developed to mimic future OLED Design, e.g. projection on to and sensing deformable objects?

4) How can physical perception of deformable displays be understood so that evaluation with diverse populations may identify haptic and tactile parameter sweet spots, user clustering, and accessibility guidelines?

5) Which methods may be applied to quantify the user experience and aid design decisions?

6) How can possibilities of digital augmented physical experiences be explored to aid designers and content providers with design patterns for future products?

The topic of deformable displays has far reaching possibilities that require interdisciplinary teams to meet its challenges in research and development. Foreseeable changes to interfaces will not be marginal but instead will revolutionize todays computing interfaces.

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