Organic Experiences: (Re)shaping Interactions with Deformable Displays

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Abstract
Display technology developments mean the next generation of visual output devices will extend beyond the rigid, flat surfaces with which we are familiar to those that the user or the machine can deform. These will allow users to physically push, pull, bend, fold or flex the display and facilitate a range of self-deformation to better represent on-screen content or support new modes of interaction.

This workshop will provide a forum to examine, discuss and shape the three primary themes of research in this area: prototyping and implementation, interaction and experience design, and evaluation. It will bring together an interdisciplinary group of academic and industrial researchers to define the current and future challenges of crafting organic user experiences with deformable displays.

Author Keywords
Deformable displays; Organic User Experience; Organic User Interfaces; user-deformation; machine-initiated shape change;

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H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction

Deformable displays cross the boundaries of Flexible and Kinetic Organic User Interfaces (OUI). User-based deformation has made progress from Gummi's [14] bendable hardware concept and PaperWindow's [6] projected flexible displays to Paperphone's [9] functioning EInk and mobile media consumption experiences with the Kinetic Device [8]. Machine-based deformation has advanced from top-projected actuatable displays [3, 7], to low resolution shape change [12], to multi-axis tiltable displays [2]. These advances underscore this field's maturation, suggesting future scenarios full of expressive, Organic User Experiences.

As a community, we do not yet fully appreciate the implications of interactions with deformable displays or understand how we will deliver real-world experiences with these devices to consumers. Designers face challenges understanding how deformable displays should be tailored for different contexts of use and how to incorporate 'shape' into interface design. This new organic design also requires the development of prototyping and implementation techniques, such as non-planar sensing materials, physical deformation mechanisms, and miniaturisation techniques. Finally, the community lacks understanding on how such interfaces should be empirically evaluated. To bring to fruition the promise of deformable OUIs, it is critical that these themes are explored and defined via a cohesive research strategy.

The CHI2013 workshop on *(Re)Shaping Interactions with Deformable Displays* aims to do exactly this by bringing together an elite, transdisciplinary group of academic and industrial researchers to define the current and future challenges of crafting organic user experiences.

Background

Deformable displays cross the boundaries of Flexible and Kinetic Organic User Interfaces (OUI). Flexible displays, and the physical expressiveness they afford, suggest a higher-dimensionality to interface design, one that can leverage shape. PaperWindows [6] is an early example of an OUI that simulates the use of digital paper displays using a combination of motion tracking and projection. Computer windows are rendered onto a piece of paper giving the illusion that the paper is, in fact, an interactive display. This metaphor is later instantiated in PaperPhone [9], a paper computer that uses flexible E Ink to bend the interface and express interaction. These concepts along with tools such as TactileTape [5] are beginning to ease the rapid prototyping process for user-deformed displays; however the community still lacks tools to facilitate rapid prototyping of machine-deformed displays.

Deformable displays may support user-initiated deformation, machine-initiated deformation, or both. The community is beginning to develop an understanding of how customers might perform user-initiated deformation: Schwesig et al's Gummi [14] suggested a range of non-WIMP interactions using bending, Lee et al. [10] provided manipulations for input, Gallant explored 'foldable' interactions [4] while Lahey et al. [9] produced a bend gesture set for a display tied at two corners.

Device-initiated deformation, even at this early stage of the field, seems less well understood, probably due to

the additional requirement of working with functioning hardware in order to investigate such interactions. Iwata et al. [7] and Poupyrev et al. [12] have successfully deployed shape-changing displays, while Leithinger et al. [11] and Alexander et al. [2] suggesting a range of gestural commands for interaction with such displays.

Evaluation of shape-changing interfaces is currently less thorough, with Rasmussen et al. [13] noting that many shape-changing interface evaluations are 'sketchy', with only a quarter of papers reporting some kind of user feedback. This likely stems from the new challenges present in evaluating such displays.

Workshop Goals and Themes

The overarching goal of this workshop is to bring together researchers spanning multiple disciplines to discuss, explore, and chart the research trajectory to form a cohesive approach to this novel and engaging research challenge. The workshop will be based around three key themes that emerged from the MobileHCI 2012 workshop on *Interaction with Deformable Displays* [1]:

Prototyping and Implementation: This theme covers deformable display realisation from rapid prototyping to technologies for high-fidelity products. Iterative, rapid prototyping is the dominant method of experimenting when building interactive systems. Yet only a few tools currently exist [5, 15] to allow industrial and interaction designers to easily develop and test their deformable interaction ideas.

Moving from low-fidelity prototypes to high-fidelity product concepts requires knowledge, technologies, and skills that traditionally lie outside the realm of HCI. However, deformable display implementation radically influences the user experience and interaction potential, requiring HCI researchers to work with experts in display and advanced material sciences.

Interaction and Experience Design: Interaction design with deformable displays poses a range of new challenges not present in traditional UI development—designers must work with unfamiliar, potentially as-yet-undefined display surfaces and develop interactions for users in a completely unfamiliar environment. Non-planar displays raise new challenges in developing core interaction styles—for example, how do I smoothly pan my display if the surface is piecewise?

Experience design considers the use of shape and deformation as a modality to make computer interfaces more expressive than traditional, flat design. The morning newspaper, credit cards, light switches, or even kitchen plates will retain their everyday identity, yet might be augmented with interactive high-resolution displays.

Evaluation: The introduction of shape and shape-manipulation into computing will fundamentally change how people perceive input and output modalities. Organic displays have no 'default' comparator systems and no standardised metrics or frameworks for rating success. This theme will focus on identification of input and feedback properties unique to deformable displays, review existing evaluation criteria and their limitations, and discuss the development of new criteria, associated measurement scales and potential best practices.

Summary

This workshop will explore the emerging area of interaction with deformable displays through the three theme areas of prototyping and implementation, interaction and experience design, and evaluation. It will bring together a diverse group of researchers across the social and cognitive sciences, design, computer science, the material sciences, and engineering from both academia and industry.

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