Displays Take New Shape: An Agenda for Future Interactive Surfaces

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Abstract
This workshop provides a forum for discussing emerging trends in interactive surfaces that leverage alternative display types and form factors to enable more expressive interaction with information. The goal of the workshop is to push the current discussion forward towards a synthesis of emerging visualization and interaction concepts in the area of improvised, minimal, curved and malleable interactive surfaces. By doing so, we aim to generate an agenda for future research and development in interactive surfaces.

Keywords
Interactive surface; projected interfaces; improvised display; minimal display; flexible display; on-body display; everywhere display; input; tracking

ACM Classification Keywords
H.5.m Information interfaces and presentation (e.g., HCI).

Motivation
The physical objects we encounter every day come in a tremendous variety of materials and shapes, which allows us to interact with them expressively and effectively. In contrast, today's interactive surfaces (such as mobile phones, tablets, or wall displays) support input through touch on flat surfaces, usually guided by a GUI interface. While we interact *on* the surface, we rarely

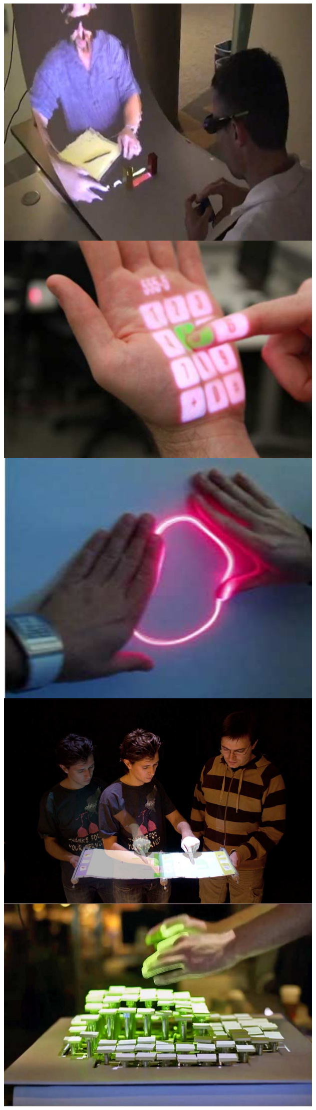

Figure 1. Examples of novel forms of interactive surfaces [3,6,5,8,10]

interact *with* it, which is in sharp contrast with how we interact with physical objects.

To start with, any display, being itself a physical object, already provides a set of physical affordances that can be exploited in a meaningful way to extend the range of possible interactions with the displayed content. Looking at the problem from the other side, we could say that understanding and exploiting the affordances of any object considered as a potential display may provide the basis for a true revolution in the field.

Everyday artifacts, parts of the body or entire architectural spaces can be recruited by a smart projection system or fitted with active displays; in the future deformable three-dimensional objects could materialize today's virtual 3D representations; but also simple, minimalistic cues are promising means for changing the perception of our environment. It may be useful to bear in mind that future interfaces may even become indistinguishable from the represented data itself – as outlined by the "Radical Atoms" vision [7].

This workshop explores emerging research on alternative display types and form factors, with the goal of generating an agenda for future interactive surfaces. It covers the following topics: *Improvised displays* investigate the transformation of everyday objects, surfaces in the environment and body parts into displays through sensing [6, 5, 12], projection [6, 5, 3] and haptic augmentation [1]. *Minimal displays* [5] provide more simple cues, e.g. a laser pointer automatically highlighting an object in the environment that the user is searching. *Interaction with curved and malleable displays* investigates how to communicate through the shape itself [2, 13], by the user deforming the display for input [4, 9, 8] and by actuating the display for output [10, 7].

These research trends are accompanied by ongoing advances in projection and display hardware, smart materials and programmable matter that hold great promise for this field. They allow for ever increasing resolution and brightness, thin, flexible form factors, and haptic output. In addition, novel sensor technologies are emerging that enable capturing the physical environment and interaction with varied shapes [6, 5, 12].

We argue that this not only promises to transform our understanding of displays, but has the potential to fundamentally change how we perceive information and interact with it. Improvised, minimal and on-body displays allow for in-situ representation and access to digital information that is seamlessly integrated with the real world. Enabling the display shape to conform to the content rather than forcing content to fit to a predefined shape improves the mapping of representation to information. Malleable shapes allow people to leverage their hands more expressively, while transformable shapes can conform to varying places and modes of interaction.

Workshop Topics and Goals

The workshop intends to provide a forum for brainstorming about future types and forms of displays, based on currently emerging technologies. Moreover there is a need for deeper and more systematic understanding of how we leverage novel displays and new shapes for output, how we interact with them and promising fields of application. The main goal of our workshop is to address these points by bringing together experts from academia and industry to discuss challenges, brainstorm, and identify an agenda for future research. By advertising broadly we hope to engage people from academia and industry with backgrounds from various disciplines, including engineering, design, material sciences, cognitive science, arts, and business.

Discussion in this workshop will revolve around enabling technologies, applications and interaction techniques in the major areas of novel interactive surfaces, as introduced above. We will specifically focus on the following cross-cutting issues. Each of them addresses one aspect that requires more systematic understanding and will help us define a research agenda:

Novel forms of interactive surfaces

Emerging technologies promise to alter our understanding of what displays and interactive surfaces are. As outlined above, there are currently rapid advances in enabling technologies. This not only involves display and tracking technologies (e.g. depth-based projection mapping [6], combination of tangible objects with stereoscopic visualizations [3], integrated laser-based projection and capturing of the display surface [5], sprayable displays [11]), but also smart materials and stretchable electronics, as well as novel forms of actuation. We aim at generating an integrated high-level picture of these technologies, provide the basis for brainstorming about how these technologies enable redefinition of interactive surfaces. This comprises the following questions: What are future forms of interactive surfaces? Which objects and surfaces can be turned into displays? Which visualizations and interactions do they enable? In turn, this will allow us to define an agenda for future research and development into enabling technologies.

Emerging interactions

Emerging research has presented first interaction techniques in several applications, each providing a spotlight in the design space. However, the field is lacking a more systematic understanding of successful application domains and interaction techniques. Our goal is to share lessons learnt from recent projects and to use these as a basis for generating a first structuring of the field. We aim at (a) identifying commonalities of interaction techniques across different forms of novel interactive surfaces, based on the affordances involved, (b) discussing whether first standards are emerging, (c) ultimately being able to provide recommendations on what applications and interactions are most promising to be successful.

General purpose displays vs. specific-purpose tangibles

Interactive surfaces that merge with physical objects add haptic and/or tangible characteristics to visual information displays. As such, they can be characterized as a hybrid that is situated in-between general purpose graphical user interfaces, and tangible user interfaces, which usually are targeted to specific purposes. We aim at characterizing these hybrid characteristics in more detail, with the ultimate goal of giving recommendations of how to integrate the competing goals of generalness and specialization.

To foster stimulating discussions, the agenda reduces plenary talks to a minimum, leaving ample time for interactive work. A keynote and four short talks by participants of the workshop will set the stage for extended phases of work in focus groups on the above topics. A final plenary session will allow us to integrate results from focus groups into a first taxonomy and a set of recommendations for future work.

Expected Outcomes

The goal of the workshop is to push the current discussion forward towards synthesis of emerging visualization and interaction concepts and identification of successful application domains. By doing so, we aim at generating an agenda for future research and development, both into interaction concepts and into enabling technologies. The workshop will also provide a venue for establishing a community of researchers and practitioners interested in the topic. To support communication and collaboration after the workshop, the workshop wiki will remain available for continued use and planning of next steps.

The results of this workshop will be shared on the workshop webpage, including all position papers and materials created during the workshop. Moreover, we will create a participatory poster to be displayed during the CHI conference, on which attendees of CHI can post their comments and suggestions. In addition, we plan to invite workshop participants to expand their submission for a special issue of a journal.

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