Coupled Display Visual Interfaces

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ABSTRACT
Interactive displays are increasingly distributed in a broad spectrum of everyday life environments: They have very diverse form factors and portability characteristics, support a variety of interaction techniques, and can be used by a variable number of people. The coupling of multiple displays can thus create interactive "ecosystems" which mingle in the social context, and generate novel settings of communication, performance and ownership. The objective of this workshop is to focus on the range of research challenges and opportunities afforded by applications that rely on visual interfaces that can spread across multiple displays. Such displays are physically *decoupled* (i.e. connected to multiple computers) yet are visually *coupled* due to the interfaces and interactions they support. This can range from visual interfaces spread across multiple small private input displays (e.g. information exchange or game play) to small private displays coupled with larger public displays (e.g. public photo sharing).

Categories and Subject Descriptors
B.4.2 [**Input/Output and Data Communications**]: Input/Output Devices – *Data terminals and printers.* D.2.2 [**Software Engineering**]: Design Tools and Techniques – *User Interfaces.* H.5.2 [**Information Interfaces and Presentation**]: User Interfaces – *Input devices and strategies, evaluation/methodology, interaction styles, theory and models.*

Keywords
Gestures, Ubiquitous Computing, Mobile User Interfaces, Interactive Surfaces, Multi-Touch, Tablet, HCI, Multi-display and CSCW.

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1. INTRODUCTION
Recent developments have seen the wide spread proliferation of both large shared displays and small display technologies. In parallel we have seen the emergence of new classes of device, which support both touch and multi-touch interaction. Examples of small touch driven devices include the PDA, Tablet PC, iPad and iPhone. Examples of large interactive surfaces (multi-touch driven displays) include the SMART Table, Circle Twelve/MERL DiamondTouch and Microsoft Surface Computer. Interactive surfaces offer great potential for face-to-face work and social interaction and provide natural ways to directly manipulate virtual objects. Small devices by contrast afford the individual a personal workspace or "scratch space" to formulate ideas before bringing them to a wider audience.

An emerging trend is the research and development of advanced visual interfaces built around a combination of small private displays coupled with larger public ones [2]. Such computer mediated multi-device interaction between personal touch-driven displays and shared public ones presents a number of novel and challenging research problems. This workshop will specifically focus on the research challenges in designing visual interfaces for multi-display ecosystems such as the combination of small touch driven private input displays (e.g. a set of iPhones) coupled with large public displays such as information kiosks, digital notice boards, DiamondTouch or Microsoft Surface. This workshop follows on from the AVI 2008 workshop "PPD 08: Workshop on designing multi-touch interaction techniques for coupled public and private displays" [1] but focuses on a different set of challenges.

1.1 TOPICS OF INTEREST
The following eight topics of interest were specified in our general call for papers for this workshop. These topics include:

- Developing evaluation strategies to cope with the complex nature of multi-display environments
- Ethnography and user studies of visual interfaces relying on coupled displays

- Understanding the design space and identifying factors that influence user interactions in this space
- The impact of social conventions on the design of suitable interaction techniques for shared and private displays
- Exploring interaction techniques that facilitate multi-display interfaces
- Novel interaction techniques for both private and public multi-touch devices as part of multi-display environments
- Techniques for supporting input re-direction and distributing information between displays
- SDK/APIs and IDEs for the development of coupled display visual interfaces

Based on the research described in the accepted position papers, this set was refined into our five workshop themes as described in Section 6.

2. AUDIENCE

This workshop brings together international researchers and practitioners from industry and academia working in the area of coupled multi-display environments and interactive surfaces coupled with private displays. Interested attendees were invited to submit a short position paper. These papers were each peer reviewed by up to four members of our international program committee. The eleven accepted position papers are available from our website http://www.hitlab.utas.edu.au/wiki/PPD10.

This workshop is designed for maximum audience participation, interaction and development of ownership of the resultant ideas. We aim to continue the tradition of turnover within the organisation of any workshop outcomes, for example in 2010 two of the four organisers were workshop participants at PPD'08 [2]. Participants this year will be encouraged to take a leading role in activities and ideas formulated during this workshop.

3. Workshop Plan

The PPD'10 workshop on coupled display visual interfaces on May 25th, 2010 is a workshop held in conjunction with AVI 2010, the 10th International Working Conference on Advanced Visual Interfaces. As a full day event it is structured to provide maximum time for group discussion and brainstorming. Each participant is familiar with all eleven position papers accepted prior to the event.

The workshop is structured around four sessions (separated by the morning break, lunch and afternoon break). In the first session the participants briefly introduce themselves and provide a brief presentation highlighting the key points from their position papers. Following this a brainstorming session is employed to develop key discussion topics for the two midday sessions. In the second and third sessions the entire group is divided into sub-groups moderated by the workshop organisers to have focused discussions on some of the key topics identified earlier. In the fourth session the entire group reconvenes to discuss the advances and challenges identified in the breakout discussions.

The workshop concludes with a detailed discussion to define immediate next steps on two fronts. Firstly, the discussion of a proposed research book drawing on submissions from some of the workshop audience. Our previous workshop resulted in a Special Issue of the Journal of Personal and Ubiquitous Computing in 2009 by Springer-Verlag, entitled "Interaction with coupled and public displays" [1]. Second, we seek discussion and input into the development of a revised European Cooperation in Science and Technology action (COST) proposal entitled "Technologies, Tools and Techniques for the design of coupled display visual interfaces". Such a COST action will be a long lived outcome from this workshop.

4. WORKSHOP ORGANISERS

Alan Dix is Professor of Computing at Lancaster University. He has worked for 25 years in many areas of Human-Computer Interaction and is co-author of one of the principle textbooks in the area. His current interests include the design of interaction with physical devices, techniques and theory of technical creativity, intelligent web interfaces and personal interaction with public displays. Alan has served in various roles for major conferences in HCI including co-organiser of the physicality workshop series. He was a participant at PPD'08 and also co-organiser of the CHI2008 workshop on Designing and Evaluating Mobile Phone-Based Interaction with Public Displays.

Aaron Quigley is the inaugural director of the Human Interface Technology Laboratory Australia and an Associate Professor in the University of Tasmania. From July of 2010 he will be Professor in the Chair of Human Computer Interaction in St. Andrews University Scotland. His research interests include human computer interaction, pervasive computing and information visualisation. He is currently chair of the Pervasive Computing conference series and workshop co-chair for Pervasive 2010. Aaron has served in various roles for leading international conferences and has co-chaired two previous AVI workshops, ITI'04 in Gallipoli, Italy and PPD'08 in Naples, Italy.

Sriram Subramanian is currently a lecturer at the University of Bristol and a visiting staff member at the human-interface engineering lab at the University of Osaka, Japan. Prior to this he has held positions as an Assistant Professor at the Computer Science Department of the University of Saskatchewan in Canada and as a senior scientist at Philips research labs in the Netherlands. His research interests are in human-computer interaction, input devices and interaction techniques for multi display environments and digital tables. He is the general chair for Tabletops and interactive surfaces 2008 and he has served on the program committee for conferences including CHI and GI. He has been co-chair for PPD'08 at AVI.

Lucia Terrenghi is an interaction designer and researcher interested in how technology can enhance people social engagement, self-expression, and creativity. She holds a Master in Industrial Design and a PhD in Computer Sciences, from the LMU University of Munich. Since 2008 she has worked at Vodafone R&D, where she investigates cross-platform user interfaces and the ways in which expressive interaction techniques can enhance inclusivity and sustainability. She has organised a workshop on Information Visualization and Interaction Techniques for Collaboration across Multiple Displays at CHI2006 and was a participant at PPD'08, and recently at the Dagstuhl Seminar on Pervasive Public Displays

5. INTERNATIONAL PROGRAM COMMITTEE

Our international program committee of twenty experts in the field, draws on strengths from pervasive computing, mobile computing, user interface design, hardware design, mobile devices, tabletops, surface computing, human computer interaction, computer vision and ethnography. The program committee included:

- Albrecht Schmidt, Universität Duisburg-Essen, Germany
- Antonio Krüger, Saarland University, Germany
- Carl Gutwin, University of Saskatchewan, Canada
- Christian Kray, University of Newcastle, UK
- Corina Sas, Lancaster University, UK
- Daniel Widgor, Microsoft, USA
- Dima Aliakseyeu, Philips Research Labs, The Netherlands
- Frédéric Vernier, University Paris Sud, LIMSI-CNRS labs, France
- Giulio Jacucci, Helsinki Institute for Information Technology, Finland
- Kenton O'Hara, Microsoft Research Cambridge and University of Bristol, UK
- Kevin McCarthy, CLARITY, University College Dublin, Ireland
- Michael Rohs, Deutsche Telekom Laboratories, TU Berlin, Germany
- Miguel Nacenta, University of Calgary, Canada
- Patrick Baudisch, Hasso Plattner Institute, Berlin, Germany
- Umer Rashid, Human Interface Technology Lab, Australia
- Ravin Balakrishnan, University of Toronto, Canada
- Rodger Lea, University of British Columbia, Canada
- Sebastian Boring, University of Munich, Germany
- Stacey Scott, University of Waterloo, Canada
- Tico Ballagas, Nokia Research, USA

We would like to thank all the members of the program committee for their concerted efforts in reviewing the submitted papers.

6. ACCEPTED PAPERS

The full versions of the papers accepted to the workshop are available online at http://www.hitlab.utas.edu.au/wiki/PPD10. The abstracts of these papers are described here in sections 6.1 – 6.11. These papers primarily address the following workshop topics.

- Developing evaluation strategies to cope with the complex nature of multi-display environments (see sections 6.7 and 6.9)
- Ethnography and user studies of visual interfaces relying on coupled displays (see sections 6.3, 6.5 and 6.6)
- Understanding the design space and identifying factors that influence user interactions in this space (see sections 6.2, 6.8, 6.10 and 6.11)
- Novel interaction techniques for both private and public multi-touch devices as part of multi-display environments (see sections 6.1 and 6.7)
- Techniques for supporting input re-direction and distributing information between displays (see section 6.3, 6.6, 6.4 and 6.9)

6.1 Experiences with Mouse Control in Multi-Display Environments

Manuela Waldner and Dieter Schmalstieg

Institute for Computer Graphics and Vision, Graz University of Technology, Austria

Abstract: It is now increasingly common to extend private workstations with large public displays into a shared multi-display environment. Mouse-based interaction across multiple displays provides a convenient way to quickly shift between private work on the personal monitor and tightly coupled collaboration on shared display spaces. However, mouse pointer navigation can be negatively influenced by display factors in the environment and thereby limits fluid interaction across displays. In this paper, we present experiences with mouse-controlled multi-display environments. Based on an experiment comparing four mouse pointer navigation techniques, we show limitations of mouse-controlled interaction in multi-display environments and suggest improvements to enhance the user interface experience with low-cost multi-display settings.

6.2 Primitive Interaction Tasks for Multi-Display Environments (PrIME): A Hands-on Approach

Mahsa Jenabi and Harald Reiterer

HCI-Group, University of Konstanz, Germany

Abstract: Cross-display interaction is a challenge for HCI researchers, because a naive adaptation of mechanisms in single-display workspaces might be inappropriate for teamwork in multi-user multi-display environments. In this paper, we identify a set of primitive cross-display interaction tasks, which, so far, have not been addressed in the literature. Additionally, we present our ideas to design a prototype that incorporates the identified primitive tasks, using an iPhone as a mobile input device with an integrated display.

6.3 Investigating Distributed User Interfaces across Interactive Large Displays and Mobile Devices

Matthias Finke, Nima Kaviani, Ivy Wang, Vincent Tsao, Sidney Fels and Rodger Lea

Media And Graphics Interdisciplinary Centre (MAGIC) University of British Columbia, Canada

Abstract: There has been significant research interest over recent years in the use of public digital displays and in particular their capability to offer both interactivity and personalized content. A promising approach is to use cell phones as a means to interact with displays, but also as a small, high quality screen to complement the larger public display. The use of a dual screen approach offers a number of intriguing possibilities including a potential solution to the problem of managing conflicts that arise when a screen is shared in a public setting or providing a means to show targeted and personalized information. However, to date, there has been little investigation into the impact for users of having interfaces distributed across this type of dual screen setup. In this paper, we report on a series of experiments carried out to determine quantitative or qualitative effects on user performance

when interaction is split across large public and smaller private screens. Our position is that using mobile devices as an auxiliary device for interaction can boost user experience when interacting with large displays.

6.4 Partial Web Interface Migration

Giuseppe Ghiani, Fabio Paternò and Carmen Santoro

CNR-ISTI, HIIS Laboratory, Pisa, Italy

Abstract: In this paper we present our solution for partial Web migration from large screens to mobile devices: it is based on the use of multiple abstraction levels for describing UIs and a set of transformations that allow the migration of user interface components selected by the user to another device. This feature is particularly useful in complex Web applications, such as various emerging mash-up applications. We also show an example of applying our solution to a Web social game.

6.5 Fridge Fridge on the Wall: What Can I Cook for Us All? An HMI study for an intelligent fridge

Manuela Bucci[1], Caterina Calefato[2], Sergio Colombetti[3], Monica Milani[4], Roberto Montanari[3]

[1]Centrocittà, Milano, Italy
[2]Department of Computer Science, University of Turin, Italy
[3]HMI Group DISMI, University of Modena e Reggio Emilia, Italy
[4]Indesit Company Spa Innovation & Digital Design, Italy

Abstract: New technologies have changed our life, making everyday tasks easier and faster. This new style of living requires a new kind of distribution of cognitive processes, resources and information. Trends in appliance design propose more sophisticated control and networking capabilities. Current white goods may be equipped with complex software and GUIs that may be inputted, by mobile phones. The ZmartFRI project aims at developing a seamless technology with an interactive fridge surface, assuring simplicity and intuitiveness of interaction. The fridge surface equipped with a display and an effective GUI provides more than additional memory device supporting human activities and providing opportunities to reorganise what is known. Thanks to a coupled display system between the fridge and the user mobile device, the fridge is able to alert products expiration date, to suggest recipes, to fill in and send by SMS or email the shopping list, to send and post messages for the house residents.

6.6 WallShare: A Collaborative Multi-pointer System for Portable Devices

Pedro G. Villanueva, José A. Gallud and Ricardo Tesoriero

University of Castilla-La Mancha, Spain

Abstract: WallShare introduces a new system to improve the collaboration possibilities among the participants in face-to-face meetings and working groups. It defines a novel interaction device and platform to develop collaborative applications. The system provides a shared zone displayed by a projector over a wall. In order to collaborate, users move their own cursors in the projected shared zone by performing gestures over their mobile device screens (mobile phones, PDAs, tablet PCs, laptops, etc.). Through their cursors and mobile devices users are capable of posting notes and messages, and sharing files, such as documents, images, etc. This article also exposes a preliminary usability evaluation of WallShare showing the effectiveness, productivity and satisfaction of users when performing a set of defined tasks with distributed user interfaces.

6.7 Labeling Large Displays for Interaction with Mobile Devices: Recognition of Symbols for Pairing Techniques

Umar Rashid[1], Lucia Terrenghi[2] and Aaron Quigley[3]

[1]School of Computer Science, University College Dublin, Ireland
[2]Vodafone Group Service R&D, Munich Germany
[3]HITLab Australia, School of Computing and Information Systems, University of Tasmania

Abstract: Interactive displays are an effective means to exchange contents with mobile devices for co-located collaboration in offices and schools. It is very important that the users are able to easily comprehend and learn the interaction techniques to pair their mobile devices with large displays. In this paper, we report on the results of an exploratory case study investigating the comprehension and understandability of the labels advertising different interaction techniques for pairing mobile phones with large displays. The results of this case study are discussed and the suggestions to enhance the comprehension level of these labels are provided.

6.8 Projector Phone Interactions: Design Space and Survey

Enrico Rukzio[1] and Paul Holleis[2]

[1]Computing Department, Lancaster University, UK

[2]DOCOMO Euro-Labs, Germany

Abstract: As projector units become smaller, brighter and more energy conserving, they are bound to become an integral part of many mobile phone models in the future. We layout and discuss the design space of interactions and applications enabled by such devices. Moreover, we focus on the implications of hardware design, discuss possible interaction concepts, describe the most relevant applications areas and give an outlook on future research topics.

6.9 Delegating the visual interface between a Tablet and a TV

Konstantinos Chorianopoulos[1], Francisco Javier[2], Burón Fernández[2], Enrique García Salcines[2] and Carlos de Castro Lozano[2]

[1]Department of Informatics, Ionian University, Greece
[2]Department of Informatics and Numeric Analysis, Cordoba University, Spain

Abstract: The introduction and wide adoption of small and powerful mobile computers, such as smart phones and tablets, has raised the opportunity of employing them into multi-device scenarios and blending the distinction between input and output devices. In particular, the partnership between a personal device and a shared one provides two possible output screens. Then, one significant research issue is to balance the visual interface between two devices with advanced output abilities. Do the devices compete or cooperate for the

attention and the benefit of the user? Most notably, how multi-device interaction is appreciated in multi-user scenarios? Previous research has raised and considered the above research issues and questions for dual screen set-ups in the work environment. In our research, we are exploring multi-device user interface configurations in the context of a leisure environment and for entertainment applications. Our objective is to provide interaction possibilities that are more than the sum of the parts.

6.10 Exploring Gesture-Based Interaction Techniques in Multi-Display Environments with Mobile Phones and a Multi-Touch Table

Tanja Döring, Alireza Sahami Shirazi and Albrecht Schmidt

Pervasive Computing and User Interface Engineering Group
University of Duisburg-Essen, Germany

Abstract: In this paper, we explore the potential of combining shared and interactive displays (e.g. a multi-touch table) with personal devices (e.g. mobile phones) as an important class of heterogeneous multi-display environments. Within six case studies applications and interactions were invented and implemented that utilize the potential of such heterogeneous multi-display environments. We were in particular interested how to design systems that include interaction across different displays and how to manage public and private information in a group setting. One case study, a digital card game, highlights these design challenges. A player has personal information (her cards), and there is public information (e.g. the cards on the table). Additionally, inherent interaction between both (e.g. transferring cards from the phone to the table and vise versa) is possible. We explore different natural ways of interaction, including touching the table as well as tilting, throwing, and shaking. With this application we provide a use case to discuss gestures combining mobile phones with tabletop surfaces, as well as to explore a private-public display setting. First results showed that combining tables and mobile phones provide a suitable and understandable way for interaction in these settings.

6.11 Digital Hospitality: Expressing hospitality towards guests in smart homes using private and domestic displays

Rasmus Gude

Department of Computer Science, Aarhus University, Denmark

Abstract: For more than a decade the use of ubiquitous computing technologies in the domestic space – the so-called smart homes - has been a subject for research. While research projects and findings has focused on smart homes and its inhabitants in various incarnations, little or no research has been questioning how these smart homes engender hospitality towards guests and how inhabitants in a smart home can express hospitality using ubiquitous technologies. This paper defines the novel notion of "digital hospitality" and proposes an early state system design based on coupled displays. The system called EWIA is designed to facilitate and strengthen the relationship between guest and host by utilizing both private smart phone displays and domestic displays. Preliminary results and topics for discussion are reported.

7. ACKNOWLEDGMENTS

We would like to thank all the authors who submitted to the workshop and all those we had position papers accepted and attended. We would also like to thank the Human Interface Technology Laboratory Australia for hosting our website.

8. REFERENCES

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