

Theme issue on personal projection

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1 Introduction

Mobile projection interfaces are no longer fiction. Integrated pico projectors in mobile and wearable devices could make mobile projection ubiquitous within the next few years and create commonplace practices where walls, desks, floors, and t-shirts act as projection surfaces for these kinds of new devices. Several projector phones—mobile phones with built-in projectors—are commercially available, have been demonstrated or are announced [5]. It is expected that such projector phones will be integrated in many of the next generation mobile handsets. Furthermore, we have seen the first research toward the integration of pico projectors and cameras into various wearable systems, such as stand-alone personal projectors [4], watches [2], pendants [3], or headsets [6], leading to new form factors, interaction techniques, and applications. These mobile

projection units, often equipped with a camera or other additional sensors for tracking input, have a great potential to overcome the limited input and output capabilities of mobile and wearable devices. They can be expected to have a significant impact on the cultural usage habits of content consumption and media sharing. This makes mobile projectors an interesting and important platform for research in the area of Human–Computer Interaction.

Current research in this field mainly focuses on the design, development, and evaluation of novel interaction techniques and applications, on the study of how this technology is used in realistic contexts and how it affects the usage of mobile and wearable devices. In addition, new sensing and tracking methods are being investigated in order to support novel ways of interaction and emerging applications. Therefore, we are still at the beginning of understanding and addressing the multifaceted challenges of this emerging research area of Human–Computer Interaction.

Of course, mobile projectors have been used in various other research disciplines for a couple of years. As the first paper of this special issue vividly shows, their history even goes back to the seventeenth century, where “magic lanterns” provided early forms of mobile projection. More recently, previous research has focused on technical aspects, such as hardware construction, optics, projection geometry [1], energy consumption, and interaction with projected multi-scale user interfaces [4]. Through continuous miniaturization, these devices have now reached form factors that allow us to focus on HCI research in the context of realistic pervasive environments, such as mobile settings.

This theme issue on personal projection is a follow-up of the successful *Ubiprojection 2010* workshop being held in conjunction with the Pervasive 2010 conference in

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Helsinki. An open call invited submissions from the participants of this workshop as well as from the overall research community. Based on the reviews, we decided to include six papers reporting novel interaction techniques, concepts, insights, studies, and prototypes that extend the current state of the art on personal projection. This theme issue on the field of personal projection provides novel insights into its history and information on how projector phones are currently being used, on how head-mounted projectors can support collaborative co-located augmented reality applications, on the advantages of mobile steerable projectors and on the artistic usage of personal projectors. The articles of this issue show that personal projection is an emerging research field with the potential to significantly extend the capabilities of mobile and wearable devices and to change the way we are using them.

2 The papers of this theme issue

The first article by Willis provides a fascinating historical account of contemporary interaction with handheld projectors. It begins by documenting handheld and belt-mounted “magic lanterns” that were used in public performances in Europe and continues with a description of projector-supported storytelling performances in Japan. The article then shows various interaction techniques that have been used with these historic devices, like device movement, projection occlusions, and overlay of multiple projected images. The article closes with a discussion on how these techniques can inform the development of future personal projector systems.

The second paper by Krum, Suma, and Bolas is primarily devoted to technical aspects. It reports a novel interaction technique and mixed reality system that offers a realistic and robust approach for augmenting the environment with projected information. In this setting, parts of the environment are augmented with retroreflective material and the user is wearing a head-mounted personal projector that projects into the user’s field of view. This approach can, e.g., be used in military training scenarios where the projection shows other soldiers or military vehicles. The usage of the retroreflective material ensures that only the person wearing the projector and persons standing nearby can see what is projected. The projection itself is brighter as this material reflects the light in the direction from where it originates. The paper reports the overall interaction concept, its implementation, experiences, and ideas for future work.

In the following article, Cauchard et al. also investigate the implications of a technological issue for interaction. Whereas most projector-device settings are configured in a fixed way, the authors consider steerable projection as a

means of decoupling the orientation of the device from the available projection space. For that purpose, they built a steerable projector prototype allowing to automatically change the angle of projection with regard to the handheld device. In a conducted experiment, they wanted to find out how suitable various projection angles are for particular tasks. Significant preferences of the user-selected projection angles were found for different tasks, such as reading and navigation. In addition, Cauchard et al. investigate hand- and foot-based interaction techniques to cope with alignment and misalignment between the projection and the phone. With favoring foot interaction, they broaden the possible interaction vocabulary and also provide evidence on the importance of fundamental user studies in this emerging field.

Besides technological and interaction issues, social implications are an essential topic for personal projection systems. Wilson et al. focus on the unknown and seek to anticipate how projector phones would be used and what social implications they would have. Identifying such practices for a future technology that barely exists is always a great challenge, and this paper bravely targets to provide insight to projector phone designers looking at physical devices, applications, and interaction design. The paper presents two-phased field research, where the studies explore the phenomena from two complementary viewpoints. In the first study involving 15 participants, users’ experiences on projecting different types of content in real-life use context were charted with experience sampling method. The second study reports on 13 participants, who kept a diary for 1 week about events, where they wished to be able to project content from their mobile phones.

Continuing in this line of research, Cowan et al. are the first to report the findings from a four-week field study in which projector phone usage has been explored. Conventional mobile phones are primarily private devices as it is difficult for others to see what is shown on the rather small screen. This is very different when using mobile projection, and this aspect is very well covered in the paper. Different usage scenarios or patterns are discussed, which took part in private, semi-private, and public settings. Furthermore, the authors report how the overall context (e.g., privacy of the setting, group size, participants’ relationships, surface, display size, and visibility) affected the usage of the projector phone. This analysis shows the multitude of contexts and situations in which projector phones could be used and which implications those have on how the projection is used and which information is displayed.

The last paper of this special issue by Bongers reports on an artistic performance using mobile projectors and thus widens the perspective of personal projection. The project, called *Videowalker*, aims to address the urban space and the natural environment with audiovisual material, responding

and reflecting on the context. This is one of the first artistic performances using mobile projects providing insights into the development and design processes of such a performance. The paper describes the background of the project and its approaches as well as experiences and reflections on a range of instantiations or performances with a mobile projector in Spain, Holland, and Australia since 2004. We are quite sure that more and more artists will make use of this technology as a new way of artistic expression and that we are just at the starting point of this development.

3 Outlook

In putting together this special edition, our goal has been to report on current research in the area of mobile projection interfaces and applications as part of the general framework of pervasive computing. The included papers provide a significant contribution to the overall research area and show that personal projection is still a relatively recent field of research with a large potential for new interaction techniques, applications, and services. With contributions from a range of diverse perspectives, we hope to document part of the current state of the field and to inspire future work in the area.

In the precursory workshop *Ubiprojection 2010*, several avenues for future research were identified as a result of the discussion. On the technical side, the main challenges lay in improvements of the projection quality, in particular resolution, luminosity, and support for various kinds of projection surfaces. Beyond that, progress in hardware technologies with respect to device miniaturization and integration as well as energy efficiency is highly desirable. Looking at the business dimension, application domains and settings need to be identified that benefit the most from projection-based interfaces. From a basic Human–Computer Interaction perspective, suitable interaction techniques, context-aware visualizations, and reliable low-latency tracking algorithms for interacting with handheld projections have to be developed. The design of

collaborative interfaces involving multiple handheld projectors is another future area that seems to have particular potential. Last but not least, the development of appropriate user study methodologies for analyzing projection-based interaction on different levels emerges as an important topic. From a societal viewpoint, the social implications in terms of privacy and behavior in public space as well as the impact on ad-hoc group collaboration need to be investigated. It is needless to say that this incomplete list only illustrates how many challenging research questions are currently emerging, which are yet to be addressed.

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