A Concept to Extend the Mobile Interaction Space with a Projected Aura

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ABSTRACT
Miniaturization in projection technology makes it possible to integrate projectors into mobile devices like tablets, PDAs, or mobile phones. This offers new capabilities for input and output, which are seen as promising possibilities to overcome the limited screen size of mobile devices. However, it is still unclear, how projection will be used in combination with the traditional mobile device's screen. In this paper, we propose a new concept, which allows users to extend the screen of their mobile device by using a set of integrated projectors. Taking advantage of the four directions, multiple projection spaces for interaction are created next to the mobile device's screen, avoiding projection jitter, arm fatigue and attention shifts between projection and mobile device display, which are recurrent problems addressed in previous work.

Author Keywords
Mobile projection, extended interaction space, multiple projection space.

INTRODUCTION
Projector phones with one integrated projector are the most common on the market. However, there exist concepts like Seabird that propose the integration of dual projectors to expand the interaction space [7]. Similar to this approach, our concept bases on a set of integrated projectors capable to project into the four directions of the mobile device, creating a projected aura to define multiple projection spaces. Each space complements the traditional display and provides new channels for input and output to overcome the limited screen size of mobile devices (see figure 1).

RELATED WORK
Interaction with mobile projections has been the focus of different work. Cao et al. [2] used handheld projectors to define and interact with dynamic interaction spaces. Based on the flashlight metaphor, it is possible to discover virtual information in the users' environment. Dynamic interaction spaces may be used to extend the existing workspace and offer the possibility to organize information in the environment. In [3], they present the collaboration of multiple handheld projectors, enabling users to overlay, dock or snap their projections for interaction and information exchange. SixthSense [8] is a wearable and gestural information interface that projects digital information into the physical environment. Interaction is done using natural hand gestures or postures. In [4], we

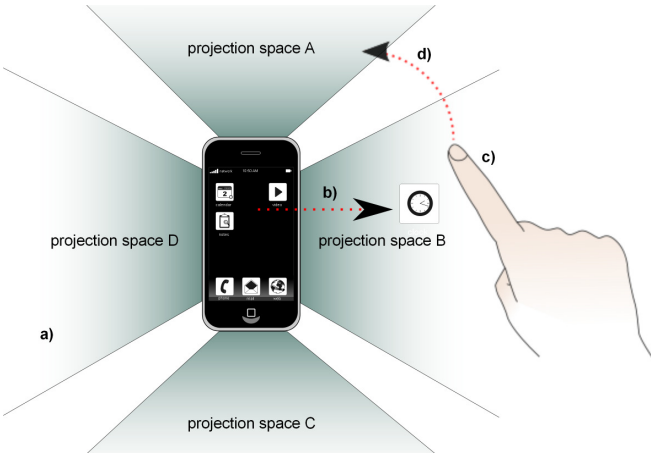

Figure 1. Concept mockup. a) Four projection spaces b) Moving objects from mobile screen to projection space c) Interaction on projection space d) Rotation-gesture to rotate projection space.

analyzed the use of projections alongside the screen of mobile phones. In a user study, we compared three interaction techniques for map interaction, using the display of the mobile phone, the projection and the combination of both, respectively. The results showed a preference towards the combination of projection and mobile display, since it allowed convenient text input on the mobile device, whereas the projection provided a large overview of the map. However, the resulting attention shifts between mobile device and projection were cumbersome. Besides problems with attention shifts, research in projection have identified further issues, regarding arm fatigue, projection jitter, and privacy concerns [2]. Shifting the projection next to the mobile device may be of advantage to encounter these issues and provides new possibilities for interaction around the device. For example, Bonfire is a system that uses projection to display interaction spaces next to a laptop's keyboard [5]. It can be used for natural interaction between physical and digital objects, and further allows direct pointing and gestures. SideSight is a prototype for multi-touch interaction around small devices using infrared proximity sensors [1]. A similar system was proposed by Kratz et al. [6], which allows handheld interaction. The main objectives of both approaches are the expansion of interaction possibilities as well as the avoidance of occlusion problems on small devices.

CONCEPT

We believe that approaches for around the device interaction are also beneficial for projector phones. So far, most research assumes the projection device to be held in the user's hand. However, putting the device on a flat surface may prevent issues like projection jitter or arm fatigue, but still provides an intuitive interaction experience. We assume that having projection and display on the same plane, will facilitate interaction with mobile projections and will reduce the inhibition threshold to interact with projection in public by creating a semi-public environment. Therefore, we propose a new concept, which creates a projected aura around the mobile device when laid down on a flat surface. The aura is created by projecting in up to four directions of the mobile device: left, right, top, and bottom (see figure 1a). Each direction represents a projection space for interaction and extends the traditional screen of the mobile device.

By placing the traditional screen and the complementing projection spaces next to each other new possibilities for interaction arise that should be addressed. Shifting objects from the mobile device's screen to a projection space can be accomplished in different ways (see figure 1b), e.g. by flicking the object or by dragging it to the border of the mobile device screen next to the corresponding interaction space. Also the interaction in and between projection spaces has to be considered. This includes single-touch and multi-touch interaction (see figure 1c) or the use of gestures. For example, a rotation of the interaction space by 90 degree could be done by a wiping gesture in the corresponding direction (see figure 1d). In order to support such interaction, technical aspects have to be discussed in detail. Technical components used in [1] or [6] may be helpful for the development of prototypes for our concept. Besides tracking user input on the projection space, the projection itself plays an important role. The use of mirrors makes it possible to divert the projection image to the table's surface when the projectors are built into the sides of the mobile device. However, the projection images must have a certain dimension to provide a reasonable interaction space. Solution and technical limitations regarding these aspects are yet to be analyzed in more detail.

Nevertheless, our concept has various advantages. Extending the interaction space of the mobile device with projections makes the need for additional adapters and monitors obsolete. The interaction spaces are directly projected next to the mobile device's screen, creating spatial dependencies making the interaction more intuitive. Furthermore, the interaction space is kept in a semi-public environment. Private information may be kept on the mobile device, whereas information to be shared may be shifted to one of the projection spaces. The concept is also beneficial for collaboration, e.g. for collaborative learning with lecture podcasts. When such podcast is composed of audio and synchronized slides, each projection may refer to one person, displaying the slides and allowing interaction in the corresponding space by highlighting important information or by making annotations for learning. It could be possible to share these annotations by pushing them to all other projection spaces. Another approach could be the use of multiple projector phones. Overlaying projection spaces of different devices could initiate the exchange of objects. In a single-user scenario the system can highlight important information that would otherwise be invisible. For example, when appointments in the mobile device's calendar are due, a projection can indicate the appointment. The user can interact with the projection beam to get further information about the appointment, but also may just wipe the projection away without having to grasp his mobile device.

FUTURE WORK

In order to identify the benefits and shortcomings of the concept, we are planning to build a prototype and evaluate it in a user study. The proposed concept is still at an early stage and many questions have yet to be discussed. We believe that the workshop on mobile and personal projection will provide helpful input regarding these aspects.

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