Pipet: a design concept supporting photo sharing

Bernt Meerbeek, Peter Bingley
Philips Research
High Tech Campus 34 (51)
5656 AE Eindhoven, NL
+31402747535
bernt.meerbeek@philips.com
peter.bingley@philips.com

Wil Rijnen
User-System Interaction
Eindhoven University of Technology
5600 MB Eindhoven, NL
+32485616907
wil.rijnen@gmail.com

Elise van den Hoven
Industrial Design
Eindhoven University of Technology
5600 MB Eindhoven, NL
+31402478360
e.v.d.hoven@tue.nl

ABSTRACT
To support reminiscing in the home, people collect an increasing amount of digital media on numerous devices. When sharing their media with other people, distribution of the media over different devices can be problematic. In this paper, we address this problem by designing an innovative interaction concept for cross-device interaction to support groups in sharing photos using multiple devices. We designed and implemented the Pipet concept. Results of a comparative study show that Pipet resulted in a pragmatic and hedonic user experience.

CATEGORIES AND SUBJECT DESCRIPTORS
C.0 [Computer Systems Organization]: General – hardware /software interfaces. H.5.2 [Information Interfaces and Presentation (e.g. HCI)]: User Interfaces - Haptic I/O, Input devices and strategies (e.g., mouse, touchscreen), User-centered design.

GENERAL TERMS
Design, Human Factors

KEYWORDS
Cross-device interaction, Photo sharing, Interaction design, Tangible user interface, Collaboration

INTRODUCTION
The living room of today hosts an increasingly large number of technical devices, from entertainment systems, such as TVs, audio installations and game consoles, to fully automated homes, with complete atmosphere creation systems, including lighting, temperature and curtains. To make all these features accessible anywhere in the room, most of these systems come with remote controls (RC), one for each device. Even though some of these devices have the same functionality or play the same types of media, e.g. send a picture from the game console to the RGB LEDs that are part of the atmosphere creation device, this is not yet possible through one remote control that can be used *across* different devices. In addition, most remote controls are designed to be efficient and effective with a button for every function, but they are not much fun to interact with. In this paper we focus on an enjoyable interaction style with a future remote control, which is specifically designed for cross-device interaction in the living room.

We investigated innovative ways of interacting, such as physical interaction, instead of taking the standard set of buttons used on most remote controls. For the application context we chose to focus on a situation in which people use multiple devices to create one shared item, namely a photo compilation of a shared group activity. Each member of the group can bring his or her photos on their personal media devices, such as mobile phones, digital cameras, external hard disks and laptops. However, in order to make this shared compilation all the photos will have to be collected on one device.

In order to investigate cross-device interaction we will start this paper with an overview of related work in the areas of physical interaction, multi-device collaboration, and memory recollection and photo sharing. After that, we describe the design exploration followed by the conceptual design phase and the prototype Pipet. Subsequently, we report on the evaluation of Pipet and the results. We will end with the discussion and conclusions.

RELATED WORK

Physical interaction
Designers and researchers explore new interaction styles that enable users to communicate with technology in a natural way, for example via speech, gestures, and physical interaction. Physical interaction or the interaction with physical artefacts in the context of an interactive product is a research topic that is becoming increasingly popular due to several reasons. For example, due to miniaturization of technology as described in the Ambient Intelligence (AmI) vision, as well as the desire to design interaction particularly for the physical skills people already have and that are not used in everyday human-computer interaction. Several topics are covered by physical interaction, e.g. embodied interaction [3], reality-based interaction [10], kinetic user interfaces [1] and of course tangible user interfaces which, as defined by Ullmer & Ishii [19], "couple physical representations (...) with digital representations". The field of tangible interaction shows a recent focus on design, interaction and physicality [11]. A well-known example of a physical interface that is related to our work is the I/O brush [17]. This augmented paintbrush can pick up textures, colours, and movements from the real world and allows a child to make drawings with them.

When we look at examples of physical interaction, we often see a focus on single user interaction [15,17,23]. There is some work on collaborative physical user interfaces, in particular on digital

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NordiCHI 2010, October 16–20, 2010, Reykjavik, Iceland.
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tabletops [18]. Another example of a collaborative physical interface is the Tangible Video Editor, a multi-user, tangible interface for sequencing digital video [22]. Also Nintendo Wii is an example of multi-user physical interaction in gaming. We want to combine physical interaction with cross-device interaction that supports simultaneous co-located collaboration.

Multi-device collaboration

As described in the introduction, there is a growing number of devices in our living rooms. Many of these devices are standalone and controlled with separate RCs. The exchange of content between devices is often still difficult. Furthermore, people increasingly own personal mobile devices (e.g. smart phones and media players) containing media that can be exchanged with other people and other devices.

Some work has been done on supporting the exchange of information between devices, both in individual and in collaborative settings. Pick-and-Drop [15] allows a user to pick up an object on a display and drop it on another display as if he was manipulating a physical object with a pen based device. Slurp [23] is another example of a device that allows a single user to move digital content from one device to another by physical interaction. Slurp can extract and inject digital media by touching and squeezing the digital eyedropper and gives haptic and visual feedback.

Research on multi-device interaction in collaborative settings mainly focuses on meeting rooms. Several techniques for moving digital content from one display (e.g. personal tablet pc) to another display (e.g. shared projection display) are suggested and compared with respect to efficiency [13]. Most important in these settings is to create an efficient solution, rather than a fun and enjoyable experience.

Memory recollection and photo sharing

Another focus of our work lies in the application area of sharing memories and everyday reminiscing. When we talk about “memory for the events of one’s life”, which underlie everyday remembering, we talk about Autobiographical Memory [8]. And the process of remembering is often initiated and supported by memory cues [9]. In everyday life people often use photos for cuing their memories and sharing their experiences. For example, people get together to show their most recent holiday photos to each other. We all know that with the introduction of the digital photo camera these traditions are undergoing some transformations. First of all people create an increasing number of digital photos [16], while people are reluctant to organize their collections [21]. On the other hand, people are still eager to share in particular face-to-face or co-present. Within co-present photo sharing one can identify three types, namely storytelling, reminiscing talk and a combination of both [5]. In the storytelling situation people share photos with others who were not present at the time the photo was taken, while for reminiscing talk both photo owners and visitors were present, so both parties can give input to the conversation. We want to support the organisation of digital photos in the reminiscing talk condition, since we see this is even more difficult than only managing and organizing your own set of photos.

Without being complete, we presented a short overview of related work. Our work extends this body of research by designing a physical interface that supports *multiple* users simultaneously using *multiple* devices with sharing photos and reminiscing talk. And unlike most previous work, we focus on making this activity a fun and enjoyable experience that can take place in the living room. In the next section, we continue with our design exploration.

DESIGN EXPLORATION

Introduction

Following the recent focus of physical interaction on design, interaction and physicality we decided to use the design research approach according to Hoven et al. [9]. This approach facilitates designing within context of use, to start designing from a physical activity, to have an iterative process and to focus more on user experiences as opposed to usability. The main activities of our interest are recollecting and sharing memories in the living room. Hence, we decided to start exploring the design space by conducting a contextual inquiry using diaries and in addition we organized co-creation sessions to generate ideas.

Sensitizing diary

Six people (three couples, age 27-36) participated in the contextual inquiry. Two weeks before the creative sessions, participants received a sensitizing package. This package contained a sensitizing diary with open-ended questions and small exercises, cards with creativity triggers, and some crafts materials. The goal of the sensitizing package is to prepare people for the creative session by asking them to think about the topic of reminiscing and express related opinions, needs, aspirations, etc. People filled out the diary for five consecutive days and needed about 20 minutes per day (see Figure 1). The diaries were completed individually in their own living room.

Creative session

Each couple that completed the sensitizing diary was visited for a creative session. First, the researcher recapitulated the diaries with the participants to shift to the right mindset for idea generation on the topic of interest and ask clarifying questions if necessary. In the first creative exercise, participants planned an event to reminisce with friends or relatives with whom they had a pleasurable experience, for example a holiday trip. After this cognitive mapping exercise, people were asked to project how this event would change if it were held in 2020. In the second creative exercise participants used handicrafts materials - including clay, cocktail sticks, fabrics, etc. – to make a creature that would support them in reminiscing with their friends or relatives. By working with a fictive creature, participants forget about technical limitations and focus on expressing their real needs and wishes.

Figure 1 Examples of completed sensitizing diaries

Main findings
Obviously, the diaries and creative sessions resulted in a substantial amount of qualitative data, which we clustered and analyzed using affinity diagrams. In this section, we summarize the main findings of our design exploration.

Participants regard the living room as both an individual and a social place. They refer to it as the place to withdraw from the surrounding world and to be safe and at ease, as well as the place where your friends and relatives are welcome. It is a place to relax and enjoy. We indentified two types of 'memory cues' in the living room: visible cues and stored cues. The visible cues are positioned in a visible place and help to remind you of a person or event (e.g. a family picture in a frame on the wall). The stored cues are precious and often private, hence safely stored in boxes or cupboards to prevent losing it (e.g. a picture of a first lover in a shoe box). With regard to recalling memories, participants distinguish between reminiscing in an individual and a social context. Individual reminiscing mainly focuses on mood intensification and mood change, whereas social reminiscing has to do with feeling connected and having fun. Most participants enjoy making photo collages or photo albums and believe that it facilitates reminiscing with others. However, they regard this as a complex and time-consuming activity.

The main findings from the diaries and creative sessions are translated into design requirements, which are described in the next section.

Design requirements
We aim to design an interactive system that supports groups in reminiscing previous pleasant experiences. People should be able to use this system in a living room setting. The system should allow groups to jointly create a photo compilation and stimulate people to recollect shared experiences. Furthermore, it should support using photos from different people and devices, but offer seamless cross-device interaction. The system should offer more value as more people participate and everybody should have equal opportunities to participate. Finally, the experience of creating the compilation should be fun. The process is more important than the end-result (i.e. the compilation).

CONCEPTUAL DESIGN

Idea generation
Starting from the requirements we stated in the previous section, we generated ideas for systems during a brainstorm session with six interaction designers. Based on these ideas, we developed five interaction concepts, which we describe in the next section.

Five interaction concepts

Mirror Cube
With the Mirror Cube (Figure 2), the compilation process becomes an interactive gaming experience. People sit around the table and browse through their own set of pictures. They can share a picture from their own selection with the group by sliding the picture from their camera or mobile phone towards a digital display table. Everyone has a Mirror Cube that he can put on top of a picture, thereby copying the picture to his cube. The compilation process starts when everybody has filled his cube with six pictures. People can add a picture to the compilation by putting the cube back on the table, as well as edit the pictures or add comments.

XXL
The concept XXL (Figure 3) is based on reaching consensus. All group members need to agree on all decisions to get the job done. Each group member browses their own set of pictures and sends them to a shared device – a huge inflatable remote control – by blowing over the display of their camera or phone. As the inflatable remote control receives more pictures it becomes bigger. By collectively pointing and manipulating the remote control, pictures are added to the compilation on the TV screen.

Dice
The Dice concept (Figure 4) consists of a set of large dices that can display pictures on each of its six faces. The displayed pictures are taken randomly from the picture collections of the group members. By tilting the dice, the picture on the bottom is deleted and replaced with another picture. By choosing the tilting direction, people can influence which pictures are deleted. The pips on the upper face indicate how often people have to tilt the dice. In this way, the best pictures are collectively selected. The dices can be stacked, resulting in a physical 3D photo collage.

Figure 2 MirrorCube concept

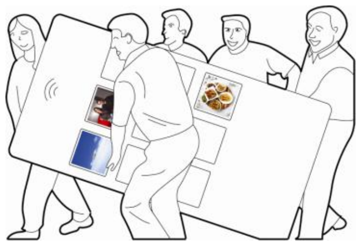

Figure 3 XXL concept

Figure 4 Dice concept

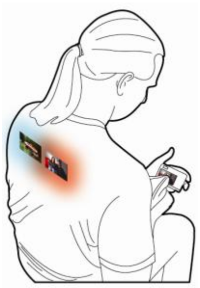

Figure 5 Byb concept

Figure 6 Pipet concept

Byb

Byb (Figure 5) is the acronym of 'behind your back' and turns creating a photo compilation into a physical activity. People select a picture from their individual camera or phone by rubbing over the display with their T-shirt. The picture is displayed on the back of the shirt. When all pictures are selected, they are presented in a slideshow on the TV screen. A green check mark and a red cross appear on the back of randomly selected shirts. People can vote whether they want the picture in the compilation by touching the shirt with the green or the red sign. After the voting, each shirt shows a different editing tool (e.g. resize, rotate, etc.) on the back side. People need to work together to create and edit the compilation.

Pipet

Pipet (Figure 6) offers groups a way to create photo compilations in a quick and easy manner. Each person has a digital pipette, which can be used to suck up pictures from cameras and mobile phones and shoot them from a distance onto a TV screen or smart phone. In a similar way, text message created on a phone can be send to the TV. The harder people squeeze Pipet, the larger the picture on the screen, but the more difficult it is to aim. Once a picture is shot on the screen, it cannot be removed, as if it were paint.

Concept evaluation

The five concepts were presented on A3 concept cards and discussed with seven participants. Most of the participants had also participated in the design exploration phase, which was considered an advantage as they were already more aware of the problems and needs in recollecting and sharing memories. Goal of the evaluation was to assess to what extent the concepts appeal and are perceived as a useful and fun alternative for reminiscing. Participants were asked to highlight the aspects they liked with green and the aspects they disliked with red. Furthermore, participants were asked to rank the concepts. For each concept, detailed user feedback was collected. It is beyond the scope of this paper to discuss it in detail, but overall XXL was appreciated the least (4 of 7 participants ranked it as the least appealing concept). Pipet was most appreciated (4 of 7 participants ranked it as the best concept). Its interaction style was considered universal and easy to understand, yet playful and spontaneous. Everybody can use it immediately, but you can also improve skills with practice.

Based on the results of the concept evaluation, we decided to design a prototype of the Pipet concept to gather more detailed insights on the user experience of this interaction concept.

PIPET PROTOTYPE

The metaphor of a pipette as used in chemistry is extended in both the design and the interaction. Comparable with transporting fluids from one place to another, the digital pipette is used to transfer content across devices. Because the Pipet has a very specific goal, the looks and the interaction can be designed specifically as well. Sucking and shooting is done by a squeeze action of the Pipet. As in chemistry, where one needs to be in the fluid to draw it up, the digital one will only get the picture if the Pipet is pressed against the screen of the smart phone. Likewise the content will be released if you squeeze without pressing it against the smart phone. Similar to putting the tip of the laboratory instrument in another reservoir to indicate in which one to release the fluid, the tip of the digital one has to point towards the screen the picture has to be transferred to. The faster the Pipet is squeezed, the faster the content will be shot. This results in a larger picture on the TV screen.

At a glance the Pipet concept may seem somewhat similar to Slurp [23] that uses the metaphor of an eyedropper. Like Slurp, Pipet supports touching and squeezing a digital eyedropper while providing haptic and visual feedback, with Pipet also adding auditory feedback. Where Slurp focussed on the extraction of digital media from physical objects and the selection of an appropriate display device to access it from, Pipet focuses on multi-user interaction and group collaboration using multiple devices simultaneously.

Figure 7 Four 3D printed Pipet add-ons with Nintendo WiiMotes

Figure 8 Four smart phones with photo browsing application

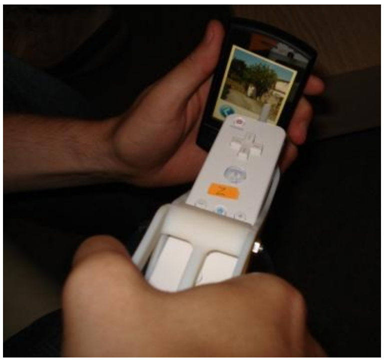

Figure 9 Pipet "sucking" a photo from a smart phone

Figure 10 Screenshot of photo compilation application on TV

Figure 11 Four persons creating a photo compilation on the TV screen using their Pipet and smart phone

The Pipet prototype consisted of four hardware Pipets, four smart phones, a Windows PC and an LCD TV. The Pipets were prototyped by 3D printing a specially designed casing for the Nintendo WiiMote (Figure 7). Foam balls were used to differentiate the Pipets by colour and to provide spring action for squeezing the Pipets. Four HTC Touch Cruise smart phones were running a dedicated Windows Mobile picture browsing application (Figure 8) that could be used with the Pipets to browse photos and to suck up a photo (Figure 9) which could subsequently be shot to the TV by squeezing a Pipet. The Windows PC served as a communication hub for the Pipets and smart phones, gathering input and distributing output to these devices. Also the PC was running an application for creating photo compilations created in Flash which was shown on the TV screen (Figure 10).

The Flash application on the TV was used to create a compilation of photos per day of the shared holiday of the users. Arrow buttons on the TV screen could be used to navigate to different days, causing the photos related to the selected day to appear on the smart phones. In this way the people were informed visually about the change, next to an auditory signal.

Feedback about the Pipet status was provided with a combination of visual, auditory and haptic feedback, as people may be focusing on different devices while interacting. When the Pipet tip is pressed against the mobile phone display, the Pipet tool starts vibrating. When the Pipet is squeezed the vibration stops and LEDs indicate that the photo has been sucked up by the Pipet. When the Pipet is aimed at the TV, a coloured cursor is displayed corresponding to the colour of the Pipet. When aiming at the screen and squeezing the bulb, the picture is shot and appears on TV. At the same time, a splash sound is played and the LEDs on the Pipet are switched off. When squirting a picture outside the screen, the picture will not appear. Nevertheless, the splash sound and the LEDs will indicate that the picture is shot and that the Pipet is empty.

All users could simultaneously suck up pictures from their smart phones and splash them on the TV screen (Figure 11). In this dynamic activity other group members can immediately see which pictures have already been chosen, and react upon them. Each individual has a big influence on the result, because nobody can undo what someone else has shot to the TV.

The prototype did not provide all functionality of the Pipet concept. The ability to shoot photos to other smart phones was not implemented, as was the possibility to scribble text messages and shoot these to the TV. Also photos were clustered by date only, and not by location.

PROTOTYPE EVALUATION

Introduction

Pipet aims to support reminiscing previous pleasant experiences by enabling groups to jointly create a photo compilation in a fun way. The goal of the evaluation was to find out how participants experience Pipet and to investigate the effect of Pipet on the group process. To answer these questions, we compared the Pipet prototype (P) with the control condition (C).

The control condition (Figure 12) was very similar to the Pipet prototype in terms of functionality and innovativeness of the user interaction device. It only differed on the two key aspects of the

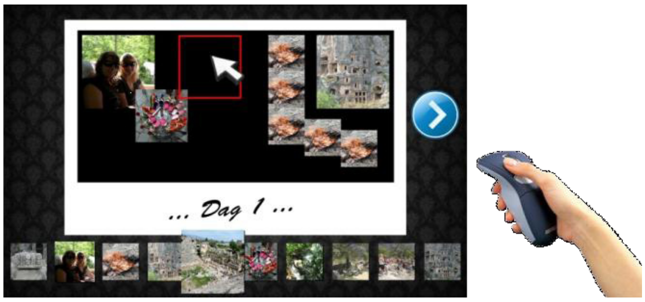

Figure 12 Control condition: gyromouse

Pipet system: the multi-user involvement and the fun interaction style ('suck-and-shoot'). The control condition consisted of a gyromouse that one group member at a time could use for selecting pictures from a shared space and dragging these to the compilation. Other group members could give instructions to the person holding the gyromouse or take it over.

There were several reasons why the gyromouse was considered the best control condition for our evaluation. In our design exploration, we learned how groups currently create photo compilations. Often, they just do not create compilations together, because it is too much hassle. But in case they do create a compilation together, they often sit around a pc or laptop, which is controlled by one person. So if we want to compare our solution to the status quo, we would have a pc and mouse as control condition. However, we believe a comparison of our solution with a condition in which four people sit behind a laptop would lead to an obvious preference of participants for newer and more innovative interaction solution. Therefore, we chose for the gyromouse, which still represents the situation where one person is in control, but is new and innovative for our participants as our Pipet is.

Hypotheses

The focus of the presented work is on designing a physical interface that supports *groups* in photo sharing and reminiscing talk, and on making this activity a fun and enjoyable *experience*. Therefore, we formulated hypotheses to test the effect of Pipet on the user experience and the group process. Next, we enumerate our hypotheses, where P stands for the Pipet condition and C for the control condition:

User Experience

H1. Overall user experience of P higher than in C

H1a. People experience P as more pragmatic ('useful') than C

H1b. People experience P as more hedonic ('fun') than C

Effect on group process

H2. P supports group process better than C

H2a. People contribute more equally in P than in C

H2b. People perceive more control in P than in C

H2c. People are more satisfied with end-result in P than in C

H2d. People are more satisfied with group process in P than in C

Method

The evaluation was conducted in a realistic living room setting in the Philips ExperienceLab, a user-centred research facility at the High Tech Campus in Eindhoven [20], and followed a within-subjects design. Three groups of four people were recruited to participate in the evaluation (12 participants, age 18-30, 9 female). To make the setting as realistic as possible, all three groups consisted of friends that had actually been on holiday together in the past year. They were asked to provide their own set of pictures of that holiday, which were used during the evaluation session.

Procedure and measurements

Each group received a short explanation about the procedure of the evaluation. After signing informed consent forms, participants could briefly try out the system. When participants had no more questions, the actual task started. Participants were instructed to jointly create a photo compilation of the holiday trip they recently made. The TV showed empty slides with a certain topic or a specific day of the trip on which participants could place their pictures. The session finished when five sheets were completed or after 20 minutes. Groups alternately started with condition P or C. For the second condition, the same procedure was followed. After each condition, people were asked to complete a questionnaire. At the end of the evaluation, a short group interview was conducted. Participants received a reward for their participation.

We used different measures to address our hypotheses, including questionnaires, objective task measures, and a semi-structured group interview. The questionnaire measured two aspects of user experience (pragmatic and hedonic) [14], perceived control [7], group result satisfaction and group process satisfaction [6]. As an objective measure for people's level of contribution, we counted the number of photos added to the compilation. In the Pipet condition, this number was automatically logged. In the control condition, we counted this offline by analyzing the audio and video recordings. During the semi-structured interview, we gathered more qualitative data on how people experienced the two systems and advantages and disadvantages of the systems.

RESULTS

Next, we will summarize the results concerning the user experience (H1) and the effect on the group process (H2). Thereafter, other interesting findings are reported.

User Experience

The User Experience questionnaire was tested for reliability (Cronbach's $\alpha = 0.88$), which indicates a high internal consistency of the scale. The scores of condition P and C were compared with a Wilcoxon signed rank test. The results (see Table 1) indicate that Pipet scores significantly ($\alpha = 0.05$) higher on pragmatic user experience, hedonic user experience, and overall experience. The qualitative results support these findings. Participants indicated that Pipet was fun to use and 9 out of 12 participants expressed that they preferred Pipet over the control condition (1 out of 12 preferred the control condition, 2 participants had no preference).

In sum, the qualitative and quantitative results give strong support for hypotheses H1, H1a, and H1b. So indeed the user experience, both pragmatic and hedonic, of Pipet was better than in the control condition.

	Control		Pipet		Pipet > Control	
	Mean	*SD*	*Mean*	*SD*	*z*	*p*
H1a: pragmatic UX	3.08	.42	3.60	.70	-2.04	.041
H1b: hedonic UX	3.37	.94	4.23	.58	-2.94	.003
H1: overall UX	3.23	.57	3.92	.58	-2.63	.009

Table 1 User Experience results

	Control	Pipet
Mean	25%	25%
Min.	0%	12%
Max.	60%	36%
SD	18.7%	7.1%

Table 2 Mean, minimum, maximum, and standard deviation in relative contribution to compilation (% of photos)

Effect on group process

We found no significant differences between the conditions in participants' satisfaction with the end-result (i.e. the photo compilation), nor in the satisfaction with the group process. Hence, we reject hypotheses H2c and H2d.

We expected that Pipet would lead to more equal contributions of participants to the photo compilation. The percentage of pictures each participant contributed to the compilation was logged and this data indicates that indeed the contribution of each participant is more equal with Pipet. A fully equal contribution would imply an average contribution of 25% (100% / 4 group members). However, in C the contributions were significantly ($\alpha = .05$, $F = 7.05$, $p = .002$) less equal than in P (see Table 2). Therefore, we accept hypothesis H2a.

Furthermore, we expected that participants would perceive more control in P than in C. The mean scores (on a 7-point scale) for perceived control were 4.45 for the control condition and 5.09 for Pipet. A Wilcoxon signed ranks test showed that the perceived control with Pipet was significantly higher ($\alpha = .05$, $z = -2.040$, $p = .041$). Hence, the results of the questionnaire show that users indeed perceive more control with Pipet and support hypothesis H2b.

Additional findings

From the interviews we learned that participants appreciated the idea of collaboratively making photo compilations in a living room setting. Not the photo compilation itself, but rather the social and fun process of reminiscing was the key reason why they liked it.

Other applications of the Pipet concept were suggested by the participants, including video editing and file exchange between storage means. Another suggestion was to use Pipet for sucking up colours from objects in the environment and paint it as an artwork on the TV. Participants also mentioned using Pipet in public spaces, for example allowing people at a party to select songs from their portable music player and 'shoot' it to the DJ.

DISCUSSION

The Pipet prototype proved to be significantly more fun and useful than the control condition for collaborative photo compilation creation in the living room. Also the contributions of the participants were more equally distributed using Pipet and the perceived control for group members turned out to be higher.

The difference in satisfaction with the end-result and the group process turned out to be insignificant. For the end-result this could be due to the limited aesthetical and layout options available in both conditions, since the aim was to explore the merits of the interaction style. For the group process we observed a levelling effect in the groups of participants. For example, a dominant person preferred the control condition as she was in full control using the gyromouse, while a shy group member was left out. In the Pipet condition the dominant person was less satisfied with the group process since she had to share the control, while the shy person was more positive on the group process as she was more able to contribute to the compilation.

Although the UX research filed is expanding, methodologically the field is not mature yet [11]. Although the notion of co-experience ("experience that users themselves create together in social interaction") has been described [1], we are not aware of validated instruments to measure the user experience (UX) in settings where groups of friends or family interact with devices. Therefore, we used a measure for individual user experiences that has already been applied successfully in the domain of Information Systems [14]. However, we recommend future work on developing valid instruments to measure user experiences in groups for consumer products.

The number of participants was small which might have affected the results, in particular when looking at group processes. However, we did find significant differences between the two conditions for most hypotheses. Another limitation of the evaluation is the choice for the gyromouse as the control condition. The gyromouse was selected because it is commercially available and it is a new interaction style for most participants. It resembles the current single-user interaction style for sharing digital photos in a living room. Results might have been different if we would have used another control condition.

The Pipet prototype supported cross-device interaction between Windows Mobile smartphones and a Flash-based TV application. A commercial product will need to support a more diverse range of devices, including a variety of digital cameras, media players, laptops, tablet computers, PC's, and a plethora of smartphone variants (iPhone, Android phones, etc.). This brings additional technical complexity which is outside the scope of this paper. The complexity of setting up communication between various devices will hopefully be solved in the coming years through standardization efforts. However, the related user interaction complexity poses a worthy challenge for future investigation.

CONCLUSIONS

In this paper, we described our efforts in designing a cross-device interaction system supporting groups sharing photos and supporting reminiscing talk, following a user-centred design approach. We explored the design space and specified user requirements for such a system. Based on the requirements, we developed five interaction concepts. After evaluation of the five concepts, we decided to proceed with the Pipet concept. We developed a prototype and evaluated this with groups of friends that had been on holiday together in a realistic living room environment. The Pipet prototype proved to be significantly more fun and useful than the control condition (gyromouse) for collaborative photo compilation creation in the living room. Also the contributions of the participants were more equally distributed using Pipet and the perceived control for group members turned out to be higher. Hence, we conclude that we succeeded in designing a useful and fun interactive system that supports groups in sharing photos. The system allows seamless cross-device interaction and enables a physical interaction style ('suck-and-shoot'). We also demonstrated that Pipet resulted in more equal contributions of group members to the photo compilation, which makes it a truly collaborative process.

ACKNOWLEDGEMENTS

We thank TU/e Industrial Design's "/d.search labs", for helping to realize the Pipet prototype and all participants in the creative sessions and prototype evaluation.

REFERENCES

1. Battarbee K (2006) Co-Experience. Understanding user experiences in social interaction. Dissertation. 2nd ed. Univ of Art and Design, Helsinki.
2. Bruegger, P., and Hirsbrunner, B. Kinetic User Interface: Interaction through Motion for Pervasive Computing Systems. In Proceedings of Universal Access in HCI, Part II: intelligent and Ubiquitous interaction Environments (San Diego CA, July 2009), 297-306.
3. Dourish, P. Where the Action Is: The Foundations of Embodied Interaction, Cambridge, Massachusetts: MIT Press, 2001.
4. Eysenck, M. W., and Keane, M. T. Cognitive Psychology: A Student's Handbook, Hove, UK: Psychology Press, 2000.
5. Frohlich, D.M., Kuchinsky, A., Pering, C., Don, A., and Ariss, S. Requirements for photoware. In Proceedings of CSCW'02 (New Orleans, LA, 2002), 166-175.
6. Green S.G., and Taber, T.D. The effects of three social decision schemes on decision group processes. Organizational behavior and human performance 25 (1980), 305-317,
7. Hinds, P.J. User control and its many facets: A study of perceived control in human-computer interaction, Technical Report Hewlett-Packard Laboratories, UK, 1998
8. Hoven, E. van den, and Eggen, B. Informing Augmented Memory System design through Autobiographical Memory theory. Personal and Ubiquitous Computing 12, 6 (2008), 433-443.
9. Hoven, E. van den, Frens, J., Aliakseyeu, D., Martens, J-B., Overbeeke, K., and Peters, P. Design Research & Tangible Interaction. In Proceedings of TEI'07 (Baton Rouge LA, 2007), 109-116.
10. Jacob, R. J., Girouard, A., Hirshfield, L. M., Horn, M. S., Shaer, O., Solovey, E. T., and Zigelbaum, J. Reality-based interaction: a framework for post-WIMP interfaces. In Proceeding of CHI'08 (Florence, Italy, April 2008), ACM Press, 201-210.
11. Law EL-C, Vermeeren APOS, Hassenzahl M & Blythe M. Towards a UX Manifesto. Proc BCS HCI Group Conference 2007, Lancaster, UK. British Computer Society
12. Mazalek, A., and Hoven, E. van den. Framing Tangible Interaction Frameworks. In "Tangible Interaction for Design" a special issue of AIEDAM 23 (Spring 2009), 225-235.
13. Nacenta, M.A., Aliakseyeu, D., Subramanian, S., Gutwin, C. A Comparison of Techniques for Multi-Display Reaching. In proceedings CHI'05 (Portland, Oregon, USA, 2005), ACM Press, 371 - 380
14. Ogertschnig, M., and Van der Heijden, H. A short-form measure of attitude towards using a mobile information service. In Proceedings 17th eCommerce conference (Bled, Slovenia, 2004).
15. Rekimoto, J. Pick-and-Drop: A Direct Manipulation Technique for Multiple Computer Environments, In Proceedings UIST (Banff, Alberta, Canada, 1997), ACM Press, 31-39.
16. Rodden, K., and Wood, K. How Do People Manage Their Digital Photographs? In Proceedings of CHI'03 (Ft. Lauderdale FL, 2003), ACM Press, 409–416.
17. Ryokai, K., Marti, S., and Ishii, H.. I/O Brush: Drawing with Everyday Objects as Ink, In Proceedings of CHI'04 (Vienna, Austria, April 2004), ACM Press, 303-310
18. Scott, S. D., Grant, K. D., and Mandryk, R. L. 2003. System guidelines for co-located, collaborative work on a tabletop display. In Proceedings of E-CSCW '03 (Helsinki, Finland, September 2003), Kluwer Academic Publishers, 159-178.
19. Ullmer, B. and Ishii, H. Emerging frameworks for tangible user interfaces, IBM Systems Journal 39 (2000), 915-931.
20. Van Loenen, E., De Ruyter, B., and Teeven, V. ExperienceLab: Facilities. In Aarts, E. & Diederiks, E. (Eds.), Ambient Lifestyle: From Concept to Experience, BIS Publishers, 2006, 47-53.
21. Whittaker, S., Bergman, O., and Clough, P. Easy on that trigger dad: a study of long term family photo retrieval. Personal and Ubiquitous Computing 14, 1 (Jan. 2010), 31-43.
22. Zigelbaum J, Horn M, Shaer O, Jacob RJK (2007) The Tangible Video Editor: Collaborative video editing with active tokens. In Proceedings of TEI '07 (Baton Rouge, LA, USA, 2007) ACM Press, 43-46.
23. Zigelbaum, J., Vazquez, A., Kumpf, A., Ishii, H. Slurp: Tangibility, Spatiality, and an Eyedropper. In Proceedings of CHI'08 (Florence, Italy, 2008), ACM Press, 2565-2574.