Usability Guidelines for Co-Located Multi-User Interaction on Wall Displays

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Abstract
Today interactive wall displays can be widely seen in industry and research. Due to their size, these displays offer the opportunity for several users to interact co-located and simultaneously. An application supporting multi-user interaction has to be designed differently than traditional single-user interfaces, for example supporting several parallel workspaces or considering by-standers. The overall goal of this thesis is the development of usability guidelines for multi-user applications running on interactive wall displays. These guidelines should aid developers of future applications in ensuring a high multi-user usability. The research approach combines literature analysis with usability studies and controlled laboratory studies. The literature analysis and the usability study will identify aspects specific to multi-user usability. The laboratory studies will deepen the understanding of two selected usability aspects, with readability in a multi-user scenario being one of them.

Author Keywords
multi-user; interactive wall display; usability; guidelines.

ACM Classification Keywords
H.5.2. [Information Interfaces and Presentation (e.g. HCI)]: Ergonomics, Style guides

Introduction

Due to technological progress [19] and falling costs [7] interactive wall displays are readily available today. The displays have become pervasive [25] and can be found in research as well as in industry, in public, semi-public and private places. Due to their size these kind of displays offer the opportunity for several users to interact simultaneously and co-located [6, 25]. Multi-user interaction has several advantages: it fosters social interaction [6] and enables social learning as well as social experience [9]. Despite these advantages research focused on multi-user interaction, especially on the design of such applications, is still rare. Which design factors need to be considered when designing multi-user applications? There is no established set of guidelines for the design of public displays [2], nor can established design guidelines from the desktop be directly applied to multi-touch interfaces [8]. Designing for a great user experience (UX) of public display applications is important, as it might increase the usage motivation as well as extend the interaction duration [2]. In order to create a rich UX it is necessary to consider the specific display characteristics (e.g. size, orientation) [8]. In this context, this work aims at developing design guidelines for multi-user applications running on interactive wall displays, focusing on usability aspects. Usability is by definition part of the UX [1], improving the usability will also result in a better UX.

Related Work

Several design or usability guidelines for desktop applications exist, for example "The Research-Based Web Design & Usability Guidelines" [23] or ISO 9241. Together with Nielsen's usability heuristics [14] and Shneiderman's 8 golden rules [20] these principles or heuristics describe basic usability aspects and require interpretation when applied [5]. These general and device-independent guidelines offer orientation but do not consider specific characteristics of the targeted interface which is a necessary requirement for achieving an acceptable UX [8].

The guidelines for developing applications for Microsoft's Perceptive Pixel display [12] focus on wall displays. But in general industrial guidelines are optimized and targeted for their specific product and cannot be easily applied to other systems and devices [8]. Furthermore, industrial guidelines are usually based on experience rather than empirical evidence and the development process is not transparent.

Alt et al. [2] developed guidelines for the evaluation of public displays. The usability heuristics for large screen information exhibits [22] also support the evaluation of such applications. This work aims at supporting developers early, namely in the design phase. Furthermore, the specific characteristics of multi-user interaction were just marginally considered. Yuill & Rogers [25] developed a design and evaluation framework for collaborative multi-user applications. While collaboration is certainly important for multi-user interaction, it is just one aspect for the usability of such applications.

Research Questions

This thesis aims at answering the following questions:

- Which factors are influencing the usability of multi-user applications running on interactive wall displays?
- How to ensure high readability in a co-located multi-user scenario?

The first question aims at elaborating the specific characteristics of co-located and simultaneous multi-user interaction at wall displays, focusing on usability aspects. Which aspects have to be considered when designing such an application? Answering the first question will result in a set of

guidelines for the design of multi-user applications. As the developed guidelines will remain on an abstract level, two identified usability aspects will be selected in the course of the thesis and further investigated.

One already identified aspect is the need for ensuring good readability for by-standers as well as users directly interacting with the screen [17]. As can be seen in Figure 1, two users are interacting with the display while five by-standers are watching in different distances, respective in different interaction zones (see Figure 2). Users in the interaction zone are likely to be interested in details on one or more information particle(s) whereas by-standers in the communication or notification zone are more likely to be interested in getting an overview on the presented information. An application has to conform to the different needs of users in the various interaction zones. According to Vinot & Athenes [24] readability forms a relevant part of interface design. Furthermore, there is still a lack of research on dynamic text on (indoor) LED displays [21]. Therefore, the second question aims at deepening the understanding of one usability factor, namely readability. Answering the second question will provide detailed recommendations on how to ensure multi-user readability on wall displays. This will include (among others) information on font-sizes, text-moving direction, text moving speed and information density. Depending on the answer to the first question, a second key aspect will be chosen.

Methodology

In this section the research approach for developing usability guidelines for multi-user applications is described. Although heuristics and guidelines have a different aim, they do have similar content (design recommendations), with heuristics being more abstract and guidelines being more concrete, including examples and the context [3]. Based on

Figure 1: Multi-user interaction with the MeetingMirror

these similarities I follow the research approach of Paddison & Englefield [18] who suggest two methods for developing usability heuristics:

1. Research-based: analysing literature and deriving heuristics based on this analysis
2. Evaluation-based: summing up evaluation results in order to derive heuristics

Although I do not aim at developing heuristics, I combine these two approaches in order to develop guidelines. First, I analyse existing research, and second I conduct usability studies as well as controlled laboratory experiments focusing on aspects unique to multiple users interacting simultaneously with the display. Identification of the aspects unique to multi-user interaction will be done in a literature study complemented by a multi-user usability study of our existing MeetingMirror application [10] (see Figures 1, 3). The

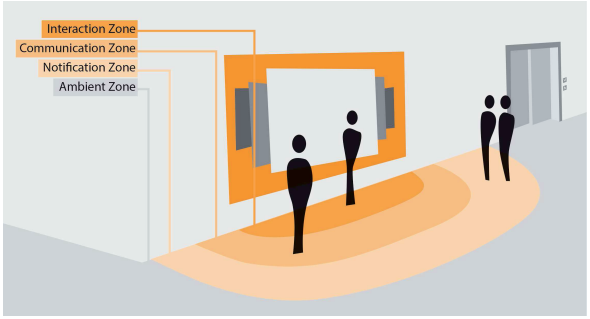

Figure 2: Interaction zone model [16]

Figure 3: Usability-study of the MeetingMirror

MeetingMirror is a suitable application for my evaluation, as it supports the simultaneous touch interaction of several persons. Users may explore the information space for themselves or collaboratively.

In several successive controlled laboratory experiments I aim to identify specific requirements regarding readability for users in different interaction zones, taking into account whether users are standing in front of the screen or walking past the screen.

Preliminary Results

At the moment, the literature study for design recommendations on multi-user applications on wall displays is almost finished. First results have been published in [15] and include e.g. "avoid the use of audio [22]" or "consider bystanders and offer supplementary value to them [13]".

Furthermore, a usability study of the afore mentioned MeetingMirror application was conducted, comparing single- and multi-user usage in a between-group design. We used think-aloud during a free exploration phase, tasks (time measurement) and a questionnaire (comprising amongst others of System Usability Scale (SUS) [4] and User Experience Questionnaire (UEQ) [11]) in order to get quantitative and qualitative results. We observed different group behavior during the multi-user interaction: no communication at all, just watching the second user (see Figure 3) or solving the tasks collaboratively. We found that the application does support multi-user interaction, but it has low usability (SUS score of 48 in both scenarios). The evaluation of this study is still work-in-progress. The same applies to controlled laboratory studies evaluating the influence of the text flow direction on readability in different interaction zones, again comparing single- and multi-user usage scenarios. With this study design I aim at extracting factors specific to multi-user usage.

Future Work

Future work includes evaluating and publishing the results of the already conducted user studies. Furthermore several controlled laboratory studies are in the planning phase.

Regarding readability the text moving speed will be evaluated next, focusing on a multi-user setting with participants standing in different interaction zones. Another study will focus on adapting font sizes to users in different interaction zones. In order to verify the results of the readability studies, the MeetingMirror application will be designed accordingly and evaluated (comparison current version with improved version). Furthermore the decision on the second usability aspect and its elaboration is also future work.

Expected Contributions

The contribution of this research is an overview on usability aspects relevant to multi-user interaction on wall display applications. This will support developers of future applications in avoiding typical usability problems. It will also contribute to the research on multi-user readability on wall displays, naming relevant factors and providing concrete design examples. Furthermore this thesis will deepen the understanding on characteristics specific to co-located and simultaneous multi-user interaction.

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