Visual Audience Moderation: Actively Shaping User Constellations to Improve Touchless Interaction with Public Displays

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Abstract
Touchless user interfaces are a promising way to let passers-by interact with public displays, but they have to cope with complex social constellations of multiple and novice users. In this paper we discuss how public displays offering touchless interaction can subtly direct individual users and thereby actively shape audience constellations by visual stimuli, thus improving parallel usage and the dynamic of interaction. As a starting point we present our findings from a field study on how a display can direct its users and dissolve crowds by using dynamic visual signifiers. At the workshop we would like to discuss how further touchless applications could benefit from visually moderating their audience.

Author Keywords
Social interaction; touchless NUI; adaptive displays; public displays.

Introduction
Touchless user interfaces, such as the ones made possible by *Microsoft Kinect* devices, let users interact with the physical world in a more accessible and natural manner by just using their arms, legs, hands, feet, as

Figure 1. Challenges with touchless NUIs in public spaces: typical by-standing and crowding effects of pairs and groups. Such social constellations can lead to active users impeding each other and prevent passive members from taking an active part.

well as their body position. This makes them promising for applications in public spaces, where passers-by can immediately use them. Yet, after users have been attracted to an interactive public display and started engaging, touchless techniques also have to cope with more complex situations than in expert working or home environments: Users in urban spaces show behaviors and social constellations that prevent to fully exploit such per se well-performing technologies. To create favorable conditions for touchless interaction and improve the effectiveness of applications, we propose that public displays subtly direct individual users and actively shape audience constellations by visual stimuli, thus reversing the notion of adaptive content just being manipulated by explicit or implicit user behavior.

Challenges for Touchless Public Interaction

Beyond environmental conditions such as lighting, touchless user interfaces in public have to consider the specific social situations, and the fact that novice users don't know about the initial premises of the contents:

Social Constellations in Public Space

With expert and habitual use of touchless devices, e.g. when playing Kinect games in the living room, one or two active users know how to position and orient or they follow the instructions on the screen. In shops sometimes floor markers are used to signal the optimal position for starting touchless interaction. Yet in public space, singles, pairs and larger groups of passers-by usually are novice users that arrive at the public display at different points in time, stop at various positions, assume different user roles (active user or passive bystander), position themselves in different body orientations and group formations, and show social behaviors such as embracing each other or deliberately performing for others [3]. Large public displays also offer extended interaction spaces for multiple users, enabled by multiple Kinect sensors (see e.g. [1],[2]). Yet, instead of using all of the available interaction space, we observed that groups and pairs often *crowd together*. This can be attributed to bystanders watching the initial user from close positions behind or next to the user, often resulting in L-shaped formations [4]. Usually these close bystanders do not distribute along the display to take an active part. In cases where passive members join the interaction, they often don't detach from the crowd and ignore other users, thereby interfering with and occluding others (see Figure 1). Instead, it would be preferable if users picked positions where they and others have sufficient space to interact, and also if they would free space for new arrivers.

Requirements of Specific Contents

In addition to the inherent social complexities in public space, certain touchless contents may require specific user constellations and starting positions unknown to arbitrary passers-by. For example, we observed that pairs playing interactive ball games in front of public displays had adjusted the distance between each other, so that they could comfortably pass the ball. Some cooperative applications may also require a close distance between users, while others may need space for detached users performing wide-reaching gestures. Further applications may require a minimum number of users to work properly. Also, user positions may have to be changed if further potential players are arriving.

Thus, if the conditions for convenient simultaneous interaction or the start conditions for cooperative applications do not emerge spontaneously, the display itself may become active to increase its effectiveness.

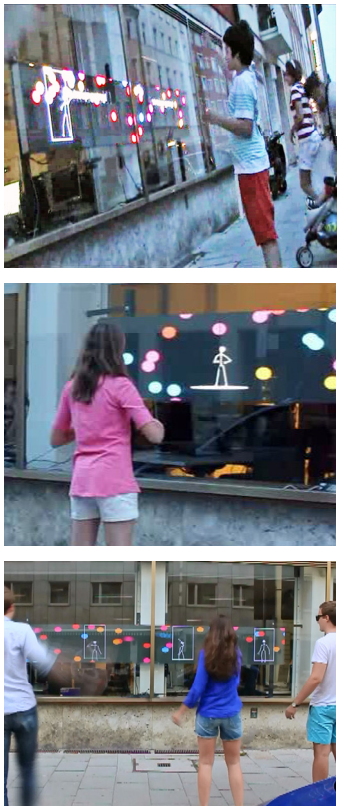

Figure 2. Different visual signifier strategies to actively influence user positions and regulate audience constellations in front of a wide banner display: *Frame* as visual positioning stimulus (top), *Ellipse* signifier resembling spotlights on a floor (middle), and *Multiple Dynamic Frames* to direct and distribute multiple users (bottom).

Visual Audience Moderation

As public interaction is characterized by spontaneous and constantly changing situations with multiple users, neither explicit instructions such as text messages that have to be interpreted, nor static and inflexible floor graphics are an adequate way to address individual users and bring them to adjust their positions and distances. Instead, subtle mechanisms should be used that seamlessly integrate into the flow of play and are immediately and intuitively understandable by users. We call the idea of actively influencing user positions and regulating audience constellations in front of public displays by visual signifiers and dynamic strategies for displaying them *visual audience moderation*.

User Positioning, Repositioning and Distribution Tasks

This process of active behavior management poses the following basic problems: First, visual signifiers must be able to effectively *draw arriving users to arbitrary positions* they would not have chosen themselves. For this, they must be wittingly or unwittingly understood and immediately accepted by users. Then, when a user already interacts with the display, it might become necessary to *reposition* him or her in order to free space for new arrivers. In this case signifiers should be able to make users step aside and clear the needed space. Third, visual signifiers should manage to dissolve crowds caused by bystanders gathering around an active user, and *distribute the audience* more equally. This may be achieved by guiding single users towards empty spots, but also by more undirected signals addressing the entire crowd. If these basic goals are accomplished, dynamic visual signifiers might also be used to shape specific audience constellations, e.g. direct active users until a minimum distance between them or a required number of players is attained.

Case Study: Actively Shaping the Audience in front of a wide Interactive Banner Display

In the following we describe our experiences with a wide interactive banner display with which we conducted two long-term field studies on active behavior shaping and visual audience moderation [1].

City Environment and Technical Setup

The interactive banner display is a wide display installed at a city sidewalk in a lively shopping and nightlife district in Munich. Its format is inspired by classical paper banner displays. To enable interaction for the complete interaction space, two *Microsoft Kinect* sensors were installed below the display with overlapping sensor ranges in the center. Several interactive applications have been developed for this banner display to first attract passers-by approaching sideways, and then to actively influence user positions and regulate audience constellations of users who had already stopped and engaged frontally with the display.

Static, Moving and Interactive Visual Signifiers

We observed the described patterns of users crowding together instead of using the available free space also in front of the banner display, which led to active group members impeding each other and also preventing passive members from taking an active part. To resolve such crowding effects and to explore if user positions could be subtly directed by visual stimuli, we developed different static, moving and interactive *visual signifier strategies* to position, reposition and distribute users. Also, visual signifiers have to be a behavior-effective positioning stimulus. We used *visual frames*, for which we had found unwitting positioning effects in [2], and now displayed them dynamically on the screen. Another representation we used were *ellipses* (see Figure 2).

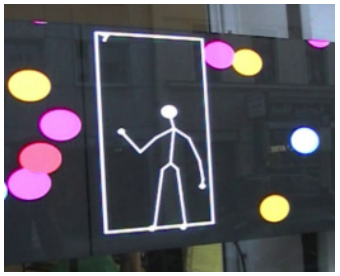

Figure 3. Improving the positioning stimulus by additional functionality: frame with a game counter in the top left corner.

Field Study comparing different Signifier Strategies
To test the effectiveness of different signifiers to direct users, we conducted a field study of five weeks. The study showed that visual moderation is an effective technique to direct users to arbitrary positions in front of the display and to actively shape the audience. Users accepted immediately and willingly this manipulation of their behavior. We found that *ellipses* generated the most effective positioning stimulus and *static frames* were also very effective. *Moving* and *strongly dynamic* signifiers also led to more distribution of the audience along the display, but users were not willing to repeatedly follow moving frames. In pairs or groups of users, we observed that social pressure often pushed one user into a *performer role* in front of the signifiers.

Further Signifier Techniques

As a next step we propose to enhance such dynamic visual signifier strategies with the following techniques:

Visual Signifiers with Additional Functionality
The performance of moving frames can be improved by augmenting them with additional functionality such as a game counter (see Figure 3). If users perceive such an obvious advantage of standing in front of the signifier, this may increase the positioning stimulus.

Additional Visual Cues as Attention Spotlights
Further, additional visual cues could improve the effectiveness of the tested *positioning stimuli*, such as the exogenous and endogenous cues for shifting the attention of users to spatial spotlights explored by [5]. Comparably, if current users in front of the screen have to be repositioned, instead of moving the frames arrows pointing to the frames or flashing frames could be used to *first direct the attention* to them.

Conclusion and Future Work

In this paper we discussed how touchless interaction in public space with sensor systems such as Kinect can be improved by actively moderating user constellations. In a field study we have already found that users can be influenced in their positioning behavior and audiences be distributed more evenly with different dynamic strategies for displaying visual signifiers. In this way visual moderation can be used to create sufficient space for touchless natural interaction in public settings, make it more convenient and encourage the dynamic of interaction. If more people interact, groups may also stay longer in front of public displays at last. Future work could investigate if actively created public audience constellations could trigger engagement and improve the performance of more complex collaborative applications such as interactive multiplayer games.

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