
Addressing Challenges in Crowded Proxemics-Aware Installations

Jo Vermeulen

Hasselt University – tUL - iMinds
Expertise Centre for Digital Media
Diepenbeek, Belgium
jo.vermeulen@uhasselt.be

Karin Coninx

Hasselt University – tUL - iMinds
Expertise Centre for Digital Media
Diepenbeek, Belgium
karin.coninx@uhasselt.be

Kris Luyten

Hasselt University – tUL - iMinds
Expertise Centre for Digital Media
Diepenbeek, Belgium
kris.luyten@uhasselt.be

Nicolai Marquardt

University College London
UCL Interaction Centre
Gower Street
London, UK
n.marquardt@ucl.ac.uk

Abstract

Proxemic interactions are one strategy for designing Natural User Interfaces (NUI) that consider people's use and understanding of spatial relationships to other people, objects, and devices. In this position paper, we stipulate a number of challenges for proxemics-aware installations that are used by large crowds of people.

Author Keywords

Proxemic interactions, crowds, multi-user, public displays, feedback, orchestrating interactions.

Introduction

Towards the design of natural user interfaces in everyday environments, proxemic interactions [4] propose leveraging people's use and understanding of spatial relationships in interaction design. Proxemic interactions envisions (ensembles of) devices that use fine-grained tracking of proxemic dimensions (distance, orientation, location, movement and identity) to mediate interactions. These interaction concepts can be applied in a variety of contexts: e.g., facilitating people's interaction with a large screen media player [4], coordinating sense-making activities [6], or supporting small-group collaboration through cross-device interactions [8].

While these installations are typically used by small groups of people, a significant number of the proximity-aware systems being deployed today are exhibited in front of much larger crowds: interactive displays in

public spaces. Moreover, due to their public setting, not everyone who is near to these installations notices the display [5] or wants to actively engage with it [3]. In these situations, we cannot just interpret a person's proximity, orientation or approach as a sign of interest. Additionally, users might perform social gestures in these settings that could be misinterpreted by the system [10].

In this position paper, we highlight a number of challenges that emerge when scaling proxemic interactions to large crowds of people. For each of these challenges, we pose a number of open questions that could stimulate possible discussions at the workshop.

Mapping Feedback to Individuals

One of the design challenges in ubicomp systems is providing sufficient feedback to users, so that they know that the system is responding to their inputs or that it is performing the intended action [2]. We argue

that providing this kind of feedback becomes even more important for proxemic interactions deployments that will be used by large crowds of people in public settings, due to the increased complexity of tracking and the difficulty of providing feedback without disturbing or overwhelming other users. Especially important goals for feedback in these settings are enabling users to avoid *accidentally addressing* the system [2] and opt-out of interacting with it [7].

The following challenges are in particular important for supporting feedback in proxemics installations for large crowds.

Identification and status – How can users be informed when they are being tracked, so that those who do not wish to engage with the system can avoid doing so and opt-out? How do we indicate what groups of users are tracked, and which group individual users belong to? How do we convey events such as formation, merging, and breaking up of groups [1]?

Reliability of tracking – How can the reliability of the tracking be conveyed to users in an unobtrusive way? How can users be informed of the inability of the system to track them when there are just too many users in front of the display (due to occlusion, which is more likely to occur in crowded environments, or a technical tracking limit of n number of users)?

Features – How can the system demonstrate which of people's movements/gestures are being tracked by the system (e.g., proximity, orientation, identity)? How can users be informed about zones in which interaction is possible, especially in the presence of other people [7]? What kind of feedback has to be shown per individual

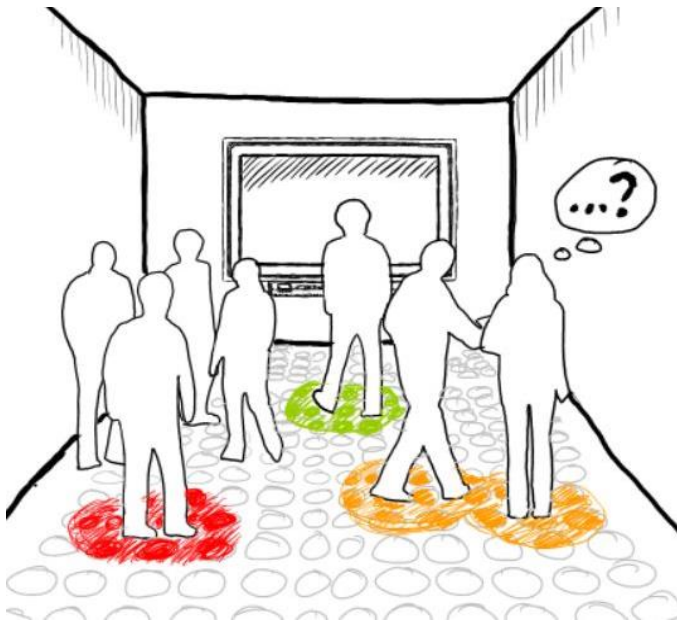


Figure 1. A crowd of people in front of a proxemics-aware installation: (left) occlusion prevents a person from interacting, (center) another person is approaching the display to interact, and (right) the system provides feedback about small group formation.

and which ones can be shown to the group? Can we use strategies of feedforward [12] to show people what will happen when they perform an action (e.g., approaching another person or group)?

As part of our ongoing research, we are currently investigating different strategies for providing peripheral feedback to both individuals and the group. We use in-situ visualizations in a floor display, which allows individual feedback to be provided without disturbing other users, while other feedback can be shown to the group when using the remaining interaction area or situated large displays.

Orchestrating Group Interactions

A second challenge is how systems can support groups to orchestrate the different individual and group interactions. In large crowds of people, there are bound to be situations where a user is unable to interact with the display, or where one user or a group is in control. This could be because others are either blocking access to the display, or because they occlude the user and inhibit her from being tracked correctly. We put forward a number of challenges regarding orchestrating interactions for proxemics-aware installations for large groups.

Floor control – becomes challenging when proxemics is scaled to larger groups of people. Systems might rely on existing social protocols to indicate who is in control (e.g., the user who is occluding the other person's view, or the one who is nearest to the display [4]). However, studies on tabletop group usage suggest that these social protocols are not sufficient to coordinate the actions of groups of users [9]. What are possible multi-user or crowd floor-control strategies?

Encouraging interactions – How can a system encourage interactions between individuals and groups of people (e.g., to accomplish tasks together)?

Conflicts – Can conflicts be automatically detected or resolved using proxemics? How do the rules of proxemics come into play?

Social Embarrassment and Awkwardness

Several studies have found that users interacting with interactive displays in public settings exhibit fear of social embarrassment [3,11]. Users tend to be aware of their role as a *performer* when interacting with a display [7], or might feel that they are blocking other people's access to the display [11]. People often do not expect displays to be interactive [11], and may be surprised when it does interact to their presence. When users do realize that a display has interactive capabilities, there are still potential issues that cause them to refrain from interacting with it, such as uncertainty about what they can do (*interaction possibilities*) and uncertainty about the available *recovery mechanisms* when they would make a mistake [11]. Providing sufficient feedback about tracking and implications of user actions, as discussed before, is a first step towards addressing this challenge.

Again, we propose a number of open questions for dealing with social embarrassment in proxemics installations for large crowds:

Awareness of others – Would making users aware of the presence of others help overcome social embarrassment?

Friends vs. strangers – What problems arise when proxemic interactions are used among groups of people that do not know each other very well, and how does this differ from groups of friends?

Creating awkward situations – In which situations might it be useful to deliberately create awkward situations (e.g., to trigger conversation or make room for other users).

Conclusion

We have discussed a number of challenges and open questions for scaling proxemic interactions to large crowds of people, centered on mapping feedback to individuals, orchestrating interactions, and social embarrassment. While there are other technical and interaction challenges that need to be addressed, we believe these three aspects are particularly important for supporting and enticing social interactions with proxemics-aware setups in large crowds.

References

- [1] Azad, A., Ruiz, J., Vogel, D., Hancock, M., and Lank, E. Territoriality and Behaviour on and Around Large Vertical Publicly-shared Displays. *Proc. DIS '12*, ACM (2012), 468–477.
- [2] Bellotti, V., Back, M., Edwards, W.K., Grinter, R.E., Henderson, A., and Lopes, C. Making sense of sensing systems: five questions for designers and researchers. *Proc. CHI '02*, ACM (2002), 415–422.
- [3] Brignull, H. and Rogers, Y. Enticing People to Interact with Large Public Displays in Public Spaces. *Proc. INTERACT '03*, (2003).
- [4] Greenberg, S., Marquardt, N., Ballendat, T., Diaz-Marino, R., and Wang, M. Proxemic interactions: the new ubicomp? *interactions 18*, 1 (2011), 42–50.
- [5] Huang, E.M., Koster, A., and Borchers, J. Overcoming Assumptions and Uncovering Practices: When Does the Public Really Look at Public Displays? *Proc. Pervasive '08*, Springer-Verlag (2008), 228–243.
- [6] Jakobsen, M.R., Sahlemariam Haile, Y., Knudsen, S., and Hornbæk, K. Information Visualization and Proxemics: Design Opportunities and Empirical Findings. *IEEE Transactions on Visualization and Computer Graphics 19*, 12 (2013), 2386–2395.
- [7] Jurmu, M., Ogawa, M., Boring, S., Riekkki, J., and Tokuda, H. Waving to a Touch Interface: Descriptive Field Study of a Multipurpose Multimodal Public Display. *Proc. PerDis '13*, ACM (2013), 7–12.
- [8] Marquardt, N., Hinckley, K., and Greenberg, S. Cross-device Interaction via Micro-mobility and Formations. *Proc. UIST '12*, ACM (2012), 13–22.
- [9] Morris, M.R., Ryall, K., Shen, C., Forlines, C., and Vernier, F. Beyond “Social Protocols”: Multi-user Coordination Policies for Co-located Groupware. *Proc. CSCW '04*, ACM (2004), 262–265.
- [10] O’Hara, K. Interactivity and Non-interactivity on Tabletops. *Proc. CHI '10*, ACM (2010), 2611–2614.
- [11] Ojala, T., Kostakos, V., Kukka, H., et al. Multipurpose Interactive Public Displays in the Wild: Three Years Later. *Computer 45*, 5 (2012), 42–49.
- [12] Vermeulen, J., Luyten, K., van den Hoven, E., and Coninx, K. Crossing the Bridge over Norman’s Gulf of Execution: Revealing Feedforward’s True Identity. *Proc. CHI '13*, ACM (2013), 1931–1940.