Keeping It Private: An Augmented Reality Approach to Citizen Participation with Public Displays

Callum Parker
Faculty of Architecture, Design and Planning
The University of Sydney
NSW 2006 Australia
cpar9842@uni.sydney.edu.au

Judy Kay
Faculty of Engineering and IT
The University of Sydney
NSW 2006 Australia
judy.kay@sydney.edu.au

Martin Tomitsch
Faculty of Architecture, Design and Planning
The University of Sydney
NSW 2006 Australia
martin.tomitsch@sydney.edu.au

Matthias Baldauf
Research Group for Industrial Software (INSO)
Vienna University of Technology
Wiedner Haupstr. 76/2/2
1040 Vienna, Austria
matthias.baldauf@inso.tuwien.ac.at

Ubicomp/ISWC '15 Adjunct, September 7-11, 2015, Osaka, Japan.

ACM 978-1-4503-3575-1/15/09…$15.00.
http://dx.doi.org/10.1145/2800835.2804401

Abstract
With the availability of displays in public space increasing, they have been proposed and studied as platform for civic engagement. Due to their situated nature, public displays have the potential to enable a larger cross-section of the public to participate in community consultation processes, compared to focus groups or online surveys. Previous research has investigated a range of interaction methods for enabling this form of citizen participation with public displays. Through an analysis of related work we identified four main categories of interaction methods: remote indirect, kiosk, mid-air gestural and mobile. In this paper we propose a formerly introduced interaction method, based upon mobile augmented reality, which promises to enable pervasive participation by making interactions more private and simultaneous, through a familiar and convenient interface.

Author Keywords
Pervasive displays; pervasive participation; community engagement; civic computing; mobile augmented reality.

ACM Classification Keywords
H.5.2. [Information interfaces and presentation]: User Interfaces: *Input devices and strategies, Interaction styles*

Introduction

Digital public displays that accept input are beginning to become commonplace these days, as the costs of touch screens are decreasing and basic input devices, such as smart phones, are becoming more affordable and ubiquitous. Public displays offer opportunities to make contextually relevant information or a message known to the broad public within a specific location.

In the case of promoting community engagement, digital public displays are used to display topics of civic interest or to publicize changes that may affect the community and its immediate environment [7]. A study by Hespanhol et al. [6] found that the use of interactive digital public displays is not only able to give the community a voice, but also entices people to participate in the consultation process. Additionally, works by Ackad et al. [1] and Michelis et al. [8] demonstrated that interactive displays have the ability to draw attention, increasing the rate of passers-by becoming actively involved with the display.

However, an underlying issue that has plagued interactive displays is privacy [3], as people may not appreciate their interactions being publicly visible to passers-by and bystanders. This is particularly an issue when asking people to vote on sensitive topics using a public community engagement interface [6]. Related to the issue of privacy is the observation that participants worry about the security of their personal information [2]. People may further be afraid to fail to understand how to use a display, leading to a phenomenon coined social embarrassment [5].

This paper extends previous research on community engagement with public displays through an analysis of current interaction techniques and their potential for pervasive participation. We further propose a new method for interacting with digital public displays based on mobile augmented reality, which allows for multiple users to interact simultaneously while retaining privacy.

Interactions with Digital Public Displays

Four main interaction methods are described in the following sections. These were chosen to categorize interactions that have commonly appeared in previous research. The table below (Table 1) gives an overview of the privacy (Poor, Good), proximity (Near, Far) and accessibility(Low, Medium, High) offered by each interaction method. Additionally, a correlation exists between proximity and accessibility, where interactions from afar are able to support multiple users.

Interaction method	Privacy	Proximity	Accessibility
Remote indirect	Good	Far	Medium
Kiosk	Poor	Near	Low
Gestural	Poor	Near	Low
Mobile	Good	Far	High

Table 1. Overview of interaction methods with ratings.

Remote indirect interaction

This form of interaction does not necessarily require the user to be in close proximity of the display, interaction can be performed from another location.

An example of such a system utilizing this interaction method was presented by Munson et al. [9], who developed and tested a public display called the "Thank You Board", which allowed people within the university to post thank you notices to other colleagues using a specified web site that they could access from their personal desktop computers or mobile devices. An issue found with this system however was that people did not appreciate posting from a web browser as it was slow to load the web page on a mobile device and accessing it from a computer was inconvenient.

Kiosk interaction

This is a direct form of interaction, the user needs to be standing in front of the display to interact. Although itis familiar to many users since the advent of portable touch screen devices, such as the iPad, it still has the inherent issue of privacy. This point was resonated by users of public touch displays that were used in a study in Oulu, Finland [2], which displayed local user-generated advertisements such as jobs, items for sale, and events. Users felt uncomfortable viewing and inputting personal contact information, such as their email address, in case of onlookers.

Screen size can also limit touch interaction. As digital public displays need to spread a message, making the display larger can increase the chances that the display is seen. However, touch screen interaction at large-scale displays is either impossible or difficult for users to interact with onscreen elements and it also makes it harder to take all the content in when a person is standing close to such a large display [13].

An alternative method of direct interaction allowed people to use their feet to vote on questions displayed on a large screen was presented by Steinberger et al. [12]. Users could step on tangible answer buttons, representing yes and no, to submit their vote. Although this method made it easier to participate, there were still concerns about privacy when it came to sensitive topics.

Kiosk interactions therefore are a direct form of interaction that provides little to no privacy and are inherently limited by the available screen space.

Mid-air gestural interaction

This type of interaction can be used to effectively grab the attention of passers-by and engage them with potentially playful interactions that require no contact with the screen.

Media Wall, a digital public display situated at a busy area of a university campus, utilizes the 3D tracking capabilities of the Microsoft Kinect to allow mid-air hand gestures that control the navigation of the interface [1]. The gestures consisted of hand swiping (left or right) for navigating through the interface horizontally and raising hand (up or down) for vertical navigation. It displayed content related to the university and a tracking skeleton (Figure 1) that mimicked the movement of the person being tracked, which can get the attention of passers-by. Additionally, a banner message would follow passers-by letting them know the screen is interactive.

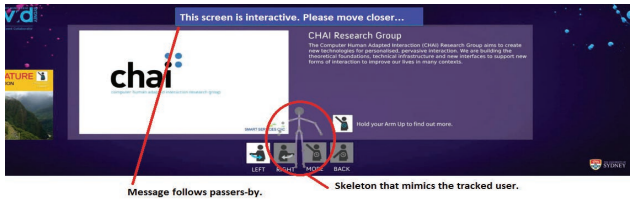

Figure 1. Media Wall - a Kinect controlled projected interface that uses on-screen elements that react to the people either standing in front or walking past. (Image adapted from Ackad et al.)

Hespanhol et al. investigated the use of gestures as an expression of full-body interaction, for engaging people on local issues that affect their community [6]. Their study found that the interaction with a camera feed that allowed passers-by to vote on issues by standing on a certain side of the screen, depending on which way they wanted to vote, increased participation as the interaction offered a more playful interface compared to a kiosk-type iPad setup. However, the iPad interface offered people some privacy and allowed them more time to consider their answer. Therefore, for people to notice the display and motivate them to use it, the researchers recommended that real time feedback and tangible or full-body interaction be utilized with just enough playfulness. The results match outcomes of previous research by Tomitsch et al., which found that having playful elements attracts users and that they can eventually become active users after they have finished exploring the interface through play[13].

Valkonova et al. [14] presented a Kinect controlled polling system called "MyPosition" which allowed people to vote on certain topics by positioning themselves in front of their preferred answer and raising their hand to vote. It was found that such interactive visualizations can promote civic discussion on the topics.

Therefore, mid-air gestures are an effective method of gaining attention from passers-by due to the computer vision technology that can make them reactive [8]. However, the interactions are still public, which means that the user's choice when voting on an issue for instance, is seen by everyone that may be watching, which may not be desirable if it is a sensitive issue [14].

Mobile interaction

Interaction with a digital public display using a mobile device is promising method allowing multiple people to interact with a display at once while retaining privacy.

Mobile interaction with public displays is indirect and can be used by a large number of people. An example of such a system was presented in a study by Schoeter et al. [11], which found that SMS and Twitter interaction with a public display enabled citizens to voice their opinions on certain topics related to the community. This method made participation more accessible as SMS is available with any mobile phone.

Baldauf et al. studied mobile augmented reality (AR) to enable public, private displays [3]. By pointing their smart phone's camera at the digital public display, the user can open and play videos by tapping on their smartphone's screen and the video would then proceed to play on their device. To contrast, a competitive mode was included as another condition where the videos would play on the public display. However, playing videos on the smartphone was preferred, as users did not appreciate competing with one another.

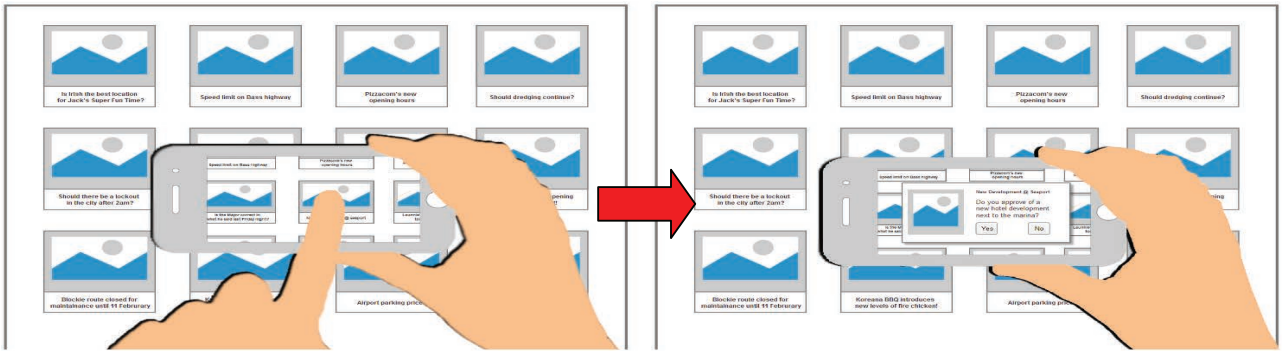

Figure 2. Concept design of the mobile AR interaction. The user points their smartphone at the public display to interact.

Therefore, interaction with public displays using mobile devices provides a higher level of privacy than direct interaction methods. Additionally, it enables multiple users to participate at the same time.

Augmented Reality for Enabling Direct Mobile Interaction

An issue that both touch and mid-air gestural interaction share is the potential for breaches of the user's privacy [2][11]. Remote interaction and SMS resolve that issue but only allow one-way communication, such as posting content to the display. Baldauf et al. [3][4] suggest that smart phone interaction via augmented reality (AR) provides the following benefits: (1) it retains privacy; (2) it allows for multi user interaction; and (3) it supports bi-directional interaction (posting and pulling information).

Smart phone interaction can essentially allow interaction with digital public displays from the comfort of a user's own device. Although SMS interaction also allows for this, AR can potentially allow for personalized and relevant information to be overlaid. Additionally, potential exists for users to take information from the display to view it later [4].

We propose to apply the formerly introduced interaction with digital public displays, mobile AR, to enable pervasive participation, as it solves issues present in the other interaction methods. This interaction method utilizes a smart phone and AR overlay to enable a private experience at a public display at the exclusion of others, therefore enabling multi-user interaction. As shown in Figure 2, while the AR app is open users can point their smart phone's camera at the public display, which uses an AR marker as the background with enough features to be tracked reliably [10]. Virtual tiles will be overlaid over the smart phone's camera feed and if the user taps one of them it will open a virtual popup window on the smart phone for the user to read more or vote on a particular issue. The virtual items displayed do not necessarily need to be the same as the ones on the display, they could potentially be personalized according to the interests of the user based upon a predefined profile, which may potentially incline them to participate.

Although this method still has inherent issues with shoulder surfing [3] if the user is standing in a busy area, it supports multiple users and provides both grabbing and pulling of information from a public display, which will likely convenience users, potentially leading to greater participation.

Discussion and Conclusion

In this workshop paper, we have discussed four different types of interaction with digital public displays. Smartphone AR was proposed as a method that enables pervasive participation while preserving privacy, allowing multiple users, and potentially personalizing content according to user interests. Additionally, this method is likely to be highly convenient due to its capability to run on portable devices. Therefore, smart phone AR has been proposed as showing great potential for enabling pervasive participation.

References

1. Ackad, C., Wasinger, R., Gluga, R., Kay, J. and Tomitsch, M. 2013. Measuring Interactivity at an Interactive Public Information Display. *In Proc. OzCHI 2013*, 329-332.
2. Alt, F., Kubitza, T., Bial, D., Zaidan, F., Ortel, M., Zurmaar, B., Lewen, T., Sahami Shirazi, A. and Schmidt, A. 2011. Digifieds : Insights into Deploying Digital Public Notice Areas in the Wild. *In Proc. MUM 2011*, 165-174.
3. Baldauf, M.,Lasinger, K. and Frohlich, P. 2012. Private Public Screens – Detached Multi-User Interaction with Large Displays through Mobile Augmented Reality. *In Proc. MUM 2012*.
4. Baldauf, M., Lasinger, K. and Frohlich, P. 2012. Real- World Drag ’ n ’ Drop - Bidirectional Camera-based Media Transfer between Smartphones and Large Displays Handheld-based Screen Interaction. *In Proc. Pervasive 2012*.
5. Brignull, H. and Rogers, Y. 2003. Enticing People to Interact with Large Public Displays in Public Spaces. *In Proc. INTERACT 2003*.
6. Hespanhol, L., Tomitsch, M., McArthur, I., Fredericks, J., Schroeter, R. and Foth, M. 2015. Vote As You Go: Blending Interfaces For Community Engagement Into The Urban Space. *In Proc. Communities & Technologies 2015.*
7. Kostakos, V. and Ojala, T. 2013. Public Displays Invade Urban Spaces. *IEEE Pervasive Computing,* 12(1), 8-13.
8. Michelis, D. and Müller, J. 2011. The Audience Funnel: Observations of Gesture Based Interaction With Multiple Large Displays in a City Center. *International Journal of Human-Computer Interaction*, 27(6), 562-579.
9. Munson, S., Rosengren, E. and Resnick, P. 2011. Thanks and Tweets: Comparing Two Public Displays. *CSCW 2011*, 331-340.
10. Qualcomm. 2014. Vuforia Augmented Reality for 3D Mobile Content | Qualcomm Vuforia. Retrieved June 16, 2015 from: https://www.qualcomm.com/products/vuforia
11. Schroeter, R. and Foth, M. 2009. Discussions in space. *In Proc. OZCHI '09*.
12. Steinberger, F., Foth, M. and Alt, F. 2014. Vote With Your Feet: Local Community Polling on Urban Screens. *In Proc. PerDis '14*,1-6.
13. Tomitsch, M., Ackad, C., Dawson, O., Hespanhol, L. and Kay, J. 2014. Who cares about the Content? An Analysis of Playful Behaviour at a Public Display. *In Proc. PerDis'14*.
14. Valkanova, N., Walter, R., Vande Moere, A. and Muller, J. 2014. MyPosition: Sparking Civic Discourse by a Public Interactive Poll Visualization. *In Proc. CSCW '14*.