

Hide and Seek: Exploring Interaction With Smart Wallpaper

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ABSTRACT

Displays are getting larger, thinner, and are consuming less power. The logical conclusion of this trend is a future in which wall-size displays are common in homes, a concept we have described as ‘smart wallpaper’ for the purposes of evaluating its HCI implications. What new kinds of experience could smart wallpaper provide? This paper describes a case study on one potential smart wallpaper experience: an interactive children’s game. Our results suggest that children and their families see substantial value in both the game and the concept of smart wallpaper. They valued the immersion, the physical activity and the shared nature of the experience. On the basis of this study, we conclude that there is substantial potential for wall-size displays to enable valuable experiences for children and their families, and that smartphones can be used as an intuitive means of interacting with them.

Author Keywords

Smart wallpaper; large displays; children’s game.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

Displays are evolving. They are getting thinner, more flexible, and consuming less power in operation. Should this trend continue, wall-size displays could become common in homes. As a result, there has been a surge of interest in exploring the kind of experiences wall-size displays could provide in the home.

Indeed, researchers are starting to explore how television can literally spill beyond its rectangular bounds and onto the surrounding walls. For example, the BBC’s Surround

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Video prototype used projection to extend the field-of-view of a television user [10]. This was achieved by projecting a ‘surround’ image onto the walls in the room, aligned suitably with the television so as to extend the view of the scene. The prototype had the express aim of deepening the feeling of ‘immersion’, as have prototypes like Infinity-by-Nine [9] and IllumiRoom [7].

The IllumiRoom consisted of peripheral projected illusions aiming to negate, include or augment the physical environment around a TV screen. This was done specifically with gaming in mind. RoomAlive [8], the evolution of IllumiRoom, takes this idea a step further by removing the television altogether and considering how projection techniques could turn any room into a gaming environment. RoomAlive allows users to touch, shoot, stomp, dodge and steer game elements that have been projected onto the physical environment.

Researchers of unconventional displays are not only interested in the sorts of entertainment experiences wall-size displays in the home could provide, but also the way in which they could become embedded into our everyday lives. For example, SurroundWeb explored using wall space to enable webpages to be experienced outside of the usual screens. [12].

As such, we can see that researchers are anticipating the arrival of wall-size displays in the home and are beginning to investigate what implications this has, both technically and experientially. For our own investigation we have detailed the specific concept of ‘smart wallpaper’ and developed a prototype to consider and evaluate the HCI of wall-size displays in homes [2]. Smart wallpaper is a vision of the future where it is possible to decorate the walls of your home with electronic wallpaper and personalise them at will. The obvious questions that arise from this vision are:

1. What kinds of experience could smart wallpaper provide?
2. How will people interact with smart wallpaper?

The prototype system we use to simulate smart wallpaper consists of two very large projection screens arranged to form the two walls of a room, with furniture arranged between them to mock up a futuristic living room. In this way, we can prototype potential smart wallpaper

experiences and use this setup to run user studies, putting the experiences under the microscope and answering our research questions.

This paper describes a case study we carried out on one such smart wallpaper experience: an interactive children's game played over smart wallpaper.

CASE STUDY: HIDE AND SEEK

The game is based on the children's game 'Hide and Seek' and involves characters hiding in a stylised landscape. This landscape is rear-projected onto the two large projection screens that make up smart wallpaper. Characters then 'peep' from behind objects in the landscape. The aim of the game is to 'catch' characters using a smartphone camera. Specifically, players use an app on a smartphone to play the game. The app provides a viewfinder, and players must move the smartphone camera to position peeping game characters in the viewfinder. The app uses image recognition techniques to determine when players have positioned a character in the viewfinder. When it detects that a character has been positioned in the viewfinder, that character is then 'caught'. When all game characters have been caught, the game ends. There is no button pressing involved. To help players find characters, the characters make sounds. These sounds are spatially positioned close to where the character is hiding to give players an indication of where to look. Figures 1 and 2 show the game in action.

Researchers have long studied playful interactive experiences for children over large displays. These include interactive storytelling environments like 'Madame Bovary on the Holodeck' [3], 'Narratarium' [6], and 'Wheel of Life' [4], which allow users to interact with virtual worlds projected onto large displays using gesture and speech. Such experiences have even been adapted into commercial products like 'EyePlay' [5], a system allowing users to interact with graphics projected onto floors or walls. However, these sorts of experiences have rarely been studied in the context of the home. Indeed 'EyePlay' is advertised as an 'out-of-home media experience'. One exception is 'KidsRoom' [1], which used large projected displays to simulate a child's bedroom, and then transform it into a 'fantasy land where children are guided through a reactive adventure story'. Given current trends in display technology, it is important to continue this study of large interactive displays in the context of the home. The game outlined above and studied in this paper begins this work. Furthermore, it introduces a novel way of interacting with large displays: the smartphone. This is a particularly interesting method of interaction to study, as it sidesteps some of the usability issues surrounding gestural interfaces (the usual interaction method for large displays), such as the lack of consistency across gestural interfaces, and the accidental activation issues [11]. To that end, the following study was designed and conducted to investigate the game outlined above.



Figure 1. The game in action.



Figure 2. The game app in action.

Study

The study ran over five sessions, with each session having at least one parent, and children between the ages of 3-6. Three of the sessions had sibling pairs, and two of the sessions had two parents. This meant there was a total of 8 children (m=3, f=5) and 7 parents (m=3, f=4).

Each session involved two plays through the game, followed by a semi-structured interview. Participants were met by the researcher on arrival and briefed on the nature of the study and what it would involve. Following this, the parent(s) were asked to read and sign a consent form. Participants were then taken through to the study space, which was equipped with the smart wallpaper living room setup. One child was then asked by the researcher to play through the game, with very minimal instruction. In the case of the sibling pair sessions, the elder child was the first to be asked. Parent(s) of participants were invited to help and encourage their children. Following the first play-through of the game, the child who had played was asked to 'teach' either the researcher or their younger sibling how to play the game, and to play through the game with them. After the second play-through, the children were given paper and coloured pencils and asked to draw their favourite part of the game. During this time, a semi-

structured interview was conducted with parent(s). At the end of each session, parent(s) were handed a debrief sheet, including information about the study, directions about where to go for more information on the research, and contact details for the researchers. Video and audio data of each session was gathered for qualitative analysis.

Results

In this section, we present our qualitative research findings. The findings relate to both the general reaction of users to the idea of large displays in the home, and to the specific experience of playing a game over such displays. We organise the results around six key themes: *overall reaction*, *shared experience*, *physical activity*, *immersive playspace*, *mixed reality*, and *familiar/futuristic*.

Overall reaction

The initial reaction of many participants when walking into the study space was to make exclamations, with the parents in session 1 proclaiming ‘*Wow, that’s amazing!*’ and the children in all sessions making noises of excitement. Moreover, participants could quickly see how smart wallpaper would fit in their own homes. For example, some made suggestions as to how the platform could be integrated immediately with their lives, with the parents in sessions 2 and 5 suggesting they could project it onto the walls of their living rooms. One parent in session 2 said ‘*If there was some way we could project this, a small projector or something like that that you could just switch on, we would put it on the walls in our house*’. On top of this, some participants expressed a desire to get the hide and seek game straight away, with comments including ‘*You could sell it as it is*’ from session 4, and ‘*If this were available I would probably get it*’ from session 5.

Shared experience

One thing we were interested in capturing was evidence of whether the hide and seek game provided a shared experience. A game over smart wallpaper has the potential to be quite inclusive. That is, as the living room itself becomes the play environment, everyone in the living room is immediately involved. We wanted to see if this was something that fostered a shared experience between siblings, families, or just between whoever happens to be in the room. And indeed, parents in all sessions cheered on their children and shouted encouragement. Furthermore, many parents found genuine enjoyment in the game: for example, several laughed at the noises made by game characters. The nature of the game was such that it was possible for people to play together: users could, for example, point out game characters to each other when they appeared. Sibling pairs would often do this, with exclamations of ‘*There! There!*’ and ‘*Over there, get that one!*’ heard repeatedly in the sibling pair sessions, 1, 3 and 4. We occasionally saw parents (in sessions 2 and 4) getting up or suggesting help to their children with perceived issues the children were having: for example, changing a child’s

grip on the smartphone to remove fingers from a blocked camera lens or suggesting the child look for a button to tap. This suggestion, to look for a button to tap, is actually a misleading one as the game was designed to require no button pressing to make it easy to use for young children – this will be discussed in more depth in the section ‘*Familiar/Futuristic*’ below. Overall though, these observations build up a very clear picture that a game using smart wallpaper provides a shared experience.

The parents in all sessions made comments about how this kind of shared experience would be valuable, with comments including ‘*Now you’ve got tablets and stuff maybe parents don’t spend as much time with their children, because it’s easy to put them in front of something. So it’d be good to have something which gets them together and doing something*’ and ‘*It’s a really good idea, because families would be able to join in as well*’. The success of the experience is clearly not at the expense of single player games though, with one parent telling us that tablets were ‘*ideal for when we’re travelling*’. Perhaps this kind of shared experience would be an occasional event, a particular time when the family could come together and share a game. Having a platform that could achieve this and integrate with one’s everyday life is clearly valuable.

Physical activity

Unlike many other digital games, a game over smart wallpaper provides an opportunity for users to engage in some physical activity. This is because the playspace in a smart wallpaper game encompasses a large area (an entire room), and gameplay can be designed to require movement to cover this area. We observed a great deal of physical activity: for example, children in all sessions ran across the room at least once to catch a game character that had appeared somewhere out of reach. Moreover, children in all sessions stood on their feet for the majority of the game and engaged their arms too. Having said this, the children in 4 out of 5 sessions had to be encouraged into movement by their parents at first. The study space had been set up to look like a living room, including a sofa, and children in all sessions would sit on the sofa until it became clear they couldn’t play the game from there. At this point, children would either get up and begin to engage in physical activity, or (much more frequently) parents would encourage children to move from the sofa. As the game interaction was through the medium of a smartphone, it is possible that the children associated the game with the screen-based games they were used to. They would usually sit whilst playing a game on tablet/smartphone and so needed prompting to engage in the physical activity required by a smart wallpaper game. Nonetheless, once off the sofa, children in all sessions engaged in some physical activity.

Parents were particularly pleased about the physical activity element of the game. There were comments including ‘*Anything that gets them moving is great*’, ‘*Instead of being*

stuck in one place they can be up on their feet!' and one parent in session 3 said *'We've always made a point that on a tablet they're constantly sat there. This is miles better'*. The sentiment from parents is clear: a game with an element of physical activity is very positive, and a game over smart wallpaper certainly provides this.

Immersive playspace

One key observation that became apparent when looking at the data as a whole was the immersive quality of the game. This appears to be due to a number of things: the spatial nature of the playspace itself, the use of spatial audio sounds, and the smart wallpaper prototype allowing the game landscape to be immersively projected at life-size. For example, we found participants would use the spatial audio sounds and their peripheral vision as part of the gameplay – as they would do in real life. In one of the sibling sessions, we saw that upon hearing one of the spatial audio cues (of a game character playing the trumpet), the younger sibling looked around sharply, pointed and shouted *'There!'* Similarly, we observed children in both single sessions looking around sharply at the sound of a noise or a movement in their peripheral vision. This natural interaction with a digital platform gives the game an immersive quality, and this is echoed in the comments from participants. For example, we heard the term *'really interactive'* being used by parents in several sessions, with many comparing this aspect of the game to using the Nintendo Wii. Participants would also directly comment on using their peripheral vision, with one child enthusiastically telling us they could *'see them [game characters] in the corner of my eyes!'* A child in a different session told us that they thought the smart wallpaper game was better than a tablet/smartphone game because *'it's massive, it's all around you, you can see all over it'*. This immersive quality comes as a result of the features pointed out above: the spatial nature of the playspace, the spatial audio sounds used, and the life-size projection of the game landscape. It is interesting to note that in many ways these features are unique to a game played out over large displays.

Mixed reality

Related to the theme *immersive playspace* is the theme *mixed reality*. As mentioned in the previous section, we heard terms like *'really interactive'* and *'far more interactive'* being used by parents in many sessions, with several of those parents comparing the game to the Wii. Interestingly, parents in session 4 also compared the game to connected toys like the Furby, Skylanders, and AppMATes, and one parent in session 3 said *'They're [the children] starting to do a lot more involving things'*. This caught our attention when looking at the data, as it appeared participants were reaching for some way of describing a mixed reality experience. The game clearly does provide a mixed reality experience - as described in the previous section, it requires a fuller use of your human senses (spatial hearing and peripheral vision) to interact with a

digital game, and it is a digital game but played over what will be the real, physical walls of future homes. We found it very striking that this was picked up on by participants as it suggests that participants understood what smart wallpaper was, that it would eventually paper the walls of their home just as naturally as their wallpaper does now.

Familiar/Futuristic

One of the interesting things about this game is the fact that it appropriates a technology many are familiar with, the smartphone, and uses it as a portal to a more futuristic experience, a smart wallpaper game. As one parent in session 1 said *'Phones interacting with walls is pretty futuristic!'* It is an interesting way to approach potential future experiences. We observed all participants picking up the hide and seek game interaction very quickly and with very little intervention. We think this was down to the fact that a familiar technology was used as the portal to a futuristic experience. This familiarity means that users pick things up quickly, and it is possible to see meaningful results about futuristic experiences without getting too impeded by usability issues. Furthermore, the familiarity means that we can debug usability issues using tried and tested guidelines for smartphone interaction. For example, we observed a lot of children (in sessions 1, 3, 4, and 5) tapping the smartphone screen, or tapping the game characters displayed on the smartphone screen. Additionally, as described in the section *'Shared Experience'*, we observed parents (in sessions 2 and 4) telling their children to look for a button to press. These are issues that could easily be mitigated using guidelines for smartphone interaction. Perhaps appropriating current technology as a portal to future experiences is a good way of gaining meaningful insights about futuristic experiences, without users getting caught up in the fragility of prototype interfaces.

Summary

Participants engaged with and enjoyed the hide and seek game, and they saw a lot of value in the smart wallpaper prototype on which it was built. Smart wallpaper brought a lot of value to the game that other platforms do not – the opportunity for a shared and immersive physical activity, that mixes real and digital worlds. We can see that homes with large displays will be able to provide a particularly valuable experience for young children and their families.

This case study has gone some way towards answering our research questions. Not only has it shown that homes with large displays will offer unique gaming experiences for families, but it has also shown that smartphones are a useful and effective interface to large indoor displays.

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