Designing for Active Place Presence at Home: The Hole in Space Design Experiment

Salu Ylirisku[α], Antti Jylhä[β], Anu Lehtiö[β], Imtiaj Ahmed[β], Craig Stewart[δ], Abigail Sellen[ε], Richard Harper[θ], Giulio Jacucci[β]

[α] SDU Design
University of Southern Denmark
Kolding, Denmark
ylirisku@mci.sdu.dk

[β] Department of Computer Science,
University of Helsinki
Helsinki, Finland

[ε] Microsoft Research
Cambridge, UK

[θ] Social Shaping Research Ltd, UK

[δ] University of Dundee
School of Computing,
Dundee, UK

ABSTRACT
Technological support for augmenting the relationship that people establish with remote places has been studied fairly little as the primary focus in telepresence studies is the connection between people. This paper addresses the design challenge for supporting 'active place presence' at home. A prototype, Hole in Space, was created to explore the design challenge. A longitudinal study of how an urban couple appropriated the prototype was conducted over the duration of seven months. The paper elaborates on how the Web-mediated design influenced place presence and outlines several aspects that need to be considered when designing for active place presence at home.

Author Keywords
Place presence; Web-mediated artefacts; Domestic design.

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

INTRODUCTION
People develop different kinds of attachment to places that play a role in their lives. The nature of the attachment varies depending on the place in question and on people's past experiences with it. We can only be physically present in one place at a time, and often only the memorized experiences – or memorable things with strong associations (such as physical items that remind us about the place) – mediate the relationship while we are not physically at the place.

Studies about supporting telepresence typically focus on establishing a connection *between people*, such as co-workers [7], elders and caretakers [3], or family members [1,17,26]. Studies with a place-oriented emphasis have been conducted by focusing on how to facilitate the ambient awareness of the immediate surroundings of a particular locale [e.g., 5,8]. The connection to a *remote place* has remained less attended to, see [23]. From this premise, to support living with the presence of a remote place, an interactive artefact for domestic use was built [38], (Fig. 1).

Figure 1. The "Hole in Space" prototype in test use.

With the Hole in Space prototype we explored the influence of the artefact to what we call *place presence*. We use the term to refer to the influence of a place in people's daily life. It may be manifested in discussion, memorising, planning, experiencing, etc. where the place is treated as a topic. We use the conceptualisation of place by Harrison and Dourish [15:69], who define place as "*a space which is invested with understandings of behavioral appropriateness, cultural expectations, and so forth.*" Turner and Turner [31:205] crystallise this idea place into the following scheme: "*PLACE = SPACE + MEANING*".

The contribution of this paper is fourfold: Firstly, we define place presence as a design challenge. Secondly, we demonstrate the design process of the prototype that was intended to mediate active place presence at home. Thirdly, we study the ways in which the artefact influenced the place presence of a family summer cottage over the duration of seven months. And finally, we discuss the dilemmas that were surfaced during the study.

ACTIVE PLACE PRESENCE AS A DESIGN OBJECTIVE
Relph [25] argued that humans have a deep need for associations with significant places, and that places have an

DIS 2016, June 04 - 08, 2016, Brisbane, QLD, Australia

ACM 978-1-4503-4031-1/16/06…$15.00
DOI: http://dx.doi.org/10.1145/2901790.2901884

integral role in human experience. He was one of the first to appraise the complexity and depth in which people develop place attachment, sense of place, and place identity. He shared an aspiration to explaining places in terms of human experience with Tuan [30], who asserted that the relationship with a particular 'undifferentiated space' evolves over time, and according to Tuan [30:6] a "*space becomes place as we get to know it better and endow it with value*". Tuan [30] argued that people's relationship with a place can be based on a predominantly *intimate* or *conceptual* experience. Intimate relationship develops through direct experiencing while conceptual experience is indirect and mediated by symbols. An example of conceptual experience would be a place through a geography book or with a map.

Harrison and Dourish [15] were the first to bring considerations of place into the field of the interaction design and argued that it is important to differentiate between the concepts of *space* and *place* in the design of interactive systems. They saw spaces as three-dimensional structures and places as spaces invested with understandings of appropriate behaviour and cultural expectations [15] alike Turner and Turner [31]. Harrison and Dourish [15] were working on theorising the development of virtual environments. Our current focus is the development of technology-mediated physical artefacts that are capable of extending place presence in the real physical world.

We define place presence as the influence of a place upon people's daily life, and it may be manifested in discussion, memorising, planning, experiencing, etc. where the place is treated as a topic. Traditional ways to extend intimate place experiences include e.g. souvenirs, journals, photos and videos. A miniature Eiffel tower on bookshelf brings back memories from a trip to Paris, and the painting bought from Chinese students in Beijing remind of the exploration into the Forbidden City. These artefacts change the home as a place not only by associating it with experiences of other places but as displays of who the people living in the place are [5] as well as contribute it to become aesthetically more diverse [22].

According to Tuan [30], conceptual place experience refers to the indirect experiencing of a place through symbols, e.g. through stories, texts and maps. Indirect experiencing does not have the sensual and kinaesthetic qualities of direct experience. Direct place experiences may be technology-mediated in important regards in today's world with ubiquitous services, which have been conceptualised in terms of Checkpoints, Hotspots, and Standalones [18]. *Technology-mediated experiences* can be seen to blur boundary between the rigid conceptual-direct distinction by Tuan [30]. Technology-mediated experiences may be pre-conceptual, yet indirect. Consider, e.g. various map-based applications, such as car navigators and GPS maps that provide people with possibilities to have indirect experiences of places while being physically present at a place. Technology-mediated experiences of places can also be indirect but visually real-like. Examples of such designs are Portholes [7], Polyscope [2], and Peepholes [12], which are all work-related designs to mediate the awareness of what happens in a remote place.

Domestic Designs Connecting to a Remote Place

There exist numerous domestic designs, which connect home to a remote place. For example, the Digital Family Portraits [24] was a system to connect two places by making framed photos active. The system was designed to contribute to the wellbeing of elderly people living alone, and they could utilise the photo frame to connect to their close ones living in a remote location, who would have similar photo frame there. The Presence Clock [27] connected two identical clocks in different homes, making the inhabitants in both homes capable of perceiving how much activity was detected around the other clock and displaying the 'presence' of people in the other end over the duration of the last 12 hours. Designs, which connect two different places through the detected activity at the other location include e.g. the Picture Frame and Augmented Mirror [6], Ambient Plant, and Check-In Tree [1]. All these designs, however, are addressed to convey presence and awareness related to activities and whereabouts of *people* rather than targeted to the augmenting the relationship between people and *places*. The Home Awareness [21] prototype is different in that it is explicitly targeted at enriching the experience of a particular place through the sound, light, and temperature that it represents on the basis of the measurements at the remote place.

The connection to a remote place to extend intimate place experience is less studied. The study reported by Wyche and Chetty [35] a low-tech prototype was created in the form of a picture frame and an analogue clock. It was equipped with imagery from the remote home of studied Africans residing in the US The aim of the design was to give the sensation of "seeing" the homes via preselected pictures that were processed according to the current conditions at the remote end. Even though the pictures were not actually captured in real time, they still provided connectedness to the home country and enabled the study participants to reflect on their experiences about the remote place. The LiveNature design concept reported by Mughal et al. [23] explored how mobile web casting could support the place experience of a cherised remote location.

Designing for the Home

Home is in many regards problematic in the point of view of interactive systems design. People's domestic routines are organised in complex, distributed, and collaborative ways around 'ecological habitats,' 'activity centres,' and 'coordinate displays' [4]. Domestic human computer interaction (HCI) technologies are often considered under the concept "smart home." In fact, until the term was coined approximately 15 years ago [16], designing HCI specifically for the home received relatively little attention. The majority of studies in the smart home field have been

technology oriented, focusing on integration of computational and Web-based technologies in the domestic context without paying attention to aspects such as integrating technologies in the domestic practices of people [4,14]. According to Taylor et al. [29], the concept of the smart home presents intelligence as a property of the environment rather than of its inhabitants. They argue that making a home truly "smart" also entails considering the people in the whole.

Moreover, what people find appropriate designs into their homes depend much on aesthetic considerations. Csikszentmihalyi and Rochberg-Halton [5] found out in their investigation of meanings of objects in the domestic environment that it hosts a variety of things whose utilitarian value was considered less important than the value of other meanings such as memories, style, and experiences that people associated with them. The process through which things become placed as part of our lives is very complex at homes, since, in addition to the complexities of becoming personal objects, the designs need to be crafted in ways considerate of the characteristics of domestic spaces and materials [13]. For example, while personal computers that were designed for the office were efficient for some tasks, they conflicted with the aesthetics of the home. When technology manifests itself through expressive artefacts, rather than functional gadgets, a more holistic perception of the "aesthetic" [22] is needed.

Hallnäs and Redström (ibid.) appraise Weiser and Brown's [33] idea of *calm technology* for meeting people's needs to be undisturbed. A key aspect of calm technology is its capability to fall into periphery, i.e. informing without burdening, and then be taken into the centre of attention, awareness and control. To sum up, the challenge of designing for active place presence at home comprises of

1. the value of significant places for people,
2. the different kinds of place-experiences, namely intimate, conceptual, and mediated,
3. and the challenges related to designing for the home.

Below we present an experiment where an interactive system, called Hole in Space, was designed for active place presence.

THE HOLE IN SPACE EXPERIMENT

The Hole in Space experiment was part of a 2-year research project to study possibilities to develop web-connected physical artefacts for the home. The project involved an initial phase, where a variety of ideas were created in workshops that were based on initial studies of users (interviews with 24 users in their homes in UK + self-documentation and interview study with 5 users in their homes in Finland) and web-related technologies. Three design prototypes of interactive systems (Manhattan [39], Tokens of Search [19] and Hole in Space [38]) were created and studied, each of the prototypes having a different research focus. The Hole in Space prototype was dedicated to the study of active place presence in order to learn how to support this with web-based technologies.

Designing the Hole in Space Prototype

During the Domesticating Search project four co-design workshops were organised with participants from two design research units, one in UK and one in Finland. Each workshop had between 12-16 participants from different professional and cultural backgrounds. The different workshops were each grounded on different groundwork materials, such as user portraits, field study videos, and material props. The workshop participants were potential users of the designs, as the focus was on domestic artefacts, and the design choices made during the process were largely based on the evolving 'sense of relevance' [37].

The design concept was originally conceived in a co-design workshop and expressed as "*a 'Portal' into another place about which you care*". It was mocked up with a transparent half-dome and foam board (Figure 2). In the first articulation of the idea, the size of the dome was considered to be large so that people could put both of their hands on it and use the dome as a tactile interface to the device. The envisioned functionalities at this first stage involved video stream, weather (especially remote temperature perceptualised through the changing temperature of the physical dome), and audio and news streams from the distant location. Already this first articulation of the design featured a clear set of ideas about interactivity: 1) a window for seeing to another place, 2) proximity-based feedback through visuals and audio, 3) touch-based feedback about weather, and 4) a bevel in the window that enabled adjusting the settings of the device.

Figure 2. The first mock-up of the 'Portal'.

Through iterations of the idea, the conceived information content (i.e. video, audio, and news streams with weather information) remained largely unchanged, while the physical form of the device as well as the designed user-interactions underwent transformations. The first iteration of the physical form continued with a convex display (Figure 3, left). However, the convex display was considered technically too challenging to develop with enough visual fidelity. Thus, an alternative concave form

was developed (Figure 3, right). The circular aperture was considered visually appealing and interactionally intriguing as it enabled peering into the device and revealing the image only a part at a time. At the time of switching to concave form the name of the design concept was changed from 'Portal' to 'Hole in Space.' The physical design was then iterated to accommodate a tablet PC (Samsung Series 7 Slate) to be used as the display. After two iterations the box was made smaller and more rectangular. The colour was also chosen to be neutral (white) to avoid the device to be visually provoking and to contribute it to better blend into the domestic environment.

Figure 3. A cardboard mock-up of the convex display (left) and MDF construction mock-up (right) of 'Hole in Space'.

A skilled artisan was recruited to make the final design of the physical artefact in order to give the device a physical appearance of an artefact that people could like to have placed on a visible spot at home. He crafted appealing dovetail joints into the box, which now comprised Nordic birch wood and black acrylic. The final polish was given with a translucent white wood wax (Figure 4).

Figure 4. Attention was paid to the quality of finish.

Detailed interaction design started once the overall physical shape and material of the device were fixed. The materiality of the device provoked the team to consider particular ways to interact, such as by knocking the box and using the surface of the device as a touch-sensitive control, which would feel engaging with the elegant wooden box and its black acrylic face. The team chose to use the rim of the hole in the front panel as the main interface for user input. Also, as the hole enabled putting one's hand inside the device, it was considered as an opportunity to provide tactile feedback, see Figure 5.

Figure 5. The Hole in Space prototype and tangible interaction with the device.

The team considered using the rim as a cyclic touch interface that would enable scrolling, zooming (with a pinch-like gesture with two hands or fingers) and tapping. They explored, enacted and discussed various alternatives for what would happen through different ways to interact with the device. The interaction design was conducted in close dialogue with technical implementation in order to ensure that the designed interactions were technically feasible. For example, one feature that the team considered was a history browser, which could be enabled by simply scrolling the rim; once released, the view would return to the current moment. The team also considered modes, where by zooming out, the user would be given a selection of views, such as news feed and live video.

The final addition to the interaction design was made with the intent to provide a calm lead-in into the interaction with the device. This happened partly as a response to the technical limitation of data bandwidth over cellular networks in the planned test context in relation to people's attachment to their summer cottage in Finland. The limited bandwidth required the team to make a choice between a very bad-quality live stream and slowly updating image with better quality. The team decided to go with the better image quality, which nevertheless resulted in a too static feel as the image updated only once in every 10 seconds. To compensate this the design team developed a dynamic lead-in pattern based on the proximity of the user (Figure 6).

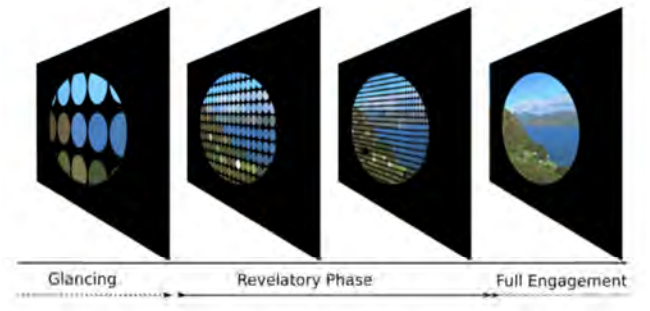

Figure 6. The lead-in through a transitory glance-pattern into engagement with full detail.

The dynamic lead-in was implemented in OpenGL, which is processed very fast in the GPU of the computer, and it enabled a very responsive appeal in the result. Once a user would approach the device, the decorative pattern that conveyed an overall sense of the atmosphere at the remote

place, would smootlhy grow increasingly detailed finally revealing the image in its full resolution (1280x720 pixels).

In addition to the imagery from remote webcam the final implementation featured news feeds, wind information, and radio channels from the remote location. The rim of the hole was made into touch sensitive control with an array of capacitive sensors. With the rim the user could browse news titles from RSS feed and switch between radio stations from the remote place. The box had two fans inside, which were used to deliver a sense of wind from the remote location based on web weather data. These were controlled by a small IR sensor inside the box, which was triggered by a hand placed inside the hole.

Pilot Tests in Homes

To ensure that the device would work properly, two pilot studies were organised. The first pilot test was conducted in Scotland in a household of two young adults. The focus was on learning how the prototype would work when be placed in an actual home environment rather than in office where the interactions were initially programmed. The appropriate distance for the visual lead-in was explored with different ranges, and various technical issues were resolved, e.g., using a personal webcam as the source for the imagery, and the behaviour of the lead-in pattern when multiple people would be in front of the device.

The second pilot test was organized in a household of four people (husband, wife, and two girls aged 8 and 11). The prototype was placed in Helsinki, Finland. One of the studied issues was the possibility to use existing webcam streams in the device, since it would avoid the need to travel to the remote location to install a new camera (which would be problematic to maintain remotely). Hence, the second pilot study used an existing webcam in a city where the relatives of the family were living. The city was Portland, Maine, USA. This test aimed also at learning how a family would appropriate the system, where it would find its place, and what kind of role it would take on when set into the real-life context of a family with children. Also it was considered a curiosity to see if the six hours' time difference would matter in the development of the place experience, as it would reveal more significant differences in daylight and weather as compared to locations within the same country.

This second pilot suggested that, while the connection to the remote time zone was considered to provide a stronger emotional bond to the remote location, the news and radio were uninteresting. This was likely due to the fact that the family did not have a previous connection to the news sources nor the radio channels in that remote place. They considered that it would be different if the remote place were their own summer cabin, where the local dialect would be audible on the radio and the local news might provoke personal associations. It was also learned that the position of the webcam in the remote location was important. The participants commented that they would like to know exactly where the camera was and where it was pointing. During the second pilot final technical tweaks were made before the longer deployment of the device. The family considered the physical design pleasing, and they placed the device on a visible spot in their living room.

ACTIVE SUMMER COTTAGE PRESENCE AT HOME

Based on the experiences of the pilots, a study setup was designed for exploring how Hole in Space could contribute to the place presence of a family summer cottage in Finland. There were mainly three reasons for this. Firstly, a summer cottage is a special place for many Finnish people, hence enabling the study of the connection between home and a remote place, rather than between people in different locations. Secondly, in Finland many families have a summer cabin within a driving distance from home, which would make it practically feasible to actually visit the remote location and install a webcam with cellular data connectivity there. And thirdly, people's use of their summer cottage varies radically depending on season, and it was expected that a longer study could reveal aspects of place attachment and place presence, which could only be revealed by a study spanning several seasons. A time frame of seven months, from spring to fall, was chosen for the study. It was also considered that the longer time frame could surface how people would develop their own routines of use beyond initial explorative use.

In Finland there were in total 489 000 summer cottages in 2010 [28], which is relatively high when compared to the total population of less than 5.4 Million in 2010. Owning a summer cottage is not elitist in Finland. For the study we chose a middle-aged married couple, a female (participant S1) and male (participant S2), who represented fairly well Finnish middle-class people owning a summer cabin. They lived in the Helsinki metropolitan area and their cottage was located approximately 100 km north of the home, which made the installation of a remote camera not too demaning for researchers coming from Helsinki. The couple also had a strong bond with their cottage, and the standard of equipment at the cottage was equivalent to that at their home. This enabled to play down effects of introducing technology (in general) to a new environment.

Data Collection

The study began with an initial interview with at the participants' home in order to understand their relationship with their cottage. The interview was done with one researcher who was accompanied by a researcher who installed the Hole in Space device. The interview covered questions such as: What does the place (summer cottage) mean for you? How would you describe your relation with your summer cottage? What types of activities are associated with the summer cottage? What role does technology play in your connection with it? The interview was open enabling the study participants also to bring up themes unanticipated by the interviewer. They were also given contact usage instructions and information for

technical support. The remote camera was installed at the summer cabin during the same week as the first interview. The participants were informed that they could freely move the HiS device and the remote camera to locations they found desirable.

In total three semi-structured interviews were conducted with the participants in their home by the same researcher. The interviews were evenly distributed over the study period (start, middle, and end) in order to reveal possible changes in the place experience of remote place, and to identify possible emerging practices related to the experiment. Both of the study participants were present in all of the interviews. The participants were also instructed to contact a researcher by email or phone bi-weekly in order ensure the participants being still engaged with the study, and to record any questions, observations, etc. that might be forgotten by the time of the next interview.

The recordings from the interviews were transcribed for later analysis, and the Hole in Space system maintained a time-stamped log-file tracking the interactions with the device. The system logged all detected touch interactions with the sensors, including the triggered outcomes of these events, such as browsing the RSS newsfeed, changing radio stations, and triggering the fans on and off. The log file also contained information about possible errors in the application while it was running, about application restarts, and about image downloads from the remote end.

The analysis of the data progressed through identified themes, such as the participants' relation with the summer cabin and with the device, the use of the device, suggestions for improvement and envisioned uses, placement of the device and camera. The system log was analysed to quantify interactions with the device. Touch interactions were grouped into interaction sessions based on the time stamps: Each stream of detected touch events, with no more than one minute between consecutive log entries, was considered as one interaction session. For each session, we analysed the number of times the RSS news item or the radio station was changed and whether the fan was active during the session.

FINDINGS

It was clear from the beginning that the participants had an existing strong bond with the remote place (their cottage) and were curious to experiment with new technology to stay better connected with it. The opportunity to have a visual link to the cottage especially influenced the participants' expectations for the trial. For example, the participant S2 thought he would "*be actively checking the image to see what was happening at the cottage while we're away*."

The participants described their cottage as *the* place where they felt relaxed and enjoyed nature and the company of their family. While nature and relaxation were important parts of the cottage experience, social aspects also shaped their relationship with the place. It served as a venue for connecting with the participants' immediate family, their daughters and the elderly parents of S2.

Against this background it might be understandable why the participants did not report major changes in their relationship with the cottage during the intervention. S1 pondered: "*Well, we go there often, almost every weekend, so there really isn't any 'room to be more involved.' We start planning what to cook etc. already in the middle of the week. I've even worked remotely so we can go a day earlier*." The connection with the place was already strong and established and the intervention was not expected to change the meaning of the place itself for the people, but provide a way to 'extend' the place into home.

When asked about the possible changes in their relationship with the cottage, i.e. whether the design intervention had affected this and related practices, the participants talked about the device itself and how it came 'in-between' their existing relationship with the cottage. They did not consider it to influence their relationship with the cottage, but rather, the cottage was part of the experience mediated by the device. Next, we summarize the key findings about the influence of the Hole in Space design intervention for active place presence of the summer cabin at the home of the study participants.

Hole in Space as Avatar of the Remote Place

The participants began eventually to see Hole in Space as a symbol and as an avatar of the cottage, which was likely to be promoted by the HiS device being the sole object in the participants' home explicitly associated with the cottage. S1: "*We don't keep 'cottage stuff' at home. For example, I couldn't even imagine putting a photo of it on display. That would be so corny somehow. It's different now there's this image that changes. That turned out to be quite nice.*" The device reminded of the cottage and triggered related thoughts: "*You see it [HiS] and then something comes to mind, like, 'oh, I wonder if the girls are coming over next weekend, what are we going to cook'*" (S1).

The HiS device made the participants consider the box as "the cottage at home". S1 descried it: "*I mean, the device was there, and it WAS 'the cottage,' the link to that place and to associated things. It's very subconscious.*" The participants considered it with the experience of peering into the device with that of looking out of the summer cabin window. S1 described: "*What's interesting in using it [HiS]? To be able to see the nature. That's what we do when we're looking out of the cottage window as well. The view is always terribly important to me. This way I could possibly extend my stay, look out of the window there from here.*" HiS was thus not just a window *to*, but also the window *at* the cottage. This made it possible to experience remotely something that was specifically a cottage activity, to get the feel of "being there." We see that the HiS device become an avatar of the summer cabin, as it acted beyond

being a mere symbol, conveying important signals of the character of the place and action from the remote end.

The participants often talked about the device as a separate entity, having its own unique "being." S1 even reported that, when other people asked about the trial, they might just inquire: *"How's the box doing?"* S2 continued: *"It's quite nice [the device]. I'm going to miss the box!"* This suggests, and for one part explains, that the connection with the device was in a way separate and unique from that with the cottage. Further explanations for this partly separate device connection include a completely new interface, the presence of the device in their home for seven months, and the participants' appreciation for the design of the device.

Hole in Space as Part of Domestic Routines

When asked why this particular object had found its place in their home, the participants stated that it was probably due to the interactive nature of the device: It was able to provide them with up-to-date information from the summer cabin. The picture contained information that was very local and detailed. Also the fact that the box was the only visible physical thing at home associated solely with the cottage seemed to foster the forming of an explicit bond with the device and with the existing attachment the participants had with their cottage. The device was also adopted to be a part of daily routines. S2 explained: *"It's always the same in the morning. I take a shower, come here into the kitchen and start to make porridge and take a look at the image."*

The evolution of the use of HiS is shown in Figure 7, which is based on data logs from the device. In total the log contained 75 interaction sessions where touch gestures were used with the device during 22 separate days during the study period. Average duration of one session was 56 seconds, while some of the sessions lasted for only 2-3 seconds. Average number of RSS feed changes per session was 4.72 (in total: 354 changes). Average number of radio station changes per session was 1.12 (in total: 84). During 76 % of the sessions the fan was active (typically for only 0.5-2 seconds at a time).

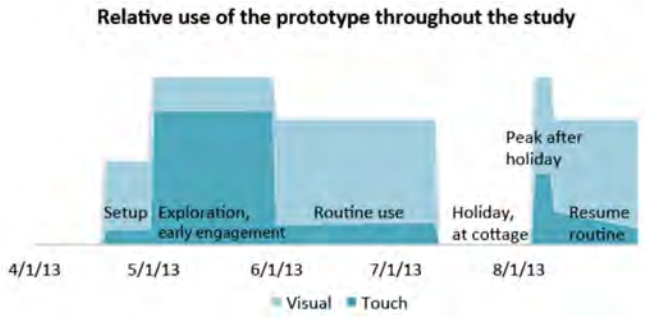

Figure 7. Use of the device over the study period. Visual = interaction with image feed; Touch = interaction with touch gestures. The data is truncated from the end of August, as the following months did not include changes in usage patterns.

The logs showed that after the initial phase of experimenting with the features, the use settled into a routine. Both participants said that they checked the device, specifically the picture, twice a day. The interactions that did not have any touch events were not captured in the log, whereby the chart is only suggestive. It is partly based on the verbal account of the participants. By the end of the study, occasional experimenting with other features had ceased. This was confirmed by the system logs, which indicated that 61% of total time used for touch interactions as well as 65% of the radio station changes and 74% of RSS feed browsing occurred during the first two months of the study. There was a secondary peak in usage after the participants returned from their summer holiday at the cottage, indicating that they felt a stronger need for retaining the connection after visiting the cottage for a longer period.

The Camera View as the Main Feature

The participants were initially mostly fascinated by the camera view, and this experience persisted throughout the whole study. The participants emphasised that the image had the capacity to convey both more information in a more local manner than the other channels of the device. S2: *"And then there's the farmer we bought the land from. He's been keeping us updated on local matters and if there's something. […] If there's been, for example, a heavy storm. Then we call him and ask what it looks like at the cottage, if there's anything concerning the cottage."* With the device's camera view, the participants now had an alternative way of getting this information directly.

The information from the camera view was appraised to be of special interest at the times of leaving for the cottage. Checking the weather conditions at the cabin through Hole in Space was considered useful. The participants described: *"The view, well, you could, for example, check whether it's been snowing heavily and if the plough guy has been there"* (S2). *"Yes! And if we need to pack a shovel"*(S1). These types of practical effects on participants' behaviour (what to pack, etc.) were a recurrent theme in the interviews, and their answers suggested a change in the participants' practices. The image addressed an already existing need and offered an option for developing an existing practice.

Even though HiS could also offer, e.g., the local weather data beyond the wind blow, the augmented data did not include the local details that the participants would consider helpful to support the relationship with this specific locale. Through the picture they could see the exact situation and make practical decisions based upon it.

In sum, the camera view was valuable for the participants for the increased awareness of the situation at the cabin, and thereafter, for practical decision-making. The image was also considered visually appealing with the smooth lead-in pattern when approaching the device.

HiS as a Resource for Social Interaction

Even though HiS did not include in itself a way to directly mediate social communication, it had a secondary effect as an initiator of social activity. In addition to, e.g. reminding to ask the family if they were coming to the cottage, it was a topic of conversation that at the same time provided the participants with information about which to talk. S1 described: *"When we were having coffee I'd go and take a look. Like,' it's still showing the car parked in the garden.' And then we'd talk about it. Yes, we've been talking about it."* When asked to elaborate why they interacted with the device this way, e.g., instead of taking turns, S1 explained: *"No, I mean, this way you can, like, you tell the other what's there and then she/he comments."* It seems that having these conversations became a routine in itself instead of the interaction being just about using the device.

As for the other features, such as the news and radio, two main reasons for the low usage were found: 1) The content was not local enough, and 2) The user interface did not meet the participants' expectations for the content. The participants explained: *"I thought that I'd spend more time, for example, reading the news, but for me, you only get this introduction piece and there's no way to continue to read more"* (S1). Hence, the camera view and wind information became features that the participants preferred over the news feeds and the radio.

The Importance of the Placement at Home

At first, the HiS box was set on a desk in the participants' study (Figure 8, bottom left). The placement turned out to be impractical, as the location required the participants to sit down to use it. This implied longer interaction sessions, which was against the original design reasoning to make the interactions fleeting.

Figure 8. Initial placement in the study (bottom left), participant interacting with the hole (top left), and refined placement in the kitchen (right)

The participants began spontaneously to envision a better location for the device (Figure 8, top left), once the placement at their study was considered too effortful. *"I started to think about where it would be practical to use it, and thought it's the corner [of the counter] over there."* (S2). In addition, S1 also thought about where the device would "fit" best as part of the décor: (S1) *"I was just thinking where it would look good. Accidentally, the place just happened to be the same."* The device was soon moved to a more central place on a higher kitchen counter, which resides between the living room and kitchen, where it stayed until the end of the trial (Figure 8, right).

At the end of the trial, the participants emphasized that the central placement at the kitchen was crucial for the use of the device: *"We're here (in the kitchen) every morning and evening; that's twice a day. It's quite possible we don't spend any time in the living room. And the hall, we just walk through it. This place, this was the right one."* The box was thus in view throughout the day, unobtrusively hinting that it was there, standing by. Although the device was quite visible, the participants did not report it demanding attention, or in any way disrupting their activities. They stated that the nice looks of the HiS device contributed to their willingness to keep it visible.

Regarding where to place the remote camera, the participants were unanimous that it should point outward: *"If we're not at the cottage, there's nothing to see inside"* (S1). The camera was first placed to look out of the cottage window into the garden, and it was later moved once. The reasons for the move were the need for variety, and desire to find an angle that allowed for the most aesthetic and widest view possible. For the rest of the trial the camera view covered trees and the parking area (Figure 9). In this way the participants thought they might also be able to see if there were cars parked or people in the yard.

Figure 9. A collage of pictures taken over time by the webcam as pointed by the participants at the summer cabin.

Improvements and Future Uses

The main suggestion for improvement concerned the HiS prototype being a closed, fixed system. The participants wished to be able to have a way to communicate with the device: *"I would have liked the type of interface that allows me to do something too. This was a bit passive; as a user you couldn't do much. If there'd be a way, for example, to connect the box's [HiS's] computer to our television and sound system to get a good quality sound and to be able to adjust the volume."* (S2) The participants wished to adjust the system according to their (changing) needs and interests.

This issue of managing the system was further highlighted when the participants discussed their favourite feature, the camera view. The participants wished to control the camera remotely, to have information about the system status, and to know when the data received through HiS was updated. S1 envisaged: *"I'd expect this to be a stream, like video*

footage, to be able to see some movement. Trees, possibly even animals." The participants also had an idea of adding audio from the cottage to the view: *"It'd be great if you could add the sounds, birdsong. That'd be lovely!"* (S1). The suggested "soundscape" would be local enough to add to the participants' "feel of being there."

The participants further pondered whether the system could be used as a sort of a security camera: *"We could maybe keep an eye on grandfather [S2's elderly father]? Just to see if everything's OK."* Also, possible damage to the cottage was mentioned. However, there was some hesitation: *"On the other hand, now the system is positive. With the security camera, thinking fear is always present. You're just waiting for something bad to happen"* (S1). The same ambivalence was present when the participants discussed adding social features to the system. They expressed that it might be nice if there was, for example, an "OK button" that you could press after arriving at the cottage and HiS would then convey this information to people at home. Still, this would also change the nature of HiS from a previously unobtrusive device into something that requires active attention and control.

Lastly, the participants commented that the UI could be well suited for information visualisation. S1 stated: *"You could add the weather data into the image? The temperature from both outdoors and indoors (at the cottage)? And you could possibly even store the weather data here, like in a diary?"*

DISCUSSION

Reflecting on the experiment the most surprising finding was about how specific and detailed the connection to the remote place needs to be. We first designed the prototype to use generally available webcams online near the targeted remote place, but these did not support the connection to the intended regard. By allowing the participants to place and point the webcam in their desired way, the process enabled the inhabitants to take ownership of the remote view. It also contributed to the physical device at home to 'become the cottage' at home, because of the similarity of the view through the device and their cottage window. This is different to, e.g., the studies Gaver et al. [8,10,11] who used a long-term situated approach to the study of several design prototypes, which exemplified how information available through the Web can be used to increase awareness about various phenomena in a domestic environment.

Live video streaming from a remote location through mobile web casting to augment people's experience of a remote place has been studied by Mughal et al. [23] and by Wang et al. [32]. The specificity issue did not surface in these studies as only the sky of a remote location was streamed over web. Sky does not have similar location-specific visual permanence and identity as landscape. Our findings support the kind of specificity described by Gaver [9] in connection with his experiment called Video Window, which nevertheless, was a local installation. The design was a simple camera view from his home rooftop delivered to a screen hanging beside his bedroom window. Gaver [9] writes that "getting it right" took a significant amount of work, and this work involved both practical and aesthetic aspects to create an experience that he "wanted to live with". Our research confirms that there is significant amount of work that the participants were willing to invest in getting it 'right' once the participants find the experience valuable. With the Hole in Space prototype it involved both placing the camera and the device at home in the 'right' place and pointing into the 'right' direction.

Balancing the use effort and ambience

Our design for fleeting interaction provoked the participants to place the device on a spot at home, where they would not need to sit down to use the device. They considered sitting down for the device to be of too much effort in regards to what the device delivered. The need for sporadic interactions with domestic ambient displays is also noted earlier [32]. The users were willing to invest only minimal time and effort for interacting with the device, which was designed to deliver information for peripheral awareness. What is, nevertheless, interesting is how they placed the device in a central place, a 'prime site' [4], so that it was not only easily accessible and effortless to use but also a salient reminder of the cottage.

The amount of effort the participants were willing to invest with the device is also related to the character of the content that the device served them. The augmentation of the visual stream with news headlines was little appreciated by the study participants. The kind of informative augmentation that we implemented is quite different from the aeshtetic augmentation reported by Mughal et al. [23]. In their study the appearance of the visual stream was modified on the basis of real-time sensor data captured from the remote location very much in the manner suggested by our study participants. We augmented the image with news titles from RSS feeds and our participants reported that they would have liked to access the details of some of the news articles they saw floating in the view, but they could only browse the headlines. We intentionally included only the headlines in order to keep the interactions fleeting. Perhaps a way to tag an interesting heading in order to access it later, e.g., on a mobile device or computer would have made the headings more useful while enabling to keep the interactions with the device fleeting. This would be in line with the recommendation by Consolvo et al. [3] to include only 'sufficient' information in an ambient display to keep the ambient display ambient.

Balancing the bandwidth and the active character

We made intentional decision to keep the refresh rate low (1 pic/10 seconds) for better image quality (1280 x 720 px). The jpeg-compressed images resulted in altogether 500 MB weekly load on data networks. This is different from the study by Mughal et al. [23] why reported using the resolution of 640x480 in streaming video with around 14

frames per second forming up to 70 GB in week from four web streaming cameras. Presently the data connections to summer cottages are often poor, making it important to find alternative ways, such as the lead-in pattern, to make the device appear alive instead of jammed.

Our choice to use reduced frame-rate in the benefit of image quality is a likely reason for a finding that seems to conflict with keeping the ambient view in the backgound of attention (recommened in [3]). Our study participants considered the design rather passive, which implies they would have wanted the intended ambient device to be less ambient. This is curious, as it could be expected that the more passive an ambient display is, the more it would fall into the periphery thus contributing to its intented ambient character.

Based on the feedback from the participants, the rather slow rate of picture update as well as the ability to interact with the device through the designed inputs provoked them to expect more, e.g. they suggested to be able communicate through the device. We assume that by including live audio and video from the remote place, and possibly also enabling the news tagging and sharing, could contribute to the experience of a more active device without transforming it too active and into a distraction. The boundary between an ambient peripheral and active appliance appears foggy and we see that finding an appropriate balance requires testing and getting feedback with particular implementations.

Balancing between different experiences

Based on our study, we see that artefacts that people utilise to enhance place presence can draw simultaneously on multiple different kinds of place experiences [30], i.e. *intimate*, *conceptual*, and *technology-mediated* experiences. The Hole in Space prototype extended an existing intimate place experience of a summer cottage by entering the participants' home in a way that they experienced as a symbol and an avatar of the cottage. The active place presence was visible in how the place, as experienced with and through the Hole in Space device, influenced on what our study participants talked about and oriented towards. It triggered discussions and new behaviours associated to the summer cottage. The participants considered these as positive impacts to the extent that they would have liked to keep the device.

The active place presence that the Hole in Space prototype supported is essentially different from a place experience that is established, e.g., with a surveillance camera on remote personal property. While a surveillance camera could also deliver a pre-conceptual technology-mediated experience of a cherished place, a surveillance system may contribute to experiencing the remote place in more than one way. It may instigate a sense of *fear* that something bad may happen and thereafter a feeling of obligation to check the status of the remote place. Hindus et al. [16] recognised the effect of designs that mediate communication to have on people's sense of obligation for others. Our participants recognised the significance of the system being positive, and considered it good that our design guided attention away from the surveillance frame, which would not only promote fear but also the feeling of obligation to keep checking that everything is fine in the remote end.

Place attachment and place presence

In the field of environmental psychology Lewicka [20] has criticised studies of place attachment to move little beyond the founding studies by Relph [25] and Tuan [30] over the last 40 years. She suggests attending on the social processes, design processes, and the processes through which people form relationship with places in the furthering of theoretical understandings of place attachment. Our intent was to design for active place presence, and we outlined *place presence* to refer to the influence of a place in people's daily life, i.e. how it is manifested in discussion, memorising, planning, experiencing, etc. where the place is treated as a topic. We see place presence as a fruitful concept to begin also to explore how place attachment evolves on the basis of how people *resource* [36] the experiences of particular places in their interaction.

CONCLUSIONS

We outlined the design challenge of active place presence at home and reported a study with a design prototype, Hole in Space, which addressed the challenge. The reported design process was driven by considerations of aesthetics and socio-material organization of home [5,22] and calm interaction [33]. The interactivity was designed with three key principles: 1) to behave in a calm-but-responsive manner, 2) to deliver a lead-in into full engagement, and 3) to support fleeting interactions in an intimate way. We conducted two pilot studies and a seven-month long-term study that investigated how people would appropriate the design prototype into their homes, and how the device would be able to contribute to the active place presence.

When designing for active place presence in the home designers need to balance between several tensions involving the effort of use, the ambient character of the data, and the way the bandwidth is used. On the basis of the study we conclude with design recommendations for the active place presence at home:

1. Embrace high local specificity of detail and allow for users to decide where to place and point the camera.
2. Value material and finishing quality for a well-blending aesthetic appeal.
3. Design the device behaviour to be calm-but-responsive in the support of low-threshold low-effort use.

ACKNOWLEDGMENTS

We are grateful for Microsoft Research for financing the original study and Aalto University as well as the University of Southern Denmark for financing the analysis and reporting of the study.

REFERENCES

1. Ingrid Arreola, Zan Morris, Matthew Francisco, Kay Connelly, Kelly Caine, and Ginger White. 2014. From checking on to checking in: designing for low socio-economic status older adults. ACM Press, 1933–1936. http://doi.org/10.1145/2556288.2557084
2. Alan Borning and Michael Travers. 1991. Two approaches to casual interaction over computer and video networks. ACM Press, 13–19. http://doi.org/10.1145/108844.108847
3. Sunny Consolvo, Peter Roessler, and Brett E. Shelton. 2004. The CareNet Display: Lessons Learned from an In Home Evaluation of an Ambient Display. *Proceedings of UbiComp 2004*, Springer, 1–17. Retrieved from http://dx.doi.org/10.1007/978-3-540-30119-6_1
4. Andy Crabtree and Tom Rodden. 2004. Domestic Routines and Design for the Home. *Computer Supported Cooperative Work (CSCW)* 13, 2: 191–220. http://doi.org/10.1023/B:COSU.0000045712.26840.a4
5. Mihaly Csikszentmihalyi and Eugene Rochberg-Halton. 1981. *The Meaning of Things : Domestic Symbols and the Self*. Cambridge University Press. Retrieved from http://www.amazon.com/exec/obidos/redirect?tag=citeulike07-20&path=ASIN/052128774X
6. Anind K. Dey and Ed de Guzman. 2006. From awareness to connectedness: the design and deployment of presence displays. ACM Press, 899. http://doi.org/10.1145/1124772.1124905
7. Paul Dourish and Sara Bly. 1992. Portholes: supporting awareness in a distributed work group. *Proceedings of CHI'92*, ACM Press, 541–547. http://doi.org/10.1145/142750.142982
8. William Gaver, Mark Blythe, Andy Boucher, Nadine Jarvis, John Bowers, and Peter Wright. 2010. The prayer companion: openness and specificity, materiality and spirituality. *Proceedings of the 28th international conference on Human factors in computing systems*, ACM Press, 2055–2064. http://doi.org/10.1145/1753326.1753640
9. William W. Gaver. 2006. The video window: my life with a ludic system. *Personal and Ubiquitous Computing* 10, 2-3: 60–65. http://doi.org/10.1007/s00779-005-0002-2
10. William Gaver, Alex Wilkie, Andy Boucher, et al. 2008. Threshold devices: looking out from the home. ACM Press, 1429. http://doi.org/10.1145/1357054.1357278
11. William Gaver, Peter Wright, Andy Boucher, et al. 2011. The photostroller: supporting diverse care home residents in engaging with the world. *Proceedings of the 2011 annual conference on Human factors in computing systems*, ACM Press, 1757–1766. http://doi.org/10.1145/1978942.1979198
12. Saul Greenberg. 1996. Peepholes: low cost awareness of one's community. ACM Press, 206–207. http://doi.org/10.1145/257089.257283
13. Lars Hallnäs and Johan Redström. 2002. From use to presence: on the expressions and aesthetics of everyday computational things. *ACM Transactions on Computer-Human Interaction* 9, 2: 106–124. http://doi.org/10.1145/513665.513668
14. Richard Harper. 2011. From Smart Home to Connected Home. In *The Connected Home: The Future of Domestic Life*, Richard Harper (ed.). Springer London, London, 3–18. Retrieved September 9, 2012 from http://www.springerlink.com/index/10.1007/978-0-85729-476-0_1
15. Steve Harrison and Paul Dourish. 1996. Re-place-ing space: the roles of place and space in collaborative systems. *CSCW '96: Proceedings of the 1996 ACM conference on Computer supported cooperative work*: 67–76 0–89791–765–0.
16. Debby Hindus, Scott D. Mainwaring, Nicole Leduc, Anna Elizabeth Hagström, and Oliver Bayley. 2001. Casablanca: Designing Social Communication Devices for the Home. ACM Press, 325–332. http://doi.org/10.1145/365024.383749
17. Tejinder K. Judge, Carman Neustaedter, and Andrew F. Kurtz. 2010. The family window: the design and evaluation of a domestic media space. ACM Press, 2361. http://doi.org/10.1145/1753326.1753682
18. Minna Kynsilehto and Thomas Olsson. 2012. Checkpoints, hotspots and standalones: placing smart services over time and place. ACM Press, 209. http://doi.org/10.1145/2399016.2399049
19. Jung-Joo Lee, Siân Lindley, Salu Ylirisku, Tim Regan, Markus Nurminen, and Giulio Jacucci. 2014. Domestic appropriations of tokens to the web. *Proceedings of DIS2014*, ACM Press, 53–62. http://doi.org/10.1145/2598510.2598542
20. Maria Lewicka. 2011. Place attachment: How far have we come in the last 40 years? *Journal of Environmental Psychology* 31, 3: 207 – 230. http://doi.org/http://dx.doi.org/10.1016/j.jenvp.2010.10.001
21. Aviaja Borup Lynggaard, M. G. Petersen, R. Gude, and M. Mortensen. 2010. Home awareness: connecting people sensuously to places. ACM Press, 416. http://doi.org/10.1145/1858171.1858251
22. Daniel Miller. 2008. *The comfort of things*. Polity, Cambridge; Malden, MA.
23. Mudassar Ahmad Mughal, Jinyi Wang, and Oskar Juhlin. 2014. Juxtaposing mobile webcasting and ambient video for home décor. *Proceedings of the 13th International Conference on Mobile and Ubiquitous Multimedia*, ACM, 151–159.
24. Elizabeth D. Mynatt, Jim Rowan, Sarah Craighill, and Annie Jacobs. 2001. *Digital family portraits: supporting peace of mind for extended family members.* ACM Press, 333–340. http://doi.org/10.1145/365024.365126

25. Edward Relph. 1976. *Place and placelessness*. Pion Limited, London.
26. Abigail Sellen, Rachel Eardley, Shahram Izadi, and Richard Harper. 2006. The whereabouts clock: early testing of a situated awareness device. *CHI '06 extended abstracts on Human factors in computing systems*, ACM, 1307–1312.
27. Kalpana Shankar, L. Jean Camp, Kay Connelly, and Lesa Huber. 2012. Aging, Privacy, and Home-Based Computing: Developing a Design Framework. *IEEE Pervasive Computing* 11, 4: 46–54. http://doi.org/10.1109/MPRV.2011.19
28. Finland Statistics. 2011. *Free-time Residences 2010*. Retrieved April 1, 2016 from http://tilastokeskus.fi/til/rakke/2010/rakke_2010_2011-05-26_kat_001_en.html
29. Alex S Taylor, Richard Harper, Laurel Swan, Shahram Izadi, Abigail Sellen, and Mark Perry. 2007. Homes that make us smart. *Personal Ubiquitous Computing* 11, 5: 383–393.
30. Yi-Fu Tuan. 2011. *Space and place: the perspective of experience*. Univ. of Minnesota Press, Minneapolis, Minn.
31. Phil Turner and Susan Turner. 2006. Place, Sense of Place, and Presence. *Presence: Teleoperators & Virtual Environments* 15, 2: 204 – 217.
32. Jinyi Wang, Mudassar Ahmad Mughal, and Oskar Juhlin. 2015. Experiencing Liveness of a Cherished Place in the Home. *Proceedings of the ACM International Conference on Interactive Experiences for TV and Online Video*, ACM, 3–12.
33. Mark Weiser and John Seely Brown. 1996. Designing calm technology. *PowerGrid Journal* 1, 1: 75–85.
34. Craig Wisneski, Hiroshi Ishii, Andrew Dahley, et al. 1998. Ambient Displays: Turning Architectural Space into an Interface between People and Digital Information. In *Cooperative Buildings: Integrating Information, Organization, and Architecture*, Norbert A. Streitz, Shin'ichi Konomi and Heinz-Jürgen Burkhardt (eds.). Springer, Berlin, Heidelberg, 22–32. Retrieved December 2, 2015 from http://link.springer.com/10.1007/3-540-69706-3_4
35. Susan P. Wyche and Marshini Chetty. 2013. "I want to imagine how that place looks": designing technologies to support connectivity between africans living abroad and home. ACM Press, 2755. http://doi.org/10.1145/2470654.2481381
36. Salu Ylirisku, Jacob Buur, and Line Revsbæk. 2016. Resourcing in Co-Design. *Proceedings of the DRS2016 conference*, Design Research Society.
37. Salu Ylirisku, Virtu Halttunen, Johanna Nuojua, and Antti Juustila. 2009. Framing design in the third paradigm. *CHI '09: Proceedings of the 27th international conference on Human factors in computing systems*, 1131–1140.
38. Salu Ylirisku, Giulio Jacucci, Siân Lindley, et al. 2013. Designing Web-Connected Physical Artefacts for the "Aesthetic" of the Home. *CHI '13 Proceedings of the SIGCHI conference on Human factors in computing systems*, ACM Press, 909–918.
39. Salu Ylirisku, Giulio Jacucci, Abigail Sellen, and Richard Harper. 2015. Design Research as Conceptual Designing: The Manhattan Design Concept. *Interacting with Computers*. http://doi.org/doi:10.1093/iwc/iwv040