The Ambient Calendar

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Abstract. It is becoming difficult to convey information from an ever-increasing number of digital sources to users in a condensed and meaningful way. This growth has particularly occurred with peripheral information sources. These are of general interest to users, but do no require or typically command constant focus or attention. Examples include weather, stock data, blogs, and calendars. Ambient Displays present information unobtrusively in an intelligent fashion using abstract visual cues and metaphors and have the possibility of acting as a complement to information filtering systems. We describe the implementation of an ambient display that contains elements representing time, weather, public transport departure times, and the proximity of friends. An initial impact study was undertaken and found a high sense of usefulness and curiosity in the finished application and in the field as a whole.

1 Introduction

With the growth of the Internet, users are increasingly bombarded with larger amounts of visual and textual information, including news and weather, blogs, message boards, emails and RSS feeds. It is becoming increasingly difficult to convey this information in an easily accessible and understandable manner. One approach to conveying such information in a more condensed and meaningful way is the use of *Ambient Displays*, which utilise visualization techniques to publish information in an unobtrusive manner.

Ambient Displays uses abstract metaphors and visual cues to inform

Fig. 1. The Ambient Calendar

users of peripheral information sources, rather than an explicit text-based means (Section 2). For example, Figure 1 shows a cartoon image that may be situated in a living room or office. This image could be decomposed into different elements, with characters in the foreground, clouds, trees and mountains in the
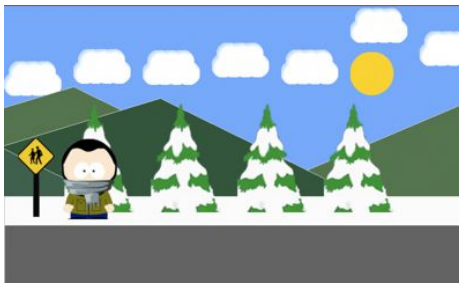
background, and a sky with clouds and a sun, each associated with a data source. By changing the elements in the image, e.g., by making them larger or changing their colour or shape, we can convey something about the underlying information.

We developed *The Ambient Calendar*, an ambient display that represents calendar information, and information from other Internet and local sensors (Section 3). Instead of explicitly telling a user that there are events in the calendar, the system conveys this implicitly by putting clouds in the sky. By glancing at the display and seeing a cloudy sky the user can tell that they have a busy day ahead. Major influences for this project include the prototype ambient display outlined by Neely et al. [1], and the *InfoCanvas* developed by Stasko and Miller [2]. A novel aspect of The Ambient Calendar is that it locates proximate Bluetooth devices and personalises the display's content for nearby users.

Like traditional art, the appeal and perceived usefulness of an ambient device is subjective and varies from person to person. A short preliminary user study was undertaken (Section 4) to investigate the initial impact and acceptance of the display, and to inform refinements before a longer study is carried out. This was done using a combination of observations as users interacted with the display, and through the application of heuristics. The results of these early evaluations show that users are highly intrigued by the concept, and find the finished product generally informative and useful.

2 Background

Wisneski et al. [3] highlighted the issue that interactions between people and digital information are entirely confined to graphical user interfaces that involve traditional input devices (e.g., keyboard and mouse). They proposed the *ambientROOM*[1] — an environment populated with ambient devices, each representing an individual data source (as shown in Figure 2). Wisneski et al. used the concepts outlined by Weiser [4], who described a *Ubiquitous Computing* environment as being technologically saturated and interconnected. He described good ubiquitous computing as consisting of *calm technologies*, which disappear into the background of human attention and become second nature. Calm Technologies aim to be unobtrusive and should go unnoticed until an important or unexpected event brings them into the foreground [5].

Vande Moere speculates that ambient displays could be considered appliances of *persuasive visualization* [6]. The author proposes that the concept of ambient display is becoming more persuasive as increasing numbers of information visualizations are used to highlight important issues. Examples include social and environmental concerns, health, welfare and economic data. The true usefulness of ambient displays, the author argues, may lie in the conveyance of these important issues in a more effective manner by informing users about personal interests on a personal level.

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[1] More information on the ambientROOM available on their homepage `http://tangible.media.mit.edu/projects/ambientroom/`

In order for ambient displays to reach their potential, artificial intelligence techniques must provide the basis of a dynamic back-end to provide and filter information and determine when an unobtrusive element becomes more explicit. In terms of traditional AI, Ramos argues that certain aspects of the field can be augmented to the ambient information paradigm to assist in supporting the users activities and better decision making with access to essential knowledge [7]. This notion is termed *Ambient Intelligence* (AmI). Ramos proposed that features of traditional AI concepts such as Machine Learning, Planning, Knowledge Representation, Speech Recognition, and Computer Vision can all assist in a more useful human-interactive system [7].

2.1 Examples in the field

Several ambient displays have been implemented in the past few years ranging from the physical icons of the MIT ambientROOM, to wearable ambient displays that relate to biometric data of the wearer [6] to the Apple Mac OS X bouncing dock icons.

The ambientROOM uses a mixture of light, physical motion and airflow, as well as physical icons to represent activities in the local environment [3]. Above a desk in the room sits a partially transparent glass pane with liquid encased. As the lab's pet hamster runs in its wheel, the liquid encased in the glass pane ripples informing its owner that the hamster is active.

The *InfoCanvas* allows users to create and personalise scenes based on data sourced online. The display depicts a colourful beach panorama that could tell the user that it is a late hour (as the boat is on the right-most edge), and that the user's stocks are down (as the bird is closer to the ground). The artifacts in the InfoCanvas are personal to the owner and the metaphors are deliberately abstract and subjective. The InfoCanvas can be seen as much a piece of art as an information display.
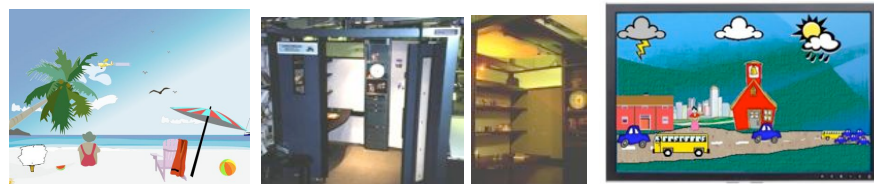

Fig. 2. Stasko and Millers InfoCanvas, the MIT ambientROOM and Neely et al.'s Visual Calendar [1]

Neely et al. proposed a Visual Calendar prototype (shown in Figure 2) that they used to demonstrate how different types of information might be conveyed in an ambient fashion [1]. Their prototype depicts a small town with artifacts

that move from left to right of the display depicting time, as well as other artifacts that represent traffic and weather information. The image conveys location information by using graphical representations of school, office, and work, along with avatars of friends or family members of the user. This approach is similar to Microsoft Research's *Whereabouts Clock*, which displays family members' remote location on a clock display situated in the home [8]. The work presented here is based on Neely et al.'s original Visual Calendar proposal.

3   Implementation
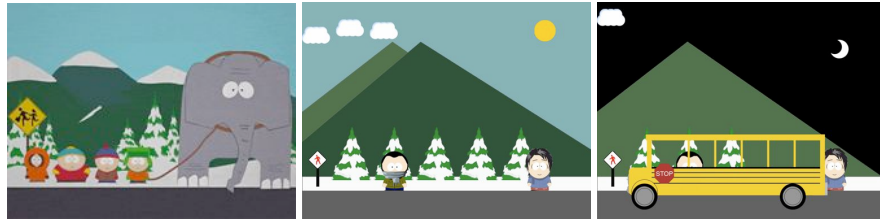
Fig. 3. A scene from *South Park*, and some states of the Ambient Calendar

The main approach considered was how to convey information in a meaningful manner using a single image, whose constituent parts can be decomposed and treated as individual metaphors, while generating an intelligent data gathering and filtering back-end that could manipulate each of the images' constituent parts. The visualization is intended to mimic of a piece of art or scene that is generally familiar to users. As such, we decided to use a screenshot from the popular television show *South Park*[2] (the first image in Figure 3) as inspiration. The image shows an everyday scene, with a variety of artifacts, including avatars, which have been shown to be useful in ambient displays [9].

A mapping between the individual elements and potential data sources can then be considered. The scenes in Figure 3 show the Ambient Calendar in various states. The display owner has five calendars subscribed (represented by the trees), is associated with two blogs (represented by the mountains), has three *remaining* events today in their calendar (represented by the clouds), their public transport is approaching (shown in the modified bus stop symbol), and there is a nearby friend associated with a Bluetooth Device name (represented by the female avatar on the right).

The other images in Figure 3 represent other times of the day. The middle image conveys to the user that it is mid evening, that they have a busy evening

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[2] Image taken from http://www.southparkstudios.com/ - South Park is a copyright of Viacom Inc.

ahead with numerous events. The user is associated with three blogs, as well as numerous calendars. The final image shows a display at night time. There is one more event in the calendar for that day, the user in question has one blog associated with them, and their public transport (represented by a bus) has just arrived (the public transport information comes from the Dublin Luas[3] online timetable).

We use Construct[4], a distributed context-aware framework [10, 11], to store, distribute, and query for information used by the display. Construct can be deployed on multiple systems, and uses zero-configuration networking technologies to allow for resource discovery on local networks. This is useful for distributing ambient information around a network and will make it easier to implement intelligent collaborative or public ambient displays in the future.

4   Evaluation

Mankoff et al. [12] outline methods and tools for defining characteristics of an effective Ambient Display. We initially planned to assess the common ambient properties of usability, aesthetics and peripherality using a heuristic evaluation. This involves the use of users who would analyze and critique the device based on a set of criteria, for example, visibility of structure. In the field of ambient information systems, evaluation aims to explain how often a display is used, how much it improves the life of its users, and how the system becomes learned *sufficiently well* by its users.

Mankoff et al. designed a list of heuristics specifically engineered for analysis of ambient displays. They argued that an earlier list of heuristics derived by Nielsen and Molich [13] did not relate to ambient displays, but rather human-computer interaction (HCI) as a whole. The evaluation of ambient displays is inherently problematic; they require relatively little traditional physical interaction beyond initial setup and visual contact. We generated a questionnaire from these seven heuristics that allowed our test subjects to quantify to what extent they agreed with each. These are outlined below:

- **Q1**: Did you find the kinds of information relevant and useful?
- **Q2**: Was the display obtrusive or interrupting?
- **Q3**: Did the display attract attention of others?
- **Q4**: Was there a feeling of Information Overload whenever you interacted with the display?
- **Q5**: Did you understand the information conveyed after you were introduced to the display?
- **Q6**: Did you understand the overall content when glancing at the display?
- **Q7**: Was the display aesthetically pleasing?

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[3] The Luas is Dublin's public transport tram system

[4] More information is available from Construct's homepage: `http://www.construct-infrastructure.org/`

Mankoff et al. discuss the proper conduct of these evaluations, and argue that tests should be longitudinal, lasting several weeks/months and be closely evaluated by trained usability experts of at least 5 years experience. It is our opinion that although the method using trained experts would produce accurate results, it is not an entirely definitive or complete manner of evaluating the usability of such devices. This is because these devices are user-centric by design, and if they were to reach any manner of prevalence it would be among users who have a wide variety of experiences using Information Technology, from Novice to Expert.

With this premise under consideration, a questionnaire and usability study was drafted to evaluate the usefulness of the display. It was targeted at four "user groups", namely *Novice* (those who rarely use computers), *Medium* (those who use it for a single purpose, perhaps work), *Experienced* (those who use IT at home and work frequently), and *High* (these users were fourth year Computer Science students) The following sections discuss this experiment in greater detail, along with the results and analysis.

4.1 Experiment

To evaluate the Ambient Calendar, a qualitative Heuristic evaluation outlined in Mankoff et al. was used. The display was placed in numerous situations for short periods of time. There were eight test subjects, (termed Subjects A, B, C, D, E, F, G, H). Subjects A and B were novice users, C and D were office workers who had basic training with IT interactions, E and F were experienced computer users, and subjects G and H were Computer Science students with an introductory understanding of ambient technologies, and an advanced knowledge of Information System design. This spread of user qualifications and backgrounds intends to highlight the different responses due to the qualitative study. The display was positioned in various peripheral locations. Subjects A and B took the experiment in a domestic setting, and the remaining subjects took the evaluation in their workplace or lab. Each subject evaluated the display over a period of one hour.

Experiment Results and Conclusions

The overall evaluation results (Figure 4) show high satisfaction among all the subjects. The overall results show the display is a generally useful, clearly mapped and aesthetically pleasing application. There was also little feeling of information overload during interactivity. Although these are generally positive results, some problems were highlighted. For instance, there was an average score of 3.1 out of 5 in terms of misunderstanding the information after the visual elements were initially explained.

Those who identified themselves as being *Medium* or *Experienced* users said the information was highly useful, unobtrusive and aesthetically pleasing. During post-evaluation interview, all but one of the subjects (Subject E) stated the display had "attracted significant attention from colleagues", which spawned
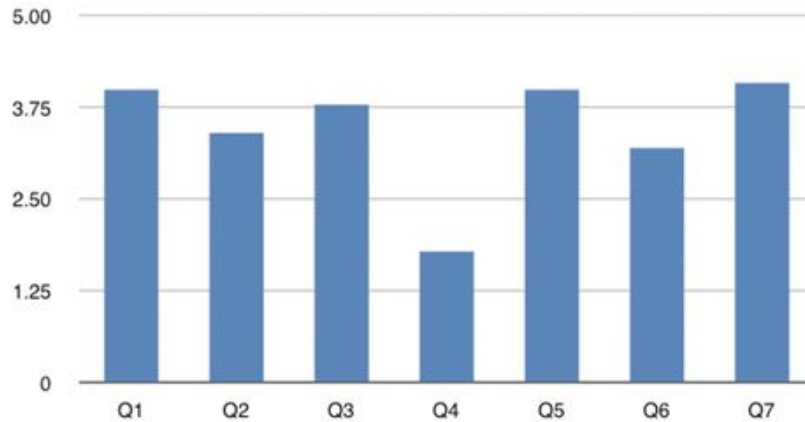
Fig. 4. Results of User Questionnaire. Eight subjects were asked a set of questions on their experiences of the Ambient Calendar, based on Mankoff et al.'s heuristics. Answers range between 1 (I strongly disagree) to 5 (I strongly agree).

debate and discussion regarding the displays purpose and use. This is similar to an anecdote outlined by Vande Moere, where he states the visual element can incite debate on interpretations of visual elements among users [6].

Those who were part of the *Novice* cohort showed satisfaction for the display, however they felt the information was not as useful as the other users, perhaps due to their lack of use for some of the calendar's data sources. They also required more prior training in the use and purpose of the display compared with the other subjects. By contrast, members of the High understanding cohort required little training prior to the experiment. These respondents found the display to be useful, and explained that the usability of the display was satisfactory, and stated in the post-evaluation interview that it had attracted "considerable attention from classmates and colleagues, but this was slightly distracting".

5 Conclusions and Future work

This paper describes the implementation and preliminary impact study and evaluation of an ambient display that visually represents a user's calendar information and other peripheral data of interest. The components that gather information from both local sensors and Internet data sources provide a wide range of information for use in the Ambient Calendar. The gathered data in visualised in a calm, unobtrusive and aesthetically pleasing manner.

The heuristic evaluation undertaken found that users displayed a high sense of usefulness and curiosity in the finished application and in the field as a whole. Some of the issues that arose were in relation to the visual mapping among the least computer literate subjects. This highlights the difficulties in representing

detailed data with a highly abstract image. Our future work will focus on the trade-offs that exist between presenting abstract personal information, and information that is easily interpretable to others. We will also investigate the most appropriate visual metaphors for different types of information.

The evaluation was valuable in verifying the usefulness of the display, however one limitation of the study is that similar evaluations involved longitudinal studies (over many weeks or months), carried out by trained usability evaluators [12]. Although this would produce high quality results, our contention is that involving users of varying knowledge and experience will provide valuable information. User-centric technologies should be tested among the cohorts whose later uptake is the key to them becoming prevalent. We are planning a more longitudinal study which will investigate Weiser's view that if people learn a technology sufficiently well it will simply disappear into the background.

The Ambient Calendar can be extended in several ways. As speculated by Vande Moere [6], we believe that ambient displays can be useful in persuading users to take actions. With AI techniques such as those discussed in Ramos, and particularly recommender algorithms, more intuitive and useful displays can be devised. We will exploit other online sources, such as social networking sites, for rich information to aid in the personalization of the display's content. We are also investigating how other nodes of the Ambient Calendar running on the local network can be used to convey collaborative or shared information.

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