AuraOrb: Social Notification Appliance

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Abstract

One of the problems with notification appliances is that they can be distracting when providing information not of immediate interest to the user. In this paper, we present AuraOrb, an ambient notification appliance that deploys progressive turn taking techniques to minimize notification disruptions. AuraOrb uses eye contact sensing to detect user interest in an initially ambient light notification. Once detected, it displays a text message with a notification heading visible from 360 degrees. Touching the orb causes the associated message to be displayed on the user's computer screen.

We performed an initial evaluation of AuraOrb's functionality using a set of heuristics tailored to ambient displays. Results of our evaluation suggest that progressive turn taking techniques allowed AuraOrb users to access notification headings with minimal impact on their focus task.

Keywords

Attentive User Interfaces, Ubicomp, Ambient displays, Notification devices, Information Awareness

ACM Classification Keywords

H5.2. Human computer interaction: User interfaces.

Introduction

In today's workplace, users are often distracted by incoming notifications of emails, phone calls and system status messages [5]. Although users currently have a one-to-many relationship with the ubiquitously connected devices that surround them, device dialogue design is still based on a one-to-one relationship with the user. Consequently, each device tries to dominate user attention without taking into account the demands of other devices, tasks or people. This behavior leads to frequent inappropriate notifications that may disrupt the primary task focus of the user.

Rather than modeling notification behavior of devices on a one-to-one relationship with the user, the paradigm of Attentive User Interfaces (AUI) [15] proposes that we use the turn taking techniques employed by humans in conversation as a design metaphor. In multi-party conversations, humans use peripheral nonverbal cues such as eye gaze to decide when they should speak or be silent [16]. We believe negotiation of interactions with groups of computers will benefit from a similar pattern. Sensing user attention determines whether the user is actually interested in a notification, before deciding to move into the foreground. This idea is called progressive turn taking, and is a primary means for achieving the goal of AUI: an optimal distribution of user attention across multiple tasks.

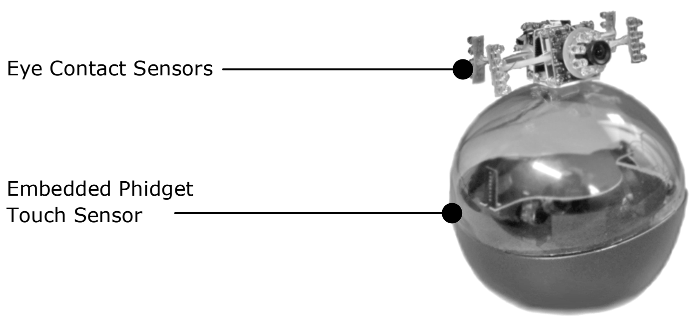

Figure 1: AuraOrb with Eye Contact Sensors and Embedded Phidgets Touch Sensor [11].

Background and Motivation

One of the key design aspects of Ubiquitous Computing is the notion of Calm Computing [17]. Although computing devices are now ubiquitous, most are not designed to be calm. They are binary machines, making fluent movements from ambient to foreground states difficult. In general, most computers are ill equipped to detect user interest in their communications.

One of the first papers to address the design of Calm Computing was ambientRoom [7]. One of its design criteria was to allow users to absorb information parallel to a focus task by deploying visual channels low in symbolic content. For example, the lighting system in the ambientRoom was designed to simulate the sun's pattern of illumination to subtly indicate time of day. A wall-mounted clock allowed users to verify the exact time through a foreground symbolic display.

Ambient Orb™ [1], which uses gradual changes in color to notify the user of information, was one of the first commercially available ambient notification devices. Although it has an aesthetically pleasing design that conveys information in a non-disruptive manner, the limited output of the display prevents any foreground interactions.

A notification display that provides foreground interactions is the Scope [14]. Scope displays multiple notifications using a radar-like visualization window. The radar is initially displayed at the bottom right corner of the user's desktop. When the user moves their cursor onto the Scope, the window doubles in size, and moves to the foreground, allowing access for more detailed information.

One exploration of the design space that lies *between* ambient and foreground information display is LumiTouch [2], a pair of picture frames used to indicate remote presence. For space restrictions, we limit discussion. Related research in peripheral and ambient displays can be found in [3,10].

In many ambient and peripheral displays, the looking behavior of users functions as a means to move from background to foreground, fluidly altering the resolution and abstraction level of the perceived information between eye movements. Humans are able to negotiate their communications along the same lines, and with great subtlety, as the following scenario illustrates:

"Jeff is in his office, having a phone conversation. He left his door open to signal to others he is available for communications. Alex walks up to Jeff's office to ask him an urgent question. Alex could interpret the open door as an invitation to interfere with the ongoing phone conversation. However, he has a number of progressive signals at his disposal to signal his request. First, Alex positions himself so that Jeff can see him. Proximity and body movement indicate the urgency of his message without verbal interruption. This allows Jeff to establish the urgency of Alex's message, and wait for a suitable moment in the phone conversation to grant the interruption. A brief glance by Jeff at Alex may signal unavailability. Sustained eye contact from Jeff serves as an invitation to Alex to take the floor. Should Jeff decide to ignore Alex's request for attention, Alex may choose to move out of Jeff's visual field, thus withdrawing his interruption request."

The subtlety of the above interaction patterns is typically lost when interacting with computing devices. The scenario serves as a metaphor that inspired our design of AuraOrb.

AuraOrb Design Principles

We envisioned AuraOrb as a social appliance [5], an ambient notification device that uses information about user interest to determine its notification strategy. Informed by the above previous work, we identified the following design principles that helped guide the development of AuraOrb:

Principle 1. Avoid Foreground Display

When a user is conducting a primary task with a foreground display, that display should not be used to provide a visual notification if that notification does not lead to immediate action [9]. The user should be allowed to determine the priority of the notification prior to shifting his or her focus task allocation.

Principle 2. Sense User Interest Across Devices

To determine user interest in their information, devices should sense when they are being attended to. By sharing this information among devices, disruptions can be kept to a minimum. This was first employed in EyePliances [12].

Figure 2a: AuraOrb displaying ambient notification in user's periphery using colored light.

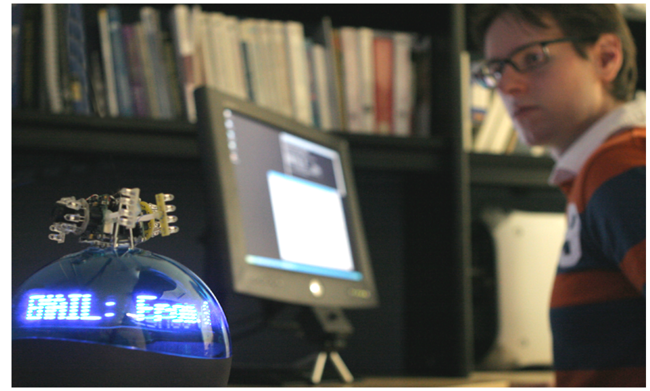

Figure 2b: Upon eye contact, AuraOrb displays the header of the message on its tickertape display.

Principle 3. Negotiate User Attention
The use of sensors can support intelligent negotiation of interruptions, which can aid in avoiding task disruptions [4]. By moving into the foreground only when interest is detected, AuraOrb can fluently go from background to foreground styles of display.

Interacting with AuraOrb
AuraOrb is connected to EyeReason [12], a personal communication monitor that tracks all interactions between its owner and her computing devices. The following scenario illustrates AuraOrb's functionality and progressive notification levels: ambient, semi-foreground and foreground.

User Kyle is writing an article using a word processor on his desktop workstation. Kyle has configured his AuraOrb to notify him of incoming messages. Figure 2a shows how Kyle's workstation display is augmented with an eye contact sensor. This allows Kyle's personal EyeReason server to determine when he is engaged with his primary display. When an email arrives, EyeReason notices that the primary display is occupied. AuraOrb immediately lights up. Kyle sees the light appear in his peripheral vision but does not yet shift his attention to the orb. AuraOrb maintains a steady glow. When he looks at the orb, it instantly displays the subject and sender of the email (Figure 2b). He notices the email is from his mother and decides to read it. Touching the orb causes EyeReason to open a message window in the foreground on Kyle's workstation, and return the orb to an idle state.

AuraOrb IMPLEMENTATION
AuraOrb was designed using a modified Olympia Infoglobe OL3000 caller ID device [18]. We augmented the Infoglobe with eye contact and touch sensors that allow AuraOrb to detect varying levels of user interest.

Eye Contact Sensors
Mounted on the top of the AuraOrb are two eye contact sensors (ECS) [13] that are capable of detecting eye

contact from a distance of up to 1 meter. A computer vision algorithm is used to examine images produced from a camera augmented with infrared LEDs. The software looks for a corneal glint in the center of the pupil, which indicates eye contact.

Touch Sensor

To allow AuraOrb to detect foreground interactions, we integrated a capacitive touch sensor Phidget in the body of the orb. To detect touch through the plastic globe, we secured strands of thin copper wire along the inside perimeter.

Visual Output

AuraOrb has two display modalities: an ambient glow and a ticker tape text display. The inside of the Infoglobe was coated with a reflective paint. This paint is transparent under normal lighting conditions, but glows when illuminated. The ambient light is controlled via a Phidget [11] relay switch. The Infoglobe provides a 36-character Caller ID display visible from any angle. Messages were formatted for display on the globe by interfacing with software that allowed us to generate Caller ID format wave output [19].

Evaluation

We performed a heuristic evaluation of AuraOrb using a modified set of heuristics tailored for ambient displays, proposed by Mankoff et al. [8].

Eight participants were recruited for the heuristic evaluation. Ages ranged from 23 to 35, all male. Three of the participants were usability experts. The remaining five evaluators were graduate students with previous experience in heuristic evaluation.

For the purpose of the evaluation, a single AuraOrb was positioned within arm's reach next to a 17" screen displaying an email client. Prior to the test, participants familiarized themselves with the heuristics. To simulate a focus task, evaluators were asked to type the contents of an arbitrary newspaper clipping into a word processor presented on the main screen. The email client was not visible during this task, as it was minimized in the task bar. Participants were sent email notifications that interrupted their task. We sent single emails as well as batches of emails that simulated a sequence of notifications.

Results

The majority of the usability problems identified were centered around hardware limitations of the device. For example, participants noted that emails containing a long subject header were truncated on the orb display. We can attribute this problem to the limited number of characters supported by the Infoglobe hardware. Another problem was that upon the arrival of a notification, the Orb went from its idle state to ambient light notification rather suddenly. Our prototype UV cold cathode tube could not be dimmed to provide a smooth transition.

However, participants enjoyed using AuraOrb with progressive notifications. The eye contact sensing afforded the ability to display headings without having to switch tasks or use the mouse or keyboard. Results of our evaluation generally suggest that progressive turn taking techniques allowed AuraOrb users to access notification headings with minimal impact on their focus task.

Conclusion

In this paper, we presented AuraOrb, an ambient notification display that deploys progressive turn taking techniques. AuraOrb uses eye contact sensing to detect user interest in an initially ambient light display. When eye contact is detected, AuraOrb displays the subject heading of the notification. Touching the orb causes the associated message to be displayed on the user's last attended computer screen. When user interest is lost, AuraOrb automatically reverts back to its idle state. We conducted an initial heuristic evaluation of AuraOrb's progressive notification techniques. The participants commented that the fluid transition to additional information upon eye contact allowed them to more quickly evaluate whether to accept or ignore the notification. It is our belief that the use of progressive turn taking techniques may lead to a more sociable and less disruptive notification strategy.

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