AMBIENT 2016

The Sixth International Conference on Ambient Computing, Applications, Services and Technologies

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AMBIENT 2016

Forward

The Sixth International Conference on Ambient Computing, Applications, Services and Technologies (AMBIENT 2016), held between October 9 and 13, 2016 in Venice, Italy, was devoted to a global view on ambient computing, services, applications, technologies and their integration.

On the way for a full digital society, ambient, sentient and ubiquitous paradigms lead the torch. There is a need for behavioral changes for users to understand, accept, handle, and feel helped within the surrounding digital environments. Ambient comes as a digital storm bringing new facets of computing, services and applications. Smart phones and sentient offices, wearable devices, domotics, and ambient interfaces are only a few of such personalized aspects. The advent of social and mobile networks along with context-driven tracking and localization paved the way for ambient assisted living, intelligent homes, social games, and telemedicine.

We take here the opportunity to warmly thank the members of the AMBIENT 2016 technical program committee, as well as all the reviewers. The creation of such a high quality conference program would not have been possible without their involvement. We also kindly thank all the authors that dedicated much of their time and effort to contribute to AMBIENT 2016.

Also, this event could not have been a reality without the support of many individuals, organizations and sponsors. We also gratefully thank the members of the AMBIENT 2016 organizing committee for their help in handling the logistics and for their work that made this professional meeting a success.

We hope AMBIENT 2016 was a successful international forum for the exchange of ideas and results between academia and industry and to promote further progress in the field of ambient computing, applications, services and technologies

We also hope that Venice, Italy, provided a pleasant environment during the conference and everyone saved some time to enjoy the unique charm of the city.

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The Persuasive Potential of Lighting: Exploring User Lighting Setting Preferences for a Warm Room Atmosphere and Energy Consumption Feedback

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***Abstract*—Ambient lighting can be used for influencing users' experience of the environment and their subsequent (energy consumption) behavior. Our research explored which lighting settings users prefer for lighting that is designed to give a room a 'warm' atmosphere and for lighting that is used as energy consumption feedback. In the experiment, three lighting characteristics (brightness, color temperature, and color hue and saturation) could be adjusted through an interactive interface according to participants' preferences. Results showed that for creating a 'warm' atmosphere, lighting with a low luminance, a low color temperature, and a highly saturated, warm color (i.e., orange/red) was preferred. For providing negative feedback about energy consumption, lighting with a high luminance, and a highly saturated, red color was preferred. Thereby, current results suggested that ambient lighting's persuasive potential might be most optimal when lighting settings are used that are appropriate to a situation.**

Keywords-Ambient Lighting, Persuasive Technology, Energy Conservation, Lighting Characteristics.

I. INTRODUCTION

Earlier research showed that ambient lighting can be used for influencing (energy conservation) behavior [1]. Thereby, lighting is used as ambient persuasive technology (e.g., [2] - [6]). More specifically, earlier research effectively used colors of ambient lighting as feedback to indicate a user's energy consumption level, e.g., more red for higher energy consumption and more green for lower energy consumption [7] - [9]. Research [8] showed that colors of ambient lighting feedback can carry meaning that has pre-existing associations with energy consumption and these associations help users to easily process the feedback messages, and thereby enhance the effectiveness of ambient persuasive technology.

In addition to using colors of ambient lighting to communicate feedback, other characteristics of lighting (e.g., brightness level, color temperature etc.) can also influence users' experience of the ambient lighting, their environment, and importantly, their subsequent behavior [6]. For instance, people prefer 'warm' lighting (i.e., lighting with a low color temperature) in winter [10], and household energy consumption for heating systems could be reduced by 5% to 8% by using this 'warm' light in winter while maintain the same thermal comfort level [11].

To expand our knowledge on how lighting settings are able to influence energy consumption behavior, the current research investigated which lighting settings users prefer for lighting designed to give a room a 'warm' atmosphere and for lighting that is used as energy consumption feedback. That is, participants were seated in a room of which they could set the lighting characteristics (brightness, color temperature, and color), and participants were asked to set lighting characteristics to their preferences for two types of scenarios. In the first series of scenarios, participants were to set the room lighting characteristics such that room lighting gave the room a warm (or fresh) atmosphere. In the second series of scenarios, participants were asked to indicate which room lighting characteristics they would prefer the room lighting to have when that lighting was to be used to give them (positive or negative) feedback about their energy consumption (e.g., caused by heating the room).

II. METHOD

Fifteen participants (11 males and 4 females) aged between 17 and 35 participated in the experiment, all without a known visual handicap (e.g., color-blindness). Participants received 5 Euros for their participation in the experiment that lasted approximately 30 minutes. The experiment was computer-based and conducted in the Lighting Lab in the IPO building at the Eindhoven University of Technology campus.

Participants were welcomed and seated in a room in which they could set the lighting characteristics. The settings interface allowed them to change three characteristics of the room lighting: Brightness, Color temperature, and Color (both hue and saturation). Participants could select one of these characteristics at a time, and change its settings using the 'right' and 'left' arrows on a computer keyboard.

After participants had gotten familiar with the interactive lighting system, they were asked to set the room lighting to their preferences for a series of room atmosphere scenarios. That is, participants were presented with a scenario (e.g., "you are feeling a bit chilly and you want to create a warm atmosphere with the light"), and then could set the lighting characteristics to their preferences for that scenario. In half of the scenarios, participants were asked to create a 'warm'

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atmosphere, and in the other half of the scenarios, participants were asked to create a 'fresh' atmosphere.

In the next task, participants were presented with a different series of scenarios, and asked to indicate which lighting settings they would prefer for receiving energy consumption feedback through changes in room lighting. For this, participants were first given a short introduction: "We are currently performing research on how lighting can be used as feedback to stimulate energy different behavior in home environments. For example, lighting can provide the feedback to inform you to turn down the temperature, use less water, shut down devices that are not in use, etc." Next, participants were asked to set the lighting characteristics for a series of scenarios related to saving energy and resources (e.g., "You've set the bathroom temperature to 28 Celsius degrees, although it will not be used until tomorrow morning. How can lighting inform you that the temperature is set too high?" as an example of negative lighting feedback). For one scenario at a time, participants were asked to set lighting characteristics to their preferences, using the room lighting interface. In half of the scenarios, participants were asked to set the lighting such that it indicated negative feedback, and in the other half of the scenarios, participants were asked to set the lighting such that it indicated positive feedback. Finally, participants were thanked for participation, paid and debriefed.

III. RESULTS

Results showed that for giving a room a 'warm' atmosphere, participants preferred lighting with 1) a lower luminance, 2) a lower color temperature, 3) higher saturated, and 4) warmer colors (i.e., orange/red), compared to the lighting settings participants preferred for giving a room a 'fresh' atmosphere (all p's$< .05$).

Furthermore, results showed that for receiving negative energy consumption feedback, participants preferred lighting with 1) a higher luminance, and 2) a higher saturated 3) color with a lower hue (i.e., red light), compared to lighting settings participants preferred for receiving positive energy consumption feedback (all p's$< .05$).

IV. DISCUSSION

The current research explored which lighting settings users prefer for lighting designed to give a room a 'warm' atmosphere and for lighting that is used as energy consumption feedback. The results of this study describe the lighting settings users prefer for these two purposes, and thereby add to our knowledge of people's associations of lighting characteristics with room atmosphere and heating (energy consumption) feedback, and thereby of the persuasive potential of lighting. The current results suggest that this persuasive potential might be most optimal when lighting settings are used that are appropriate to a situation. This research studied basic lighting characteristics (brightness; color temperature; and color, both hue and saturation), and future research might assess other characteristics of room lighting (e.g., patterns, movement, etc.). Based on the current results, future research can investigate the effectiveness of changing these characteristics of lighting for actually changing people's perception of ('warm') room atmosphere, temperature perception, effectiveness of energy consumption feedback, and ultimately, the effectiveness of ambient lighting changes for influencing energy consumption behaviors.

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We would like to thank Martin Boschman for technical assistance during the experiment.

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Review of Activity Measuring Techniques For Assisted Living Systems

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***Abstract*—An individual's Activities of Daily Living (ADL) are difficult to accurately measure in Ambient Assisted Living (AAL) systems. Such ADLs are invariably, in part, verified using technologies requiring key user interactions. The User Interface (UI) applied to these living systems is critical in order that the elderly achieve their daily living milestones of health supervision, social engagement, physical movement or daily prompts. In order to bootstrap effective machine learning necessitates accurate daily user interaction. This paper reviews AAL system interface's and seeks to establish if ADL measurement accuracy could improve if UI's were prioritised within system development.**

Keywords-*Ambient Assisted Living: Measurement Techniques: Activities of Daily Living.*

I. INTRODUCTION

Population aging is an issue in the European Union with those aged 65 years or over increasing from 17.1% to 30.0% in 2060 (84.6 million in 2008 to 151.5 million people in 2060) [1]. As we age our health becomes more complicated and our ability to sense accurately, disseminate information at speed and conduct various tasks simultaneously decreases dramatically. Consequently elder's living independent lives, find that over time their ADL performance diminishes they become burdened with daily chores and AAL UI's unburden them from the ADL's limiting their daily lives. Multiple UI's assist the elderly such as, the MONAmI project encouraging social participation [2], the i2Home project UI [3] and the Universal Remote Console (URC). ADL interfaces for the kitchen have also been addressed in the SWEET-HOME project utilising voice command for automating a home, with a speech activated assistive kitchen and the Smart Kitchen [3] offering nutritional advice on food in real time. The research spotlight on AAL and ADL systems has concentrated on UI's enabling elder's to live independently. ADL monitoring is difficult to measure accurately and research conducted in purpose-built labs is not representative of the systems available for commercialisation or those being currently used in homes on a daily basis. UI design is critical within the area of AAL as its success dictates a system's usability. Good User Interface (UI) design regularly quote Neilsen's 10 usability heuristics [4] in conjunction with Shneiderman's 8 golden rules [5], whilst other design principles [6] are utilised less frequently. Research studies within the area of UI's for the elderly include a universal interface design [7] using touch-based and multimodal user interfaces. Viewing the elderly as a combined age group has been encouraged yet their user interaction could be observed for usability as two separate groups of (65-80yrs) and (80+yrs) [8]. Several research studies acknowledge that UI usability between younger and elderly adults is very different [9] but not between the two elder age groups [10]. This paper reviews AAL system UI's, their subsequent usability for users and seeks to raise the question, that if greater emphasis was placed upon UI design could ADL measurement subsequently improve.

Section II deals with Buxton's framework and how humans interact with Ambient Assisted Systems, thereafter Section III reviews UI design guidelines and they're subsequent inculcation in the various systems throughout Europe. The original framework of Buxton is extended in Section IV to incorporate subtle human-computer interactions. Section V in turn proffers UI usability recommendations while Section VI examines the conclusions drawn from this review of UI methodologies applied to AAL systems and the methods available for measuring human-computer interactions in order to facilitate ease of use and uptake.

II. HOW HUMANS INTERACT WITH COMPUTERS

A basic framework categorising the subject areas of computing [11] (see Fig.1), constituted a foreground and background, indicative of conscious and un-conscious tasks. This framework established how humans interacted with computers and that the success and failure of AAL systems relied upon the technological ability of the user. All interactions, whether implicit or explicit, were in the foreground when required [12], otherwise in the background. AAL interaction ought to be ubiquitous, operating in the background as the user interacts in the foreground.

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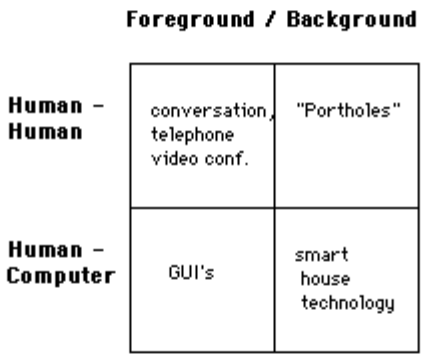

Figure 1. The Basic Model

The UI's should incorporate features such as, ease of use for medical professionals, carer's or elder's and be productive in their ability to enable effective human-computer interaction. Systems utilising UI's that support effective user interaction result in greater uptake [13]. Conversely varying UI's on different devices affect user uptake and impede the older user's ability to successfully navigate the technology [14]. Commonality in UI design for the elder user should be central to best practice guidelines and it's prioritisation within AAL system development is paramount in order to improve usability and ADL measurement possibilities.

III. UI Design Review

A. UI Research Design Approaches

Usability is fundamental to good UI design [15] and the pivotal role it plays has received significant coverage in conjunction with the challenge of interweaving technological advancement into our modern lives. The UI needs to facilitate the user in executing their desired tasks and this occurs if the interaction is intuitive and seamless. Designing for interfaces must include those factors which influence how humans interact with, and process information, while executing other tasks [16]. Ambient Intelligence (AmI) [17] over time has permeated many computer science areas of together with engineering, biosciences and education. The involvement of Human-centered Computing (HCC) [18] approaches to interface design has resulted in more effective methodologies being implemented. Many typical AAL system users have no medical or technological training, yet are often required to input and assimilate data spanning both these fields. Systems acclaimed to be most effective have utilised icons to represent ADL's**.**

B. A Review of ADL Measurement Techniques in Assisted Living Systems

Previous reviews of AAL systems [19] have expressed concerns regarding UI development costs and data protection issues which have produced inefficient designs leading to insufficient uptake. Design frameworks that support adaptable UI's for user's with complex medical and social needs is a goal for AAL researchers [20]. System effectiveness has been reviewed and several productive systems developed, UniversAAL [21] being Europe's leading research platform. Projects such as, Soprano [22], Persona [23], Amigo [24], Oasis [25] and MPower all strive to work toward the goal of a baseline open source platform for researchers. Europe's prominent AAL systems are reviewed to ascertain the emphasis ascribed to UI design and it's role within the system's architecture. AAL systems proclaiming self-organisation include Persona an AmI system with a UI framework, platform modules and it aims to offer independent living options for elder's. Self-learning ambient systems such as Soprano rely on the user for inputting manual commands conveyed through sensors and actuators, UI's for medicinal reminders [26] physical exercise programs and social interactivity. Soprano's Ambient Middleware (SAM) is the technical core which receives user commands. Systems promoting independent rural living include Remote [27] for those with conditions, such as hypertension, asthma, Alzheimer's and Parkinson's disease. Tele-healthcare services [28] record daily biometric readings in conjunction with physical movements and at-risk scenarios UI's enabling the complex health needs of the users and their technological abilities are offered on several devices and the project was considered a success in that sensor monitoring decreased cardiac mortality rates.

Open source platforms such as MonAMI assist elder's with ADL's, improving security and health monitoring living options [29] via user friendly UI's for wearable devices. User-friendly interfaces are accessible through internet browsers encouraging social interaction with family/friends thus supporting independent living options. Emerge [30] assists elder users with monitoring and accident prevention through sensors providing ambient supervision and reasoning in emergency situations. ADL evaluation [31] is logged and deviations from expected routine behaviours enable swift detection of situations requiring intervention. The Human Capability Model (HCM) is the resultant medical file of the elder created in association with their medical experts. The I-Living Project developed an assisted living environment for embedded devices (sensors, actuators & displays) which could operate individually or cooperatively in the Assisted Living Hub (ALH) [32]. The Secure Active Aging: Participation and Health for the Old (SAAPHO) Project facilitates elder involvement as it prioritises usability features by utilising interface tools to increase user interaction and uptake. Another project, which focused on the importance of interface usability for ADL monitoring, was the Home Sweet Home project in Ireland which evaluated the impact of tele-monitoring on an elder's life. The physiological and mental health, living environment factors and ADL reminders was evaluated for its effect, if any on the participants lives. A simple user-friendly interface supervises each user's health and well-being through the information collated from various sources including, environment sensors, video conferencing and other enabling services.

IV. UI DESIGN FRAMEWORKS

In 2008 the basic Human-Computer interaction framework was expanded to include an axis of relevant criteria, (see Fig. 2) [33] accommodating more subtle, implied interactions that occur as humans and machines exchange information. Traditional computing can manifest as implicit or explicit and interactive exchanges are along a continuum that either demand a user's attention with a command or responds to a command initiated by the user. Reactive interactions are typically user initiated while proactive are system initiated. AAL systems demand implicit and explicit communications as a consequence of user demands for unobtrusive systems. Achieving a information exchange is the key to success and it cannot appear within the user's attentional foreground. AAL systems need to be in the foreground if required by the user and fade into the background when the need for them has been responded to.

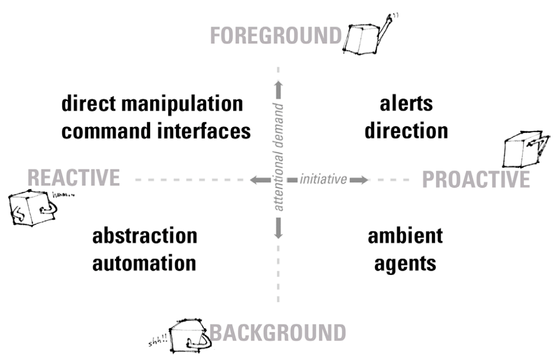

Figure 2. Implicit interaction framework with a range of interactive system behavious.

The original framework and the extended version contends that human-computer interactions can be plotted along a continuum of activities counter-balanced against the degree of invasiveness for the user. Critical to the evaluation of UI design is the emphasis in AAL systems of the scales of balance for the user. The goal is system adaptivity whereby it assists when requested or when a scenario requires direct intervention. This evaluation theory encourages independence not isolation, inclusion not exclusion and facilitates communications from either direction. AAL systems that acknowledge UI design guidelines and prioritise these have the ability to be truly effective in assisting the user with their ADL's. If standardisation within assisted living development became a goal then the possibility of improving and harmonising ADL measurement would ensue as a result.

V. RECOMMENDATIONS

This paper postulates that pre-existing UI design guidelines for the elderly should be adhered to when creating and implementing AAL systems in unison with Nielsens and Shneiderman's usability guidelines. The four primary areas of focus in designing for the elder user include vision, hearing, mobility & cognition, with specific suggestions for each area of concern. AAL UI design should incorporate dynamic interfaces capable of autonomically adapting to the specific needs associated with the user's age and medical condition progression. Representation from both distinct elder groups is required when testing systems to ensure increasingly complicated daily living needs are accommodated. AAL designers acknowledge the UI usability differences between these two elder groups yet continue to combine them into a single homogeneous group when designing and testing systems. A reasonably healthy 65yr old with IT skills has radically divergent AAL system requirements to an 85yr old with limited mobility, attention span and IT skills.

VI. CONCLUSION

Ambient systems provide users with daily living assistance. They generally present in a myriad of forms, providing condition specific forms of support, are more or less ambient and demand greater or lesser user interaction. UI's affect uptake which impacts directly upon usability. Those achieving commercial success have tended to employ highly stylized and easily recognisable icons to represent ADL's. Given ambient systems require subtle user interactions from an audience which will become progressively more infirm then perhaps the only solution is that of multi-modal UI's [34] which are dynamic and fulfill the users needs at any given point in their health continuum. Adaptivity of the system interface tracking the longitudinal progression of age, circumstance and condition is paramount for system adoption and persistence. This benefits users as the interfaces remain familiar and gracefully and seamlessly evolve to reflect the capabilities of the senior citizen as their condition/age progresses. Research has shown [35] that an AAL system providing UI's for elder's that exhibits reasonable functionality, is both physically and cognitively usable and consequently has the ability to extend the independent lives of those using them and impact positively on those assisting the elder. This paper advances the view that AAL usability will be improved, firstly as a result of UI prioritisation within system development facilitating ADL measurement and secondly through the development of adaptive interfaces sensitive to the evolving needs of the individual.

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