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ScienceDirect

Procedia Computer Science 52 (2015) 690 – 694

Procedia Computer Science

The 6th International Conference on Ambient Systems, Networks and Technologies (ANT 2015)

Turning Leaf: Eco-visualization for Mobile User Engagement

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Abstract

Awareness of environment trends and global warming is widespread, but personal knowledge of energy consumption is not provided in real-time or in an actionable manner to individual consumers. Using recent work in eco-visualization, an innovative mobile application has been developed, depicted with a turning leaf. The illustration of individual energy use in a mobile hand held device is designed to improve awareness while encouraging personal conservation. Additional user motivation may be present, with the turning leaf symbolizing turning over a new leaf or encouraging positive social behaviors. The mobile application is illustrated, with an analysis of the motivation and behavior which would be expected from energy-aware users.

Peer-review under responsibility of the Conference Program Chairs

Keywords: eco-visualization; mobile application design; human computer interaction.

1. Introduction

The most pressing environmental issues of the early 21st century are the accumulation of carbon dioxide (CO2) and global warming. With a global dependence on fossil fuels to meet the energy needs of worldwide growth and development, the amount of fossil fuels that are burned annually has increased exponentially over the years. This increasing annual consumption rate has resulted in a corresponding increase of CO2 concentration. Reduction of energy consumption is one of the first actions the global community can collaboratively take to reduce the growth of

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Peer-review under responsibility of the Conference Program Chairs
doi:10.1016/j.procs.2015.05.076

CO2 emission. Energy consumption reduction is also the most inexpensive and feasible alternative to counteract rising temperatures related to climate change. To do this, the energy consumption behaviour of consumers should be analysed and presented in an accessible, informative manner.

As part of the increasing number of smart grid deployments, smart meters are being installed in residential homes and buildings. A smart meter is "a device that collects and measures the data about energy usage and power quality at each consumer's location"[1]. The data collected by smart meters has an important role in smart grid applications and can also be used to enable energy consumption behaviour analysis. However, processing and analyzing smart meter data is very challenging, because of its volume, frequency and variety. To highlight the importance of the need to conserve power consumption, we need to find the ways to inform householders of how electricity is being consumed within their home in a way that does not require an understanding of how energy is measured, what those measurement units are, and what those units mean; but at the same time communicate how much energy a total home is consuming in a relative manner. This identifies a need for the integration of eco-visualization concepts into a mobile application. The eco-visualization patterns related to specific household characteristics may influence occupant behaviour[2,3] and can lead to significant differences in energy usage[4].

2. Previous Research

Numerous climate change reports have discussed increasing global temperatures and sea levels. There is no fixed or easy solution to combat our deteriorating environment. The United States has one of the highest levels of annual CO2 emissions levels overall and per capita in the world[5]. Innovative ways for reducing electricity consumption must be identified. Eco-visualization is a combination of art and technology to dynamically represent environmental data permitting individuals to understand and see the effects on environment. Earlier research[7] states that "consumers generally have negative attitudes toward mobile advertising unless they have specifically consented to it". It has been found that push notifications are often considered by users as "forced upon" them and are often ignored, deleted or disabled by users, unless the users are really interested in getting certain messages.

A very popular form of environmental research is eco-feedback or eco-visualization[6,8]. A well known public environmental art form is *7000 Oaks and counting* installation by Tiffany Holmes. It uses everyday imagery to communicate the energy usage in the building. It starts with healthy green trees revolving and as the day passes by the trees are replaced by electric appliances to show the electric consumption, in hope of persuading people to use less. It was found that "ambient display can boost the awareness of their everyday and micro-habits, so they are motivated to change them"[9]. A comparative analysis was done to understand the effect of different visualization styles in persuasive media. A figure of coral reef, and a digital display for electricity consumption were compared and it was found out that the former was more effective in inducing behaviour change amongst participants. This also calls for the definition of ambient design as used in this research paper. Ambient display is defined as "an information system that displays information that is important but not critical, can move from the periphery to the focus of attention and back again, provides subtle changes in the environment, and is aesthetically pleasing"[10].

3. Design and Implementation

With increasing concern about electricity consumption and the effect on environment, a solution which appeals to people across cultures, spaces and at all times is needed. The solution must be imperative, so that people do not ignore it, and encourage personal accountability, such that individuals feel personally involved or responsible towards environmental outcomes. With the widespread adoption of the smart phone, mobile phone users seem to be a clear user community for the needed services. Smartphone users are people of all ages, throughout the day.

As consumers have a negative attitude towards mobile advertising[7], consumers must be reminded about electricity consumption without feeling intruded upon or pushed. Numerous research studies[11] have suggested that people remember and relate to things which appeal or arouse emotion in them. Taking the facts above into consideration, a design model was developed that would appeal to human emotions, remind them of their electricity consumption, and let them understand environmental data in an easy way. A mobile widget, to be installed on the mobile phone, along with a mobile application for home energy monitoring, was designed. A leaf image appears on the mobile home screen as a small icon to depict the home user's current daily electricity usage in simplest form to