Ambienizer: Turning Digital Photos into Ambient Visualizations

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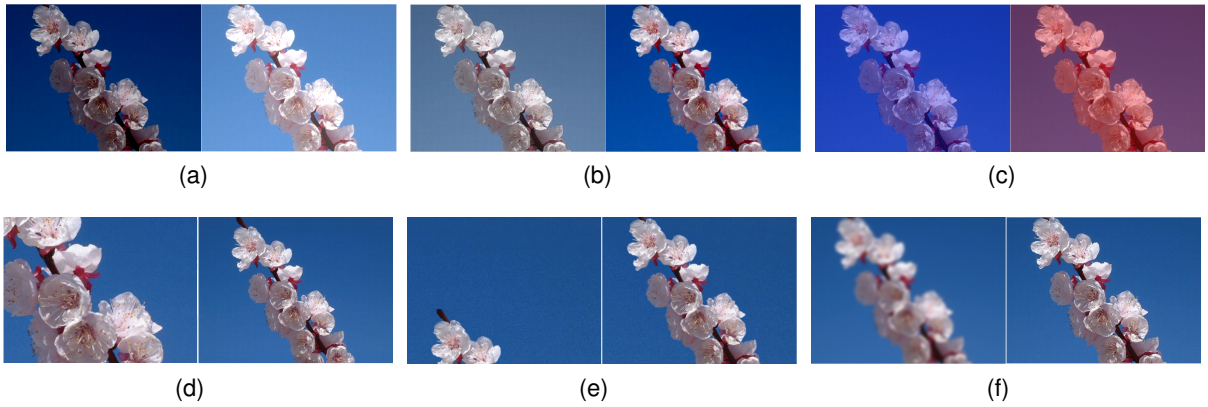

Figure 1: Data encoding techniques in the Ambienizer: color modification techniques (top) and the content modification techniques (bottom): (a) lightness: dark and light, (b) saturation: low saturation and high saturation, (c) warmth: cool and warm, (d) zooming: zooming in and out, (e) size modulation: short and tall, and (f) blurriness: blurry and sharp.

Abstract

The Ambienizer is a visual encoding approach that seeks to convey a user's personal data in a casual non-technical way. In the Ambienizer, a user can choose any image and map any of the provided image processing techniques to the variables from personal data. In this work, we use the Ambienizer in the context of monitoring household energy use. We allow the user to compare the user's energy consumption with a social norm, a past consumption, or a targeted consumption.

Index Terms: Human-centered computing—Visualization—Visualization design and evaluation methods

1 Introduction

Traditional information visualization systems are of great aid to experts in analyzing data. However, some systems to visualize data from everyday life are targeted to not only visualization experts but also to visualization novices. For these systems, traditional information visualization approaches can be inappropriate because not every user desires professional data analysis or has the same background knowledge and experience in information visualization [7]. Similar to traditional information visualization systems, any information communication system that is geared towards the general public in a non-work environment should allow users to view information easily. Additionally, an artistic and aesthetic approach for the system incorporated in users' daily environments is an intriguing option for engaging the users with their own data [8].

To address these needs, ambient visualization approaches were introduced. The concept of ambient visualization satisfies the requirements noted above and also enables the communication of information in an unobtrusive near-subconscious manner [7]. To convey information in this way and do so in a visually pleasing manner, previous approaches included preset paintings, images, or simple shapes [8]. However, customization of ambient visualization is important to accommodate the user's artistic taste and to blend with his[1] surrounding environment because each user has different artistic preferences, and the ambient visualization systems can reside in any environment [8].

Coincidental to the emergence of ambient information, digital cameras and mobile devices with a built-in camera have become very popular in the last decade, allowing almost anyone with such devices to easily take and share photos. Digital cameras enable people to set photos as a backdrop on a mobile device and/or a computer. This trend offers strong potential to exploit photos from these devices as metaphors of ambient visualization systems.

In this paper, we present the Ambienizer, a visualization approach that uses any image and applies various image processing techniques to that image. The goal of our approach is to convey information with an aesthetically pleasing display with the purpose of engaging users. We use household energy consumption data as an example of the Ambienizer since this is a topic of growing importance. Energy consumption data has a diverse user base that is a prime audience for ambient visualization approaches, and visualization of energy consumption can encourage people to conserve energy [1]. Moreover, visualizing energy consumption requires some tasks such as comparison and goal-setting for users [3], which are essential tasks in visualizing personal data [4].

To address these requirements, the Ambienizer provides two encoding methods to depict both current and accumulated energy consumption (cumulative energy use for a certain period of time) at the same time, which can allow users to understand their energy consumption. Each encoding method has three image processing techniques and allows a user to set goals and/or compare between his consumption and a social norm to encourage energy conservation by showing two images rendered with the data. Additionally, the Ambienizer supports a user in comparative analysis tasks with different data granularities, such as weekly, monthly, and yearly views.

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[1] 'he' and its derived forms ('him', 'his', and 'himself') are used in a gender-neutral sense in this paper.

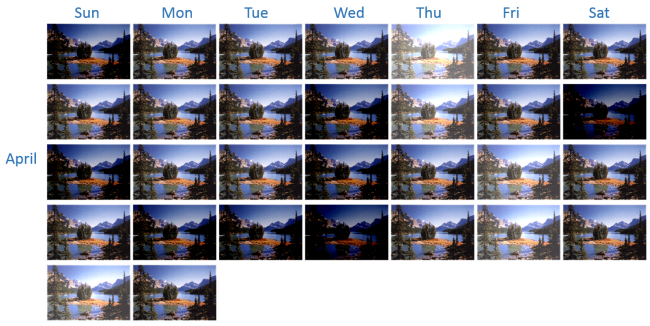

Figure 2: An example of the monthly self-comparison view.

2 The Ambienizer

In the Ambienizer, information is mapped through image processing techniques to satisfy all of these requirements because people can comprehend the gist of an image at a glance [6] and easily download images from the web or use images from their own photo albums.

2.1 Representation of data

The goal of the Ambienizer is to show an image and at the same time to provide meaningful information with aesthetic satisfaction. To represent current energy consumption and accumulated energy consumption in one image, we design two encoding methods: color modification and content modification. In the color modification and the content modification, we change the color of each pixel in the image and modify the content of the image to encode data, respectively. For each encoding method, we present three image processing techniques to satisfy various personal artistic tastes (Figure 1): lightness, saturation, and warmth for color modification; zooming, size modulation, and blurriness for content modification.

Based on existing literature [5,9] and the result of our preliminary study, we map data to one of the image processing techniques. First, we categorized the energy data into five values: extremely low, low, average, high, and extremely high. For extremely high (extremely low) data, we turn an original image into lighter (darker), highly saturated (less saturated), reddish (bluish), zoomed-out (zoomed-in), sharper (blurrier), or an image with a tall(short) object. Average energy consumption is always represented by an original input image. The other levels of data values such as low and high are represented by linearly interpolating a value of extremely low or high state and a value of the input image.

2.2 Goal-setting and social comparison

Setting goals and comparisons is one of the essential components in an eco-visualization system because it stimulates a user to change his behavior [3]. Thus, we add functionality that enables a user to set his own goal and compare between the current and a desirable future status. People can also be motivated by social comparison [3]. Thus, the Ambienizer can also be employed for social comparison by displaying a social norm, for example, to compare the user's current consumption to the average of his neighbors. We put two images side by side to help the user understand the difference between the two images for goal-setting and social comparison.

2.3 Self-comparison

Visualizing up-to-date data such as current energy consumption and accumulated energy consumption is only useful when it is comprised of short periods of energy use. If one accumulates data for a long period, such as more than one month, data about the accumulated energy consumption is useless since it only shows an increase of energy use. Thus, we should save the data periodically. However, if a user views the saved data one by one, he cannot effectively measure how much he reduced or increased his electricity use.

Several studies have shown the effectiveness of self-referenced feedback where one's current behavior is compared to his previous behavior (i.e., self-comparison) [2]. From this point of view, a self-comparison of energy data sets is essential so that the user can recognize how efficiently he consumes energy, by comparing his current consumption to his past consumption [3].

For displaying the user's past data, we arrange images similar to the calendar visualization [10]. The Ambienizer can show the data with different levels of granularity such as weekly, monthly, and yearly views, depending on the user's preference (Figure 2).

3 Conclusion and Future Work

We have presented the Ambienizer, a visualization approach for ambient visualization that uses consumer photography and applies a variety of image processing techniques to convey information. The Ambienizer can be used on any peripheral display, such as a backdrop or a screen saver on a computer, or a mobile device. As a specific scenario to demonstrate the Ambienizer, we have chosen in-home energy use since this scenario is of pressing interest and potentially reaches a highly diverse mix of users.

In the current prototype, we have created images encoding low and high energy consumption by linearly interpolating a value of extremely low or high state and a value of the input image. However, we found that users do not linearly perceive some features such as lightness and saturation. In the future, we will investigate precise mapping methods for encoding techniques. Additionally, we will evaluate refined versions of our prototype in longitudinal studies to assess several aspects such as the comprehensibility, attractiveness, and awareness of the encoding techniques in real households and the impacts on a user's behavior changes.

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