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ECOISLAND: A SYSTEM FOR PERSUADING USERS TO REDUCE CO_2 EMISSIONS

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Abstract
A significant portion of the carbon dioxide emissions that have been shown to cause global warming are due to household energy consumption and traffic. EcoIsland is a computer system aimed at persuading and assisting individual families in changing their lifestyle patterns in a way that reduces CO_2 emissions. The system builds on our earlier work on persuasive ubiquitous computing applications, and applies ideas from behaviorism, social psychology and emissions trading to attempt to motivate changes in users' behaviour. In this paper, we briefly describe the concept and the theories behind it, and provide preliminary results from a user study measuring its effectiveness.

1. Introduction

According to Intergovernmental Panel on Climate Change [1], global warming caused by greenhouse gases released into the atmosphere through the actions of man is a major threat to the earth's ecology. Efforts to reduce greenhouse gas emissions come in two forms: technological solutions and changes in human behaviour. Technological solutions broadly include improving energy efficiency and developing cleaner energy sources. Dramatic changes in human behaviour may also be necessary if catastrophic climate change is to be avoided.

Public and private efforts to change individual behaviour towards more environmentally friendly practices usually rely on education, but there are psychological limits to the ability of education alone to effect behavioral change. Even when a person well knows that a particular behavior is so detrimental to their long-term well-being as to offset any possible short-term benefits, their may still irrationally choose the short-term indulgence. Future consequences, while widely known, are easily ignored in the present.

In our earlier work on *ambient lifestyle feedback systems*, we used ubiquitous computing technology to construct a virtual "Skinner box" to motivate children to adopt correct tooth brushing patterns [2]. The system monitors the user and rewards desirable behaviour using techniques familiar from computer games, while punishing undesirable behaviour. This approach may be described as falling in the general field of *captology*, computers as persuasive technologies [3].

In *EcoIsland*, we apply a similar approach to attempt to motivate behaviour changes that reduce CO_2 emissions. Compared to the earlier work, *EcoIsland's* design is informed by a richer psychological theory and includes a complete "virtual economy" for emission rights trading. The purpose of the work is to study the applicability and effectiveness of these techniques for persuasive purposes.

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2. The EcoIsland concept

EcoIsland is a game-like application intended to be used as a background activity by an ecologically minded family in the course of their normal daily activities. A display installed in the kitchen or another prominent place in the household presents a virtual island. Each family member is represented on the island by an avatar (Figure 1). The family sets a target CO_2 emission level (e.g. national average minus 20%) and the system tracks their approximate current emissions using sensors and self-reported data. If the emissions exceed the target level, the water around the island begins to rise, eventually sweeping away the avatars' possessions and resulting in a game over.

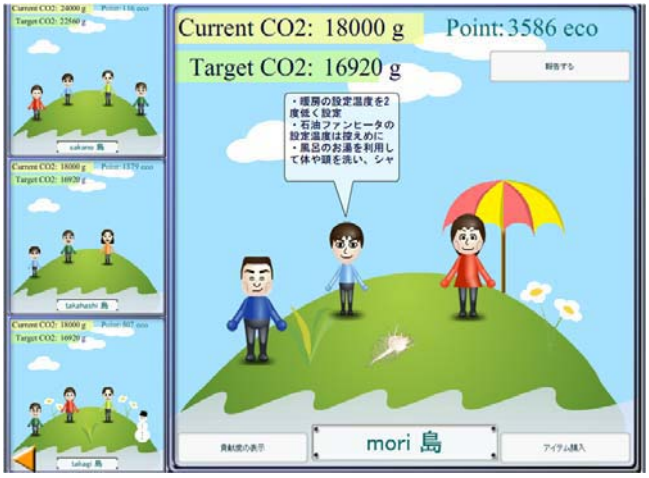

Figure 1. EcoIsland main visual

On their mobile phones, the participants have a list of actions that they may take to reduce the emissions: turning down the air conditioning by one degree, taking the train instead of the car, et cetera. Upon completing an action, a participant reports using the phone, and the water level reacts accordingly. Reported activities are also shown in speech bubbles above the corresponding avatars. A lack of activity causes the avatars to suggest actions.

Participants can also see neighbouring islands and their activities in the display, and can list buy and sell offers for emission rights on a marketplace. Trading is conducted using a virtual currency obtained from a regular allowance. The credits are also used to buy improvements and decorations to the island, so successful sellers can afford to decorate their island more, while heavy emitters have to spend their allowance on emission rights.

3. Persuasive techniques

The general approach from ambient lifestyle feedback systems is to provide a feedback loop for user behaviour. The virtual island shown in the display acts as a metaphor and makes the participants conscious of the ecological consequences of their choices and activities.

We also tap into social psychology, attempting to exploit *social facilitation* and *conforming behavior* to encourage the desired behaviour. Social facilitation is the phenomenon where a person performs better at a task when someone else, e.g. a colleague or a supervisor, is watching [4]. Conforming behaviour is the desire not to act against group consensus [5].

EcoIsland's design facilitates these by involving the whole family, and by presenting the participants' activity reports in the speech bubbles and providing contribution charts and activity histories. On the other hand, the fact that the game is played by a family unit instead of an individual means that participants can also agree to assign tasks to certain members.

Lastly, there is the trading system, which is based on the same principle as industry level emissions trading systems: reductions should be carried out in places where it is easiest to do so. A family that finds it easy to make significant reductions can sell emission rights to households that find it difficult due to e.g. location or job. This should make it possible to attain the same amount of total reductions with a lower total cost (measured in disutility), promoting use of the system.

4. Implementation

We have developed a prototype system that implements the functionality described above, except that sensors are not yet used. Figure 2 presents the overall architecture and technologies used. The kitchen display uses Adobe Flash to render a visualisation based on data obtained from a server running the *EcoIsland* application, which is written in Java. The mobile phone clients use a normal web browser to interact with the server. The application is of the thin-client type: data is managed in a database on the server side, so that the client machine stores no data.

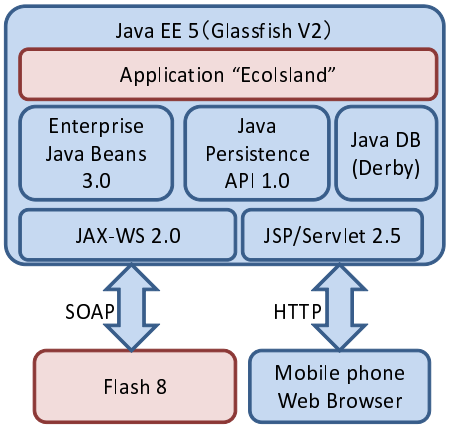

Figure 2. EcoIsland system architecture

5. Evaluation

For our first user study, we recruited six families (twenty persons) who are interested in environmental issues and live in a family. The experiment lasted for four weeks. In the first week, we equipped the participants' air conditioners with a simple *Ecowatt*[6] electricity usage meter to compare the readings between experiment weeks.

In the second week, the system was installed and only one family member from each household was asked to use it. In the third week, all family members used the system. Comparing the results of the second and third week provides insights regarding the social psychological effects. In the fourth week, we introduced the emissions trading system, and observed how it affected user behaviour. After the experiment, we conducted a survey in the form of a questionnaire asking about changes in the participants' attitudes and feedback.

6. Results and Discussion

In the survey, 17 out of 20 participants said that they were more conscious of environmental issues after the experiment than before. Several families said that the sinking virtual island contributed to a change in their consciousness, suggesting that the metaphor works well. But when asked about their motivations for the emission reducing actions they conducted during the experiment, they responded with reasons stemming from the system, such as wanting to save the sinking virtual island, purchase items and amass points, rather than using environmental reasoning.

A log of the emission reduction activities reported by the participants shows that five out of six persons reported more actions in the third week than the second week, lending support to the hypothesis that social facilitation and conforming behaviour can be used effectively. During the fourth week, only two out of six families used the emissions trading system. Ten participants reported that the target reduction levels were so easy to achieve that there was no need to resort to emissions trading. This highlights a common challenge in game design: how to set the parameters (in this case, target levels, effect of actions and currency allowances) in such a way as to provide an optimal challenge.

As for the air conditioner electricity usage recorded by *Ecowatt*, there was no observable correlation with the reported emission reducing activities. While this is an alarming result, it does reflect the fact that the experiment period was short considering ordinary day-to-day variance in electricity use. The time of the experiment (in December and January) was also such that the appliance may have been used less than normally. In the future, *EcoIsland* could be linked to a HEMS (Home Energy Management System), which would allow for a large variety of usage data to be automatically reported to the system, also enabling a much more comprehensive evaluation. However, some participants noted that the act of manual reporting itself probably contributed to the motivation, so we must be careful when replacing self-reporting with sensor data.

Work on *EcoIsland* continues, probably in the form of a larger and longer user study that among other things tries to provide an evaluation of the trading system. At the same time, we plan to apply this particular flavour of persuasive technology to other application areas.

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