GreenSweeper: A Persuasive Mobile Game for Environmental Awareness

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ABSTRACT

In this paper, we discuss *GreenSweeper*, a collaborative, mixed-reality, photo-based mobile game aimed at promoting environmental awareness. By collectively sensing the environmental landscape through photographs and text descriptions of surrounding artefacts, GreenSweeper is designed to be more than just fun, to deliver environmental messages and provoke reflection. In this paper, we briefly discuss the design and implementation of GreenSweeper, followed by a brief discussion on the value of persuasion and mixed realities in promoting environmental awareness.

Categories and Subject Descriptors

D.3.3 H5.2 [Information interfaces and presentation]: User Interfaces. - Graphical user interfaces. K.4.2.Social Issues

Keywords

Mobile games, Sustainability, Urban computing, Persuasive technologies, Serious games

INTRODUCTION

The urban landscape is constantly negotiated and re-appropriated through informal urbanities, signage, hoardings, and housing or industrial developments. However, in the midst of these urban spaces, we rarely stop to think about the damage to surrounding environmental landscape. Environmental sustainability is often treated as resulting from making conscious, environmental-friendly decisions. This form of separation from our everyday interactions posits environmental sustainability as a complex, disconnected notion. However, weaving environmental awareness into our lifestyles, by reflecting on our local surroundings and the artefacts that we use regularly, could help us better understand the world around us.

A characterising feature of infrastructures is that they are sunk into and inside of other structures, social arrangements, and technologies, adopting Star's description [6]. Urban infrastructures are fraught with issues such as increasing damage to flora and fauna, energy depletion, pollution, garbage, and toxic wastes. The embeddedness of urban infrastructures results in greater cumulative damage, which goes unnoticed until it manifests itself as a colossal catastrophe. The problem here is that we do not take notice of the surrounding environmental landscape on a day-to-day basis.

In a parallel vein, the advent of mobile devices has spurred a slew of mobile applications supporting environmental sustainability, such as the usage of mobile sensors to create maps representing environmental damage [7], and the generation of environmental data for consumer products [5]. We extend the notion of Participatory Urbanism and citizens acting as agents of change [4]. We briefly present *GreenSweeper*, a mobile, mixed reality, photo-based game designed to promote environmental awareness. By collaboratively marking out the greenness of the infrastructure, our goal is to raise awareness of surrounding environmental sustainability issues that deem further action. *GreenSweeper* makes use of photographs and text descriptions of artefacts to qualitatively define the environmental landscape. In the following sections, we will provide descriptions of the game design and technical implementation of *GreenSweeper*.

GAME DESIGN

Our motivation for *GreenSweeper* is to promote a new delivery of environmental awareness by combining game play with reflection. GreenSweeper differs from typical handset games like Snake, Tetris, or Bejweled, by layering meaning through combining elements of the real world with the virtual. It is designed to be played by pedestrians or cyclists within bounded urban grids. As a serious game, GreenSweeper informs users about the greenness of the surrounding infrastructure, by which we hope to shed light on environmental damage and impact. We initially prototyped our system to work on the UCI campus, but it could be scaled to any map. *GreenSweeper* works both indoors and outdoors, as long as a network connection is available.

GreenSweeper is motivated by Minesweeper, in that the prime goal is detecting and avoiding mines on a grid. In our game, the presence or absence of mines is determined by the level of greenness. The user first selects a square on the map, then shoots a picture of the most green/non-green object within an area, and

provides a relevant description and green/non-green tag. The map can be programmed to be any geographical map. This tag serves as input for the learning algorithm which determines whether or not there is a mine in the area. Initially the mines are chosen at random, but on reaching a convergence point with increased input from users, the algorithm thresholds out areas with more non-green tags as mines. The pictures, descriptions, and tags are sent to a public account on Flickr, which are later randomly displayed at the end of each game session, along with the user's picture history. By displaying pictures, we provide compelling visual feedback of environmental impact.

The GreenSweeper system architecture is composed of Nokia N800s connecting to Flickr photo sharing web application and an AMP (Apache, MySQL, and PHP) web server. The Nokia N800 is the front end of the system, running the GreenSweeper application that consists of the graphical user interface and game logic. The front end of the system communicates with both Flickr, to store photos, and the web server, for processing. The back end of the system consists of Flickr and GreenSweeper's web server. The web server serves the content to the Nokia N800 device and also gathers information from the user's data stored on Flickr.

We do not employ any automatic location-detection techniques; rather we gather location data from the user input. The rationale behind this design decision is to allow the device to theoretically work smoothly in any wirelessly-connected area, but by by-passing problems of General Positioning Systems (GPS) within closed doors and Wi-Fi based positioning in areas without access points. Wi-Fi based positioning is attractive, however, along with the issue of not having enough access points to cover most areas [2], there is the issue of the variance of Wi-Fi signals. In addition, due to our large environmental landscape, surveying Wi-Fi access points will be an issue. The larger variance of Wi-Fi signals seen by moving users [3] may present problematic data to *GreenSweeper's* server, for example, a location can be mistakenly reported as another.

3. SYSTEM ARCHITECTURE

Back-end:

GreenSweeper offers a game play that reflects the environmental sustainability of the area that surrounds the users by placing mines in areas that are less environmentally friendly than others. In addition, we wanted to support many users accessing the system and a system that can support a large user base and user generated data. Our goal for the backend was to create a system that allowed for scalability, reliability, security, minimal latency, and have a good performance to allow for a multiple users. To support this, we implemented a system that allowed for growth and easy integration to future development. The developed system uses various technologies to collect and generated data from and to the users.

GreenSweeper's backend is build upon an AMP (Apache, MySQL, and PHP) web server along with Flickr for photo storage. The web server provides GreenSweeper the map of mines, collect information generated by the user's game play, and display information on area's environmental sustainability. The Flickr account allows a large storage area for users to submit their photos along with meta-data that is relevant to the study, including meta-data on the game played, general location, and the greenness according to the user. The Flickr album is made public so users of the game can view the pictures of the area played to gain more information on what other users perceives as environmentally friendly/un-friendly.

The mines in GreenSweeper are generated through an algorithm using the weight based on an area's greenness. We were able to determine the area's greenness by applying a small weight to every user's photo submission. The photo submissions include meta-data on the game played, general location, and the greenness according to the user. This user generated data is stored within Flickr until a nightly update is activated on GreenSweeper's web server, in which it parses the information and updates the data accordingly. Using this data, we can effectively generating an approximation of the greenness of an area by allowing the user generated location weights within the algorithm. An area that is persistently non-green will have a higher percentage of having a mine than a location that is greener according to the users. Over a period of time, we predict the user-generated data will reach a convergence point in which the data will accurately present a map with locations of environmental friendly/un-friendly locations.

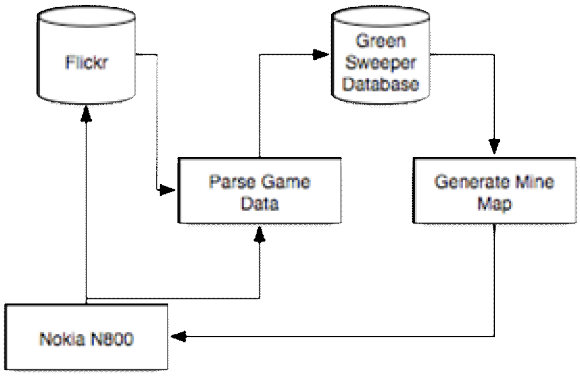

Figure 1 – High level architecture of GreenSweeper with flow of information within the system.

Front-end:

The Nokia N800 tablet was chosen for its large screen, built-in camera, and ability to connect to wi-fi networks. The user interface is written in Python using the PyGTK framework, a set of wrapper classes for the GTK+ library. The application runs on the default Maemo development platform and Hildon framework. The camera programme is written using Python bindings for the Gstreamer library, a multimedia framework.

The game logic of GreenSweeper includes network connection and mine determination. We query the mine map from the server for the particular grid, which has a total of 4 mines in 3X3 sub-grids, through Python urllib connection. Then, we notify the sever, through urllib protocol, to check photos on the Flickr album when the game session is over. Pictures taken by the user to Flickr are uploaded by emailing contents through SMTP protocol directly to the unique address of the Flickr account. Based on the mine map retrieved from the server, the user can see how many of the square's neighbours are mines. All mines explode if the square is a mine, ending the game. Also, the user can flag the square, which is equivalent to right-clicking the square and marking it as a suspected mine.

4. DISCUSSION

In this section, we will discuss aspects of GreenSweeper relevant to the theme of the workshop.

Value of Mixed Reality in Environmental Sustainability: GreenSweeper seamlessly combines elements of the real world with the virtual game play. Environmental degradation is a physical issue – it concerns changes in air quality, level of contaminants in water, amount of CFCs released by auto-mobiles, and so on. Solutions to monitor sustainability should be as close tied to the real world as possible. By creating a non-immersive environment, that mandates the player to devote equal amounts of attention to the physical and the virtual worlds, actions in GreenSweeper directly translate to and result from meaning-making in the real world.

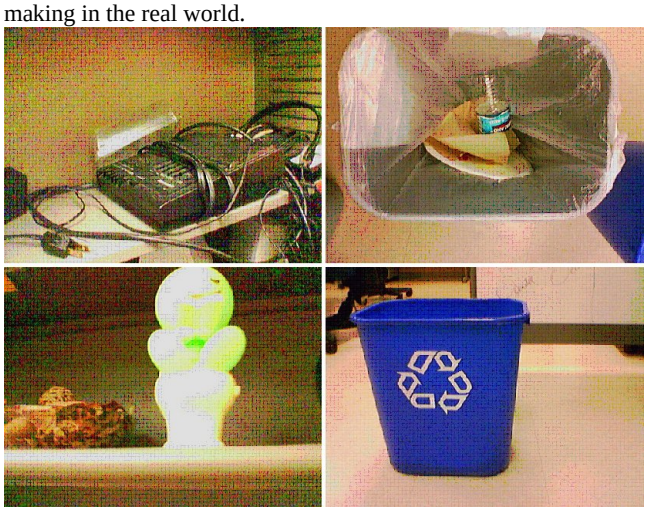

Figure 2 – Various pictures shot using GreenSweeper

GreenSweeper as a *Persuasive* ***Game:*** GreenSweeper supports existing cultural and social positions by allowing the player to document artefacts, but also contributes to influencing the position, leading to a change. When these changes are significant, the player will be motivated to act on the issue. [1] The immediate outcome of GreenSweeper is not as important as the understanding of the world. The implications of players' actions serve more than the purpose of momentary recreation or competition. The game has function and outcome, both while playing the game and outside of it.

Raising environmental awareness: Awareness of environmental issues is the first step towards building a sustainable environment. GreenSweeper underscores artefacts that are typically ignored, by forcing the user to find an artefact and evaluate its greenness. Moreover, the player has to move around the grid to advance further in the game, inherently exploring different areas. By tightly integrating data collection with recreation, we hope to highlight problems in the surrounding environment. By collective qualitative sensing, we hope to gather a range of opinions on urban infrastructures.

Deductive and Descriptive: We construct a space for two experiences – deductive, that allows game play and competition, and descriptive, that allows exploration of the area and contribution to information content. They are mutually inclusive, since the user has to describe the artefact in order to play the game. By encouraging deductive playfulness and modelling on a familiar game, we hope to sustain the interest of the player, while implicitly sampling the world.

Reflection and reflection: We speak of two kinds of reflection here – mirroring and cogitation. By displaying the player's picture history, GreenSweeper mirrors the player's pictures to reveal the import and meaning of hir actions. By displaying other players' pictures and descriptions, unpredictable, intersection/non-intersecting decisions and artefacts captured by other players are shown. This may lead to cogitation, surprise, amusement, disagreement, or approval. The game aims to bring meaning to rituals of walking, waiting, or boredom.

Protecting privacy: GreenSweeper protects privacy of the players through anonymity. Only a unique ID for every player is generated to distinguish on Flickr and for the processing, but player information is not collected. Although this does not establish reputation of the other players, we are only concerned with the information contained within the pictures and descriptions.

Ubiquity: Our motivation in making *GreenSweeper* a mobile game is to incorporate environmental awareness into the everyday practices of the user, without requiring additional infrastructure. In addition, it permits unrestricted movement of the user, hence covering a greater range of artefacts. Furthermore, it encourages pedestrian activity in tagging and covering squares of the grid.

The above pictures and descriptions were gathered informally from 5 users to rapidly evaluate our system. We are currently conducting large-scale user studies to evaluate and improve our system design. Of particular importance is the question of the impact of the size of the play grid and the population density of artefacts on the motivation of the player. Parking lots, parks, and other open areas tend to be visited rarely, so the statistics in that area affect the convergence of overall sustainability analysis. The nature of tags and descriptions and its relation to the pictures will also be evaluated. Above all, we seek to understand the value of games in promoting environmental awareness.

5. ACKNOWLEDGEMENTS

Many thanks to Prof. Bill Tomlinson for advising us and teaching the Sustainability course, both of which were invaluable in the design of the project.

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