Walk2Build: A GPS Game for Mobile Exergaming with City Visualization

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Abstract
In recent years public health has become of great concern, in particular the personal and national economic burden resulting from increasingly sedentary lifestyles. Sedentary lifestyles are particularly serious for young people who are badly affected by obesity problems that impact on their current and future lives. In an effort to tackle this problem games designers are designing games aimed at motivating people to take part in physical activities and have coined the term *exergaming*. This poster presents a mobile exergaming application developed in Android Java and HTML 5 targeting under-active teenagers and young adults. The objective is to encourage users to increase walking by an incremental number of steps each week. This is visualized as an isometric virtual town on a web browser (with rewards for achieving targets) and published on Facebook to exploit social networking in supporting users. This poster will examine the motivation behind our game, design decisions, our prototype and concludes with future plans.

Author Keywords
Exercise; healthy lifestyle; mobile support.

ACM Classification Keywords
H.5.2 User Interfaces: Input devices and strategies

Motivation

According to recent surveys and reports obesity is becoming an increasing problem worldwide. A recent survey for England shows that in 2009, 61.3% of adults were currently overweight or obese [4]. The same report estimates that, if no action is taken, by 2050 60% of men, 50% of women and 25% of children will be obese. Walking has been shown in many studies to have inverse correlation with body mass index (a measure of obesity) and to generally improve health [9, 13]. According to the International Journal of Behavioral Nutrition and Physical Activity, 7100 steps per day is an appropriate health-enhancing walking guideline for adults [12]. Walking also improves mental- health and alleviates symptoms of depression. Women who achieved over 7,500 steps per day had a 50% lower prevalence of depression than women taking fewer than 5,000 [12]. The UK's National Health Service states most people currently walk between 3,000 and 4,000 steps per day[1].

Joint university research on walking and cycling recently concluded that the image of walking itself needs to be changed. The research stated that campaigns should be aimed at and accessible to the general population, not just fit individuals or habitual regular exercisers. If more people begin walking, higher daily step counts may then be regarded as the norm [10]. In order for people to take part in any kind of physical exercise, it is often necessary to motivate them. Motivational science is based on the principals of behaviour theory [11]. Behaviour theory can be divided into three main schools of thought:

- Transtheoretical Model of Behaviour Change;
- Social Cognitive Approach or Self Efficacy Approach;
- Social participation [1].

The first approach divides the fitness of a person into various stages to maintain a certain behaviour. These stages are:

- *Precontemplation* where the person does not even think (s)he needs a change in behaviour;
- *Contemplation* where the person realises that he needs to change his behaviour;
- *Preparation* where the person prepares to act;
- *Action* where the person starts to change his behaviour;
- *Maintenance* where the person keeps up the behaviour change;
- *Termination* where the transition in behaviour changes, and at this stage it is possible that the person will relapse back to the old behaviour.

The second approach focuses on self-esteem to achieve the behavioural change, on the premise that people with low confidence are less likely to take part in difficult activities like physical exercise.

The last approach is the one we employed when designing our application. This approach uses the perception that people can use the performance of others to motivate themselves not only to start an activity but to keep it up over a period of time. Our aim is to develop a game such that as the game progresses players can constantly compare their achievements with each other and will be motivated to walk further distances.

[1] www.nhs.uk/Livewell/loseweight/Pages/10000stepschallenge.aspx

Popular social networking games can reach a potential audience of over 200 million[2], with the worldwide social networking game market being worth $3.65 billion in 2010 and estimated as $6.20 billion for 2012[3]. Social Participation and Mobile Monitoring were chosen from the possible options as it would make excellent use of current technologies. However, even without direct social sharing, social networking sites are valuable for continuous awareness as people tend to visit regularly.

Related Work

In recent years health has become a crucial issue even for game designers [11]. Game designers have started to shift the idea of gaming, from a sedentary activity to a more active one where physical exercise becomes the central mechanic of the game [5, 11]. As an example we can think of the success of the Nintendo Wii and Microsoft Kinect that use body movements to simulate sports. Even the field of arcade games, which used to be confined to pressing buttons, has started to give space to exergaming, testament to that is the success of Dance Dance Revolution. (DDR), the objective of which is to dance on a pad controller following the on-screen instruction.

Pervasive Gaming has a strong recent research history. Pervasive games are games which are not confined to a board or an electronic device but rather take place in the real world. If pervasive games are played with the use of mobile phones, the game genre becomes mobile pervasive. For example a pervasive treasure hunt would have clues distributed throughout an area which could be picked up by a mobile phone with user movement being an incidental requirement of playing the game. Our game idea is mobile pervasive but since its main objective is to motivate the user to exercise, we want to focus more directly on the exercise benefits.

The term *exergaming* was invented by Gorgu et al. [7]. Their game, *luften,* is somewhat similar to ours but was developed to function inside their university campus with players having to achieve a number of solo objectives as it did not utilise social networking functionality.

There has been some closely related work on supporting walkers. In their seminal work, Consovolo et al. identified four key design requirements for technologies that encourage physical activity:

1. "Give users proper credit for activities,
2. Provide personal awareness of activity level,
3. Support social influence, and
4. Consider the practical constraints of users' lifestyles." [2]

In the *Fish 'n' Steps* [8] and *UbiFit* [3] projects, two innovative ambient displays were created to encourage healthier lifestyles: one based on fish growth in a shared tank and one on a garden growing as a mobile phone wallpaper. Our aims were, however, slightly different in that we want to give more direct feedback and want to build on the success of social network based games such as FarmVille[4]. Related is the work on encouraging people to have more environmental lifestyles, where many of the approaches for supporting

[2] http://tinyurl.com/nielsenwire-jan10-socialmedia

[3] http://casualconnect.org/research-reports/

[4] http://www.facebook.com/FarmVille

Figure 1: Prototype client feedback

adoption and maintenance are similar to those for more active lifestyles (and well discussed in [6]).

Prototype Design

The main idea is to use mobile phones as a tool to involve players in walking activities. GPS data is recorded on an Android mobile phone application and distance travelled calculated. This distance is then converted into steps and submitted to a server. A browser based app can then show a city map graphic displaying each user's walks and progress throughout their time using the mobile app. The more steps walked in a day the taller the buildings. Similarly, the more sessions walked, the bigger and more complex the city.

Users are given an initial walking target per day. Once a week has passed the target walking distance is then increased via the mobile application to give a higher goal. Using this technique the user will slowly increase their level of walking towards a recommended level. When a user reaches these intermediate targets special building roofs are added to their city map on successful days as an additional incentive.

Social sharing and social motivation will be featured through integration with social networking sites. This will both support motivation and can act as a powerful advertising tool to spread the application – and thus, ideally, increase participation in walking activities.

Client Side Mobile Application

The purpose of the client side is to use a phone's GPS to calculate the distance walked by users and to send these to the web server to build the virtual town. We initially focussed on raw distance walked as this was simple to develop, however the visualization is based

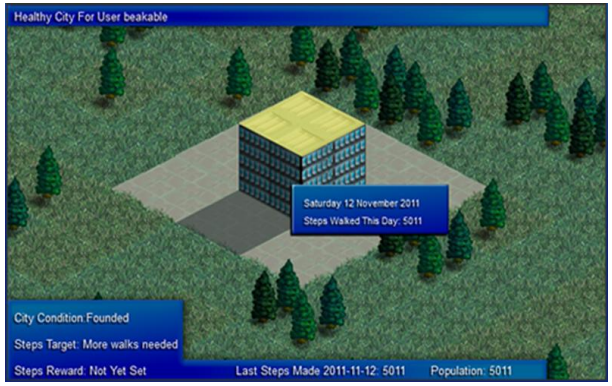

Figure 2: Initial result of one day's use

on steps as a more tangible measurement that is related to walking behaviour. At the moment the translation is based on a simple average step length. There is increasing evidence, however, that simply counting steps is not enough – people need to achieve a certain cadence (step rate) in order to gain meaningful health benefits. We are currently investigating separately recording steps taken above this threshold and our design would easily allow the visualization to adapt to show, say, boosted building heights for steps taken above the recommended cadence.

The initial aim of the application was to give new step goals to users as the weeks progressed. These step goals were to be incremented by 10% every week based on the distance that the user had travelled that week. In the current prototype, the information visible to the user is the distance travelled the current speed in metres per second and the accuracy of the GPS fix. User studies are planned to investigate what information users want while actually walking – there is a major design compromise here in that users tend to

slow down when looking at a screen. In particular, we need to investigate how to give users feedback if they have reached the cadence threshold, ideally in a non-visual way (e.g. via a vibration or auditory signal).

Server side & Web Client
As walking data had to be accessible to both the web client and mobile application an online database was required rather than local. However, the HTML5 canvas can be viewed on most modern mobile browsers.

Once identified by login, an HTML 5 Canvas displays the currently built city for the user. This city consists of a tile based isometric map displaying users' progress over the weeks which they have been using the mobile application and starts as a single city block (see Figure 2). Initially we generate and record trees randomly to give a unique consistent look to each player's city.

Once walking data is sent for each subsequent day, the server side scripts randomly position a new building per day. The blocks vary in height depending on distance walked – see Figure 3 for a sample city after 7 days walking.

To give more direct information, an overlay mode was implemented to switch from the game like graphics to a more graph like appearance showing colour coded blocks representing days of the week. A rollover popup also gives date and step information about that block.

Similar to the initially generated trees, we randomly add blocks to give variation but maintain the location once generated to increase the feeling of a personalized generated specific city. As per standard in city like presentations, the isometric map display can be rotated and zoomed. The interface around the city displays other factual information for the player such as total steps made and the size of the city.

Social Implementation

Facebook integration was implemented allowing users

Figure 3: Sample city after a week's use

Figure 4: Sample city with data overlay

to connect to the application and run the visualization. This allows users to share and post directly to their Facebook account.

Conclusion

The poster presents a novel motivational application based on building a city through walking. Walking is tracked through a mobile phone GPS application and steps are calculated to build a unique city for every user with incentive rewards to push users towards health-improving levels of walking. Each user's online game like city can be shared amongst others or via a social network to provide additional social motivation.

We are currently revising the algorithms to boost building height for steps taken when activity is above 100 steps/minute – a recommended cadence for achieving health benefits. We will then trial the applications through user studies conducted in the School of Psychological Sciences and Health.

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