Exploiting Users Natural Competitiveness to Promote Physical Activity

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Abstract. *ClimbTheWorld* is a *serious game* to promote physical activity, by asking users to climb stairs, simulating the climbing of a real building. In this paper, we describe the complete redesign of the game to improve its persuasion capability, by adding collaboration and competition between users, and micro-goals to encourage the user to do not give up. Our experiments show that the game is really effective in incentivizing people in taking stairs, in particular singleplayer modes increased the average amount of stairsteps made of about 61%, while multiplayer modes of about 64%.

Keywords: Persuasive technology · Serious games · Mobile computing

1 Introduction

The reduced or insufficient amount of physical activity is a well-known problem of modern society, which spreads across different ages, since in the recent years also children suffer from some of its consequences, e.g., obesity [2,3]. Many figures, e.g., doctors, teachers and personal trainers, constantly warn population against risks connected to physical inactivity, but they are often unsuccessful.

In the recent years, researchers have explored the possibility to use smartphones as a sort of *digital personal trainer*, since they are equipped with a set of sensors which allows to analyze and recognize users' activity. Moreover, they are already present in most users' pockets, therefore there is no need for the user to buy other expensive devices.

Many applications have been developed with the aim of persuading people to increase their physical activity. Some examples of *digital personal trainer* are "Runtastic" [11], "FitBit" [4] and "Nike + Running" [9], which propose a set of exercises, record the user performances and, sometimes, share them with users friends. Their biggest problem is that they have a very specific target users, that are people already healthy and that want to keep themselves active.

A different approach is the usage of the *serious game paradigm* to persuade users to perform physical activity while having fun. A *seriuos game* [15] is a game whose principal intent is not fun, but to hide under fun an activity which is useful for the user. In this case, the application transforms physical exercises in games. As an example, "Zombies, Run!" [12] asks to the user to run away from

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a group of zombies following him/her; the "Piano stairs" Project [14] transforms stairs climbing into music playing since each stairstep is a key of a piano.

Another example is *BeatClearWalker* [6], a smartphone Android application that asks people to do 8000 steps/day, walking in a moderate intensity. This *serious game* helps users to walk at the right cadence by reducing the audio quality of the music when the target walking cadence is not respected. *Fish'n'Steps* [8] is a *serious game* that links the walking activity with the growth and moving activity of a fish in a fish tank. Moreover, a kind of social function of the game has been introduced, since it is possible to create a sort of environment with other participants both for competition and collaboration. After the first two weeks of experiment, players' enthusiasm for the game decreased. Nevertheless, this was a really good result since the participants changed their habits and lifestyle in the meanwhile and they did not need any more the *serious game*.

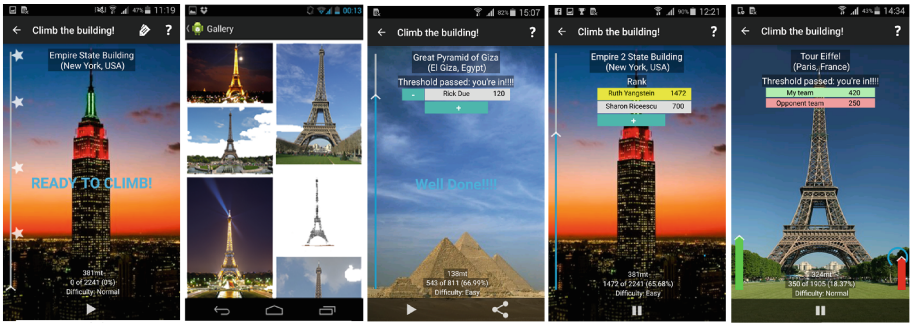
In this paper we present the redesign of our application *ClimbTheWorld*, a *serious game* to promote physical activity. It is an Android application which is able to recognize and count stairsteps. Each stairstep in a *real* building corresponds to a *virtual* stairstep. In this way the user simulates the climbing of a building each time he/she, chooses the stairs instead of elevators or escalators. Figure 1a shows the user interface of the game. When the user reaches the top of a building, he/she gains the access to a gallery of pictures about the building and the view from the top of it, as shown in Fig. 1b.

A first version of this game was presented in [1]. We aimed at understanding if it was possible to recognize stairsteps using only smartphone sensors and its limited computation capability. In this paper, we focus on improving its persuasive capability. In particular, we have added collaboration and competition between users, implementing challenges between single users or group of users. Players can also collaborate to reach the top of a very high building. We analyzed the game using the Fogg Behaviour Model (FBM) [5], and we implemented a system to provide *Trigger* at the right moment. Then, we added micro-goals to encourage the user to do not give up.

2 Modelling Persuasiveness

The Fogg Behavior Model (FBM) [5] is a model to design tools with a good chance of persuading users to do something. Three elements must converge at the same moment for a behavior to occur: *Motivation*, *Ability* and *Triggers*. *Ability* is not a problem for our target audience, since the game is not intended for impaired users, so our target user is considered able to climb the stairs. Clearly, climbing stairs can become tiring or even frustrating. For this reason, we added *sub-goals* so that the goal is not too far away. In Fig. 1a, the stars on the bar on the left side of the interface denote the sub-goals. They are used to encourage users to never give up.

Each stairstep in real life corresponds to one (or more) stairstep in the game, according to the difficulty level. Different difficulty levels also bring different quality and number of provided photos, thus user's satisfaction (see Fig. 1b).



(a) Interface for climbing (b) Gallery (c) *Social Climbing* (d) *Social Challenge* (e) *Team vs. Team*

Fig. 1. *ClimbTheWorld* application.

To improve both *Motivation* and *Ability*, we designed four different game modes: we call "social" the game modes which involve user's friends[1].

The "Solo Climb" game mode requires the user to climb a building alone (Fig. 1a). Figure 1c shows a screenshot of the "Social Climb" game mode, where the user has invited one of his/her Facebook friends to help him/her to reach the top of the Pyramid of Giza. This game mode improves *Ability*, since it lowers the required number of stairsteps. *Motivation* is strongly affected by two other game modes, "Social Challenge" and "Team vs. Team", by exploiting the natural competitiveness of the users. The first one implements a challenge between two (or more) players. Differently from "Social Climb", the players do not collaborate but compete. The winner is the first user that reaches the top of the building. Figure 1d shows a screenshot during a challenge between two players. Similarly, the "Team vs. Team" game mode (Fig. 1e) implements a challenge between teams of an equal number of players.

The game also considers the problem of the management of *freeloaders*, i.e., players who join a team or a "social" climb but do not contribute to the climb with stairsteps. To avoid this kind of players, *ClimbTheWorld* imposes a threshold (see Fig. 1c and e): players who do not contribute with a minimal set of stairsteps are not rewarded even in case of victory.

Triggers are implemented by a push notification that remembers the player to play the game and take stairs. According to the FBM, this type of *Triggers* are called *signals* and are discussed in details in Sect. 3.

To increase the engagement of the user, the game provides some bonuses, to constantly encourage and help the user. Each bonus depends on user's performance: if the user improves his/her performance with respect to the day before, he/she gets a 30% increase on the total number of stairsteps made.

[1] These modes require the user to connect to Facebook and to give the application the right to explorer his/her network of friends.

3 Design of the Trigger

According to FBM, one of the key elements that influences the possibility or not to change people' behavior are the so called *Triggers*. To be efficient, *Triggers* should happen at the right time. This is a very difficult issue, since, for example, if we want to suggest to the user to take stairs instead of elevators or escalators while he/she is working and cannot move from his/her desk, or simply there are no stairs in the area, these *Triggers* are absolutely useless, if not disturbing, and will not help in behavior change. Moreover, *Triggers* can also be used to keep users involved in the game.

The task of choosing the right time to fire a *Trigger* is hard to solve. The simplest solution, presented in [13], is to ask the user to set by himself/herself an alarm for the following day, at a time that he/she thinks could be the right moment to perform the target activity or, in general, some physical activity. This solution has some drawbacks: it is not ubiquitous, and it is boring for the user since it requires the person to set every day the alarm for the day after. We propose a solution which is able to automatically adapt itself to user habits, showing *Triggers* only when it is supposed to be the best moment of the day. This solution is to silently sense user's activity, in order to learn user's habits. It is not intrusive, since it requires only an initial setup, and afterwards is able to understand user habits and the best moments to show *Triggers*.

We were inspired by genetic algorithms [10]: we consider a population in which each individual corresponds to an interval of time of one our. At the first run, the user has to indicate in which time slots performs/probably performs/do not perform physical activity. Figure 2 shows the user interface to give this initial knowledge: time slots in which the user declares to perform physical activity are marked as green, the slots in which he/she declares a probability to perform some physical activity are marked as yellow, and the slots in which the user does not perform physical activity are marked as red and are not considered by the algorithm. The stairstep classifier, which is more expensive in terms of energy consumption, is used to sense the user activity during the green intervals of time,

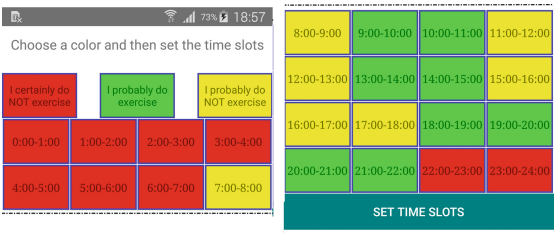


Fig. 2. Initial setup of time slots to provide initial information to the algorithm (Color figure online)

while the Google Activity Recognition service[2] is used to understand if, and in which measure, some physical activity is performed during the yellow intervals.

The algorithm senses the user activity for a week and then decides when to listen user's activity in the next weeks and when to fire the *Triggers*. How the population (intervals) evolves is easy: (1) if during a yellow time slot the Google Service returns an evaluation $v(x)$ so that $0 \leq v(x) < 0.5$, i.e., the user performed no or very few physical activity, the time slot is marked as red, (2) if the evaluation $v(x)$ is $0.5 \leq v(x) < 1$, i.e., some physical activity was performed, the time slot becomes green and (3) a green slot remains green if more than one stairstep is performed by the user, otherwise it is marked as yellow.

The use of a genetic algorithm is important since the user can change his/her behavior during time, or the initial description about his/her habits can be inaccurate. To allow an automatic adaptation to changes in user's behavior, a random exploration of the time slots marked as red is needed. According to genetic algorithms, a random probability of mutation is introduced: a red interval can be mutated into a yellow one. In this way, Google Service is used to analyze physical activity, and the same interval can be better analyzed the following week if the user performs a sufficient amount of physical activity.

Triggers notifications are implemented considering intervals marked as green. First of all, to avoid to disturb too much the user, we decided to notify at most two *Triggers* during the day, separated by, at least, 6 h. Moreover, we do not notify the user if he/she is already playing with *ClimbTheWorld* in the same temporal interval. If these conditions are satisfied, the *Trigger* is notified if the number of stairsteps made so far that day does not overtake the number of stairsteps done the day before plus 10. In this way, we aim at keeping constantly active the user and try to increase his/her performance among the days.

4 Users Tests

ClimbTheWorld was tested with a users study to evaluate its persuasive power with real users. We selected 13 participants, 8 females and 5 males, and we asked them to use the game and to answer to a small questionnaire. Players involved aged between 24 and 30.

The experiment lasted 9 days, and each participant used his/her own smartphone. We did not ask participants to change their daily routine, we asked them to freely use the application whenever they could or wanted.

Players were randomly divided into two different groups of 7 and 6 users. We used these two groups to randomize our test, changing the order in which each group used the singleplayer or the multiplayer modes (see Table 1). The first two days we asked all the participants to use the "Step counter" mode to record a baseline about the number of stairsteps made without a *serious game*.

[2] https://developers.google.com/android/reference/com/google/android/gms/location/ActivityRecognitionApi.

Table 1. Game mode order for each of the two groups. (MP) denotes the multiplayer mode.

Day	Group A	Group B
1	Stairstep counter	Stairstep counter
2	Stairstep counter	Stairstep counter
3	Singleplayer	*Social Climb* (MP)
4	Singleplayer	*Social Challenge* (MP)
5	*Social Climb* (MP)	*Team vs Team* (MP)
6	*Social Challenge* (MP)	Singleplayer
7	*Team vs Team* (MP)	Singleplayer
8	Stairstep counter	Stairstep counter
9	Stairstep counter	Stairstep counter

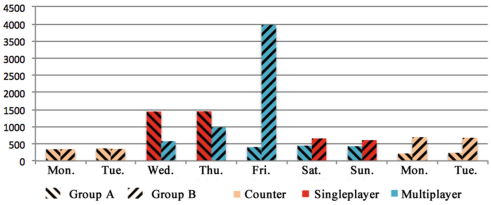


Fig. 3. Number of stairsteps made by both groups each day of the test.

At the end of the experiment, each participant completed a 5-point Likert questionnaire, based on the *IBM Computer Usability Satisfaction Questionnaires* [7], with possible answers ranging from "Strongly disagree" to "Strongly agree". Our questionnaire was divided into two different main sections: the first one to describe the participants that took part to the experiment, e.g., what they think about physical activity and being physically active, and the second one contained questions about *ClimbTheWorld*, the different game modes and their experience during the days. Thanks to a background logger, during the experiment we collected objective data about the number of stairsteps made by participants.

Data about users showed that our participants were a difficult test case, since they already preferred to take stairs and have an active life, meaning that, actually, they do not need a *serious game* to increase their physical activity. In fact, even if 77% of participants have positive feelings about being physically active, 54% of them think they do not need any form of external stimulus to be active, and about 61% does not frequently use elevators or escalators, but prefers to take stairs in order to be more active. Moreover, 53% of participants does not play any sport and the other 47% performs an individual sport. They were mainly "casual players" (69%), that play almost alone (61.5%) or with another player in the same room (46.2%). Finally, only 23% of participants frequently plays with mobile games. These data are confirmed also from the second part of the questionnaire: about 70% of participants preferred to play in single mode, while only 38.5% preferred to play with his/her friends. Moreover, 92.2% of participants liked the "Solo Climb" mode.

The multiplayer mode obtained less appreciation. In particular, the most preferred multiplayer mode was the "Social Climb" mode, since all the participants used it at least one time and 92.3% of them ranked it positively. The second preference was "Social Challenge", played by 77% of participants and 80% of them liked it. Finally, "Team vs. Team" mode was played by 61.5% of participants and 63.6% would play again with it. This rank can be explained by the fact that this mode, that should be the most challenging and engaging one, has the drawback that it is difficult to set up: it is necessary to find at least 4 users,

active in the same interval of time, to be able to start the game (and this could take time that not all users are happy to wait for).

The last part of the questionnaire asked an evaluation of *Triggers* notification and battery life. The majority of the users declared that *Triggers* did not disturb them (70% of the users) and were able to motivate them to take the stairs (only 38.5% of the users declare to not be motivated). Moreover, only 30.8% of the users reported a drop in the battery lifetime. Therefore, we can argue that the *Triggers* implementation was well tolerated by the users and also the system to save energy power worked well.

Analyzing data acquired with the data logger, we evaluated the number of stairsteps participants made, and the game mode used during all the days. We compared answers provided with the questionnaire with objective data, and performance of participants depending on the game mode used. Figure 3 shows the number of stairsteps made by all the participants during the experiment. Together with Table 1, the figure also shows the number of stairsteps made by participants depending on the game mode used: the number of stairsteps made using the *serious game* (both in singleplayer or multiplayer) is higher with respect to the number when using simply the counter. In particular, singleplayer modes increased the average amount of about 61%, while multiplayer of about 64%. This means that the game is effective in incentivizing people in taking stairs, and this is even more important since our test groups were made by people that think that they do not need to be incentivized to be physically active.

A very important result is about efficacy of the "Team vs. Team" game mode that, when used, allows to reach the highest number of stairsteps made. This probably comes from the fact that this game mode combines both collaboration and competition among users, a combination that is able to engage participants and create high motivation. On the other side, the big difference between the two groups even shows the limitation of this game mode, since the setup phase is longer than the other ones and could reduce users' interest.

There is another important difference in the behavior of the two groups. In fact, the second group, the one that used the "Team vs. Team" game mode, approximately doubled the number of stairsteps made with the simple counter in the last two days, while the first group lowered the number of stairsteps made without the game in the last two days with respect to the first two days of the experiment. This means that the "Team vs. Team" game mode is not always accepted by the users due to the initial setup phase, but, if used, is able to obtain good results in persuading people to change their behavior, and this result remains also in absence of the game. On the other side, singleplayer games were able to engage both groups, showing how an easy entry setup of the game makes it more engaging.

As we can see from these results, it is clear that *ClimbTheWorld* is really effective in incentivizing people in taking stairs, and both singleplayer and multiplayer modes are engaging and appreciated by users.

5 Conclusions

In this paper we presented the redesign of our smartphone application, *ClimbTheWorld*, to improve its persuasiveness. To incentivize people in taking stairs instead of elevators or escalators, we used the Fogg Behavior Model and we exploited natural competitiveness between people creating competition and collaboration, to increase users' engagement and so the power of the game to correct a bad behavior. Moreover, we introduced an algorithm that is able to understand user's habits and automatically determines when it is the best moment during the day to fire a *Trigger* to remember the user to perform some activity (in particular, to take stairs).

Our tests showed that the game was effective in incentivizing people in taking stairs (about 61% of increase with singleplayer modes and 64% with multiplayer modes). Even notifications provided were considered not intrusive and helpful.

In the future, we plan to increase persuasiveness of our system adding more game modes to *ClimbTheWorld*, and more challenges between users. Moreover, we plan to increase the precision of the algorithm that defines *Triggers* timing, in order to make them even more useful and less intrusive. We will study other approaches, like the use of artificial neural networks [10].

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