Can a Game improve People's Lives? The case of *Serious Games*

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Abstract. The popularity of digital games and the wide diffusion of mobile devices with sensors and communication capabilities have led many researchers to think how this technology can be put to good use to improve people's lives and, in general, our society. In this short survey we present an overview on how mobile games can go beyond their entertainment purpose to pursue a service that may be useful to overcome health and accessibility impairments.

Key words: serious games, mobile technologies, mobile games

1 Introduction

The proliferation of game technology and the commercial success of mobile devices endowed with sensors and communication capabilities is fostering the creation of new software systems able to ubiquitously engage and entertain users. At the same time, the most interesting part of this process is represented by its potential in generating mobile serious games able to amuse players while providing benefits to them or even to larger communities [13], [22].

To better understand this scenario and its trends, we overview here some of the most recent and representative examples of mobile serious games devoted to foster physical exercise (Section 2), to be employed in the medical field (Section 3), and to increase the accessibility in our society for people with impairments (Section 4).

2 Exergames

The first category of games that we want to describe, the *Exergames*, use the game paradigm to push users into increasing physical activity. They use sensors to understand users' movement and they use this movement as a form of interaction with the game. In this category, the success of Nintendo's Wii platform is very well known, but also mobile platforms provide the capabilities of exploiting users' real movements as a form of interaction (e.g., rotating the iPhone to have a virtual car steering).

An example of mobile game which aims at increasing people physical activity is *ClimbTheWorld* [4], a serious game which uses a machine learning based technique to recognize and count stairsteps. This game aims at persuading people to use stairs instead of elevators or escalators. The idea underlying the game is simple: the user has to climb real world buildings, e.g., the Empire State Building or the Eiffel Tower, engaging in physical activity during her/his everyday life. Once started, the game records and analyzes data from the accelerometer and counts the number of stairsteps made by the user. The game performs a fine-grained analysis by exploiting smartphone sensors to recognize single stairsteps. An experiment with a group of 13 users has shown that the engagement of friends in the buildings climb can increase the number of stairsteps made by the users.

The same technology has been exploited to implement pervasive healthcare systems. For instance, wrist rehabilitation is currently accomplished through very expensive and bulky machinery that cannot be moved from hospitals or through exercises that the patient is supposed to perform at home but with no way for the doctor to verify the patient's dedication or performance. Instead, DroidGlove is a serious game for Android and iPhone platforms that proposes to the users several movement tasks [9], [10]. The user can perform the exercises anytime and anywhere, the smartphone can remind her/him to exercise with a certain frequency, while the gyroscope is utilized to determine the accuracy of the user's movements so as to assign a score. Both the assigned movement exercises and the accomplished scores can be exchanged in real time between the player and her/his doctor for a comprehensive supervision.

Serious games are also used to train people to do something, for example, in the military field, they are employed to train soldiers using virtual environments that reproduce real-world scenarios. The main scope is to prepare soldiers to situations and obstacles they may encounter in the real world, making them able to take decisions faster and safer. Serious games can be used in the governmental field to simulate the population's reaction to political decisions [3] and in the educational field to increase children' learning abilities, as well as to train employees [29].

3 Serious games used in the medical field

The second category of games includes games developed to help doctors and patients. The former use the game and train to correctly execute specific procedures or to be exposed to real-life situations [12]. Patients can be pushed into rehabilitative exercises hidden by games, e.g., to perform specific upper limb movements [19] or to offer telerehabilitation to post-stroke patients so that they can perform the long series of exercises at home [11]. Furthermore, games and social communities can improve patients' recovery and motivation [24]. For instance, Re-Mission is a game that improves young patients understanding of cancer by employing game avatars representing drugs which destroy cancer cells, additionally providing a forum where patients can discuss and support each other [18].

PlayWithEyes is a serious game for the early diagnosis of amblyopia in children [8], [15]. The authors developed a system for iPad and iPod Touch that uses a serious game to perform an orthoptic test to evaluate children visual acuity. This project has shown how children find more appealing playing with a game than performing regular tests; their increased attention results in more accurate diagnosis.

Ciman et al. [7] designed a serious game to help the rehabilitation process from CVI (Cerebral Visual Impairment). The game is able to adapt the rehabilitative exercises to each child, also following the improvements of the patient, to reduce the influence of her/his disability in future life. The system also helps doctors to perform a good assessment of a patient and to create a rehabilitation program.

Other examples of serious games used in the medical field regard the use of serious games in identifying the risk of dyslexia in children even at preschool age so as to intervene as soon as possible [16], [28]. In particular, in [16] the authors developed a set of serious games that, thanks to a crossplatform approach, can be played both on desktops and on tablets. The set of games share an appealing underwater environment with different sea creatures used to engage the player in activities that stimulate those cognitive capabilities involved in the reading acquisition process. The games are intended to capture children's attention to achieve more accurate measurements than those obtainable with non-entertaining tests.

Similar in spirit to the former works, DYSL-X integrates dyslexia predictors in a tablet game [28]. The authors evaluate several existing games for preschoolers to derive a set of guidelines so as to design an optimal tablet game for 5 years children; then, these guidelines were used to develop Diesel-X, a game about a robot dog (Diesel) which has to fight against a gang of criminal cats.

Instead, Letterprins [27] is a reading game designed to improve the reading development of children with reading disorder through a series of reading tasks. The game requires the children to pronounce letters or words, while a parent or a caregiver has to indicate the correctness of the childs answers. The game allows parents to facilitate the children during the tasks and to record a message to be played at the end of the game.

These examples show that serious games are extremely useful for children since a game can change a boring rehabilitation task into an interesting activity. They can be used during assessment, rehabilitation and telerehabilitation programs. An engaging and easy-to-use interface is a key issue for this kind of games. One solution is to use the so called tangible interfaces, which use physical artifacts for accessing and manipulating information [23]. To this end, Forlines et al. [14] investigated the differences between mouse and direct touch input, both in terms of quantitative performance and subjective preference. The work shows that touch interfaces, even if they may not lead to greater performance, especially for speed and accuracy, are preferable for other considerations like fatigue, spatial memory and simplicity . This is particularly true for children, even called digital native speakers, who find touch interaction very natural, thus avoiding the need for long training sessions to learn how to interact with touch applications.

4 Improving accessibility through serious games

Mobile serious games could also be used to support people with impairments. In particular, consider social communities composed by thousands (or even much more) of mobile users present in each city. The combination of games with social networks, crowd-sourcing and mobile users with sensor-equipped mobile devices could create a major force able to tackle serious challenges that can be considered too complex for single users and/or difficult to automate. As an example, imagine how a serious game could help visually impaired users. Bringing the Google Image Labeler serious game [2] into the real world, we could design a social community where mobile users are asked to play a game involving the labeling of the surrounding environment (e.g., crossroads, architectural barriers, parks, stores). This way, they will add digital tags to real objects, creating a social community similar to Panoramio [1]. The serious advantage would be that of having a participatory, augmented reality environment where a visually impaired person could perceive the surrounding real world through her/his mobile device able to retrieve the aforementioned digital labels and transform their format (text, image, video, etc.) into audio, thus improving her/his autonomy.

Algorithms supporting mobility-impaired pedestrians have already been proposed by researchers, providing means to generate specific urban routes that consider the accessibility of roads and curbs [5], [17]. However, one of the most complex challenges is related to the accessibility assessment of roads and curbs [26]; without this initial assessment, there would be no data to feed to the aforementioned algorithms. To this end, some approaches have focused on the possibility to autonomously and anonymously detect favorite routes chosen by people with a certain impairment (e.g., being on a wheelchair) and consider them as preferable when someone else in the same condition searches for a route in the neighbourhood [6], [20]. However, we have to mention that games have been considered as well to involve citizens in playing a mobile serious game whose goal is achieved by labeling as many accessible or non accessible roads, curbs, pedestrian crossing, traffic lights, etc. [21], [25]. Aiming at improving as much as possible the inclusion of people with impairments in our society, the best approach is probably a mix between the two approaches: automatic detection and serious game.

5 Conclusion

The combination among digital games and mobile technology is creating unprecedented opportunities in terms of ubiquitous, mobile entertainment. In this paper we have overviewed recent advancements in the field of mobile serious games and shown how they are expected to improve our lives regarding exercise, health and accessibility.

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