

A Model Proposal for Augmented Reality Game Creation to Incentivize Physical Activity

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Abstract: Obesity and a sedentary lifestyle are relevant issues in today's society. Even though different resources can be used to approach this problem, technology provides endless possibilities to fight against this problem. This article presents the results of a model to create augmented reality games where goals are achieved by doing physical activity (moving between different places). In order to evaluate the model, a prototype was built and presented to 50 participants. The results obtained indicated that an important percentage of the interviewees were attracted to the idea of playing a game to increase their physical activity.

1 INTRODUCTION

Nowadays more people are concerned about their physical fitness. In fact, activity trackers and some games to stand up and to move in a place are commonly used to keep people motivated; however, not all users feel the same about these long term commitment resources (Buchem, Merceron, Kreutel, Haesner, and Steinert, 2015).

Users, due to their human nature, tend to be motivated by challenges that come in a competitive, cooperative or solo form (Spillers and Asimakopoulos, 2014). For those that may require extra motivation, gamification is a possible way to incentivize them to do more exercise.

Related to the topic of using technology to keep people moving, the term of Augmented Reality (AR) is extremely useful. AR can be defined as "a technology that superimposes a computer-generated image on a user's view of the real world, thus providing a composite view" (Oxford Dictionary of English, 2010). This technique is becoming more and more popular among the users of new technologies like Google VR (Kipper and Rampolla, 2013).

The previous elements help developers to create appealing health video games that engage users while motivating them to do more exercise in a daily basis (González et al., 2016).

This fact led us to create a game model to encourage people to do exercise not only to be more

active but also to continue with the physical work as time passes by.

By using AR, a GPS device, an accelerometer, a gyroscope and other elements, we propose a model where we identify the most important parts that a game should have in order to create a health-based video game. The latter will require users to move to specific points in a map by walking, running or climbing floors to get rewards and to advance in the video game story.

In sum, the main goal of this article is to create a model for the development of a generic video game that incentivizes users to be more active and to have a healthier lifestyle.

The following sections in this article include the related work in the area of game-based research, the purpose and the explanation of a generic model for AR health-based games, and the data related to the implementation of the model by creating a Role Playing Game (RPG), which may urge people to go to different places in order to level up and to get better gear to unlock game missions. Later, an evaluation of the proposed model will be conducted before discussing the final results.

2 RELATED WORK

Organizations, healthcare providers, and public initiatives promote healthy lifestyles through

information technology. Alahäivälä and OinasKukkonen (2016) presented a systematic literature review that focused on “health gamification.” The study discussed 32 studies conducted between 2011 and 2015. Nine of them were categorized as “increasing physical activity.” Some of the studies in their literature review are described below.

Recent technological devices inspire new applications. By using Microsoft Kinect, Brauner et al. (2013) proposed a game to promote physical fitness that focuses on elderly people. An avatar is presented within a garden. The player, through the virtual avatar, can pick up carrots from the soil or fruits and vegetables from trees and the soil. An experiment was conducted with 70 users. Most of the participants (72%) stated that this game increased their motivation to exercise on a regular basis (Brauner et al., 2013).

Nintendo Wii Fit activity games were also evaluated. A group of beginners and non-beginners played with Wii Fit games in different settings. The former was positive about the games when combining fitness and fun. However, the latter was unsatisfied with the Wii Fit as a fitness tool (Reynolds, Sosik, and Cosley, 2013).

HealthyTogether is an Android application that uses an activity tracker (FitBit) that was developed in 2014. By following simple rules, the user can win badges and points (karma points).

The game is a step and floor counter. The application includes three settings: competition mode, collaborative mode, and hybrid mode. HealthyTogether was evaluated with 18 dyads. The study found significant step and floor increase in both cooperation and hybrid mode (up to 21.1% and 18.2%, respectively) but not in the completion mode (Y. Chen and Pu, 2014). Another study was carried out that considered solo mode in similar conditions. The researchers found an increase in the amount of exercise that was associated with gamification. Furthermore, they concluded that gamification affects software design (Giannakis, Chorianopoulos, and Jaccheri, 2013).

Spillers and Asimakopoulos (2014) discussed how extended gamification and social elements in the mobile and the fitness context can improve people’s motivation. Indeed, a positive short term behavioural change was observed in their research project.

Zuckerman and Gal-Oz (2014) evaluated the effectiveness of virtual rewards. They argued that according to the self-determination theory (SDT) of human motivation, three innate psychological needs determine motivation: (1) competence, (2) autonomy, and (3) relatedness. Results showed that daily walking or running time while interacting with an application was significantly higher than walking time without any application interaction.

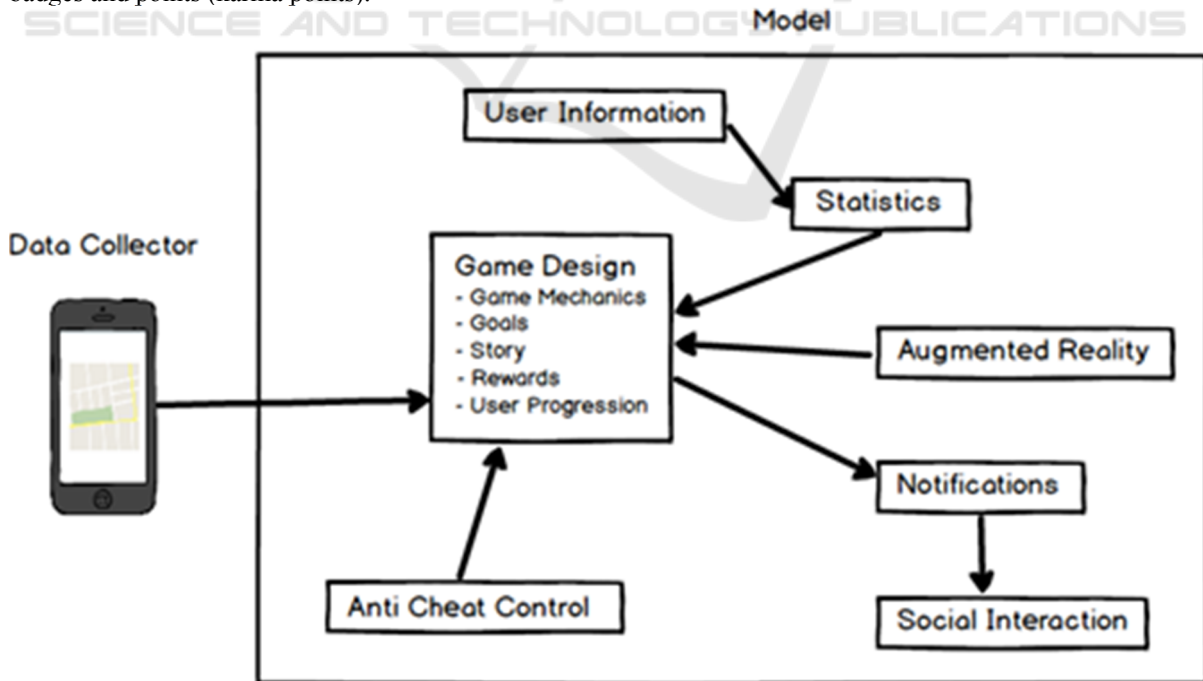


Figure 1: Video Game Model.

3 MODEL DESCRIPTION

This section describes the elements that all AR games that involve moving from one place to another should include. These elements are the result of years of developing different video games of diverse genres. Aside from the expertise acquired through the years, some of the key components explained in this article can be found in the most popular games available in the market (Novak, 2012).

The games that use this model should comply with the following requirements: a mobile device that has an active internet connection, a GPS, and a camera.

Figure 1 shows the proposed model with its components. These components include game design, statistics, user information, anti-cheat control, augmented reality, notifications, data collector, and social interaction. The following sections describe the previous concepts.

3.1 Game Design

Game design is an essential component that includes rules, gameplay, and storyline. All of them combined facilitate the interaction between players in case the game has health purposes (Novak, 2012).

3.1.1 Game Mechanics

There are several game mechanics that can be incorporated in order to incentivize people to do exercise. We consider that there are four main game mechanics—steps, walking, running, and floor climbing—that can be used in order let the player interact with the game. By using and mixing these four mechanics, different types of exercises can be covered (from casual training to more complex exercise routines).

Some actions can be followed in order to promote physical activity in the players (González et al., 2016). For instance, if it is assumed that users do not exercise regularly, they can start using the stairs instead of elevators to get to their destiny. Moreover, they can start walking short distances every day.

The game should be able to distinguish between walking and running. This can be achieved by using a combination of the GPS and the accelerometer of the mobile device. By using the correct type of movement and velocity, the game can provide users with different options in terms of the quests to be accomplished and the type of loot to be earned.

3.1.2 Goals

The game should have different goals that can be achieved as a result of the interaction between the user and the application (Novak, 2012). The game must have a list of customized daily goals for the player. The goals will be based on (1) how many steps have been made, (2) the distance, either by walking or running, that has been traveled, and (3) how many stairs or floors have been climbed.

The game should have an algorithm capable of creating customized goals based on the users' performance. The idea is to ask players for an extra effort every day they use the game. This idea can be achieved by presenting different places to visit in a single day or by including a far place to go.

When the goals depend on the users, the game provides a personalized experience and will get the highest possible retention ratio. If the user is falling behind, aspects such as distance and time should be easier for them to complete.

The game should spawn points on the map. Those points will represent the places the player should visit in order to make some kind of progress in the game. In addition to spawning points all over the map, the user can be encouraged to get to a specific place, within a time limit, by walking or running. Some goals can be based on the number of times a specific place is visited within a timeframe. Similarly, the player can achieve a goal by traveling the double or thrice of the standard goal.

3.1.3 Story

An essential part in today's games is their story. The story is the way people can get identified with the game and have an urge to keep playing. All games have a story which can be as simple or complex as the creators want (Dille and Zuur Platen, 2008). The idea is to have an easy-to-pick-up story to attract more people into the game. This should be aligned with the goals described in Section 3.1.2. In other words, the users have to be motivated during the game in order to keep moving through the different levels.

Another important aspect is to have a story that has a replay value. The story cannot be linear with a beginning and end because the main goal is to keep people interested in exercising from a mid to a long term. In order to do this, the story can have multiplayer elements that give an additional replay value to the players.

The two techniques that can be used with the players are to have them compete by themselves or to have them cooperate among each other to get a common goal (Novak, 2012). Aside from the

retention ratio, these techniques can help to attract more users into the game in less time because its existence can be easily spread (González et al., 2016).

3.1.4 Rewards

When a goal is achieved, the user should be rewarded by the effort made while playing the game. The reward can be a permanent upgrade—like gaining experience for the character, getting perk, or unlocking new weapons—or a temporary upgrade—like being healthier and causing more damage for a specific amount of time.

The rewards are an essential part of any game because users feel engaged with the story and may want to do more exercise to get more rewards (Novak, 2012). Additionally, they can have a positive impact on the replay value by making it easier for people to feel attracted to the content that the game offers.

3.1.5 User Progression

In order to have the highest percentage of retention ratio, the game should make the players feel that they are making progress. This can be done by unlocking the game content as the user goes through challenges or achieves a goal.

User progression creates the illusion that players are constantly completing different actions and that there is a constant purpose and motivation to finish the game (F. X. Chen, King, and Hekler, 2014). The story elements and the user progression can give a higher replay value to the game because the idea is for users to come and play again.

The game should be able to create new goals and objectives based on the characteristics of each user. By learning about the players' habits, the game can provide a personalized experience. For instance, the game can create goals or missions that require more effort when the user is more interested in the game.

3.2 Statistics

Every game that is intended to motivate people to be healthier by doing more exercise should collect and present statistical data (Brauner, Calero Valdez, Schroeder, and Ziefle, 2013). With this information, players can learn more about their performance in a specific timeframe.

The collected data can be presented in charts and in a granular way. The data can include what the user did in a particular day with an hourly breakout or with their performance within a month, a quarter, a semester, or any other long-term timeframe.

Developers should compare users' performance between different timeframes by using friendly-via graphics, which include the time users prefer to do exercise and the average workout time.

3.3 User Information

Health-related applications should create a customized experience for their users by gathering information about their physical activity performance (Alahäivälä and Oinas-Kukkonen, 2016). The game should ask the players for basic data that includes—but not limited to—age, sex, height, weight and how often he or she does exercise or intends to do it.

The weight data gathered from the user should be updated on a monthly basis in order to enable developers to create more accurate health plans for the players. Moreover, the progress made by the users can be tracked while they use the application.

The user information module should keep the raw data of how a player has been performing while using the app. Also, this module should be able to create an estimate of the calories the player has burned within a specific timeframe. Furthermore, if the users have a weight or distance target, this module can feed the game goals to help them achieve the health goal.

3.4 Augmented Reality

AR is intended to give users the bridge between reality and the game they are playing (Kipper and Rampolla, 2013). The idea is to collect objects in a real world location and to use them within the boundaries of the virtual game.

There are several ways AR can be incorporated into the game. For instance, when a player gets to a target destination, he or she will have the option to search a zone and find an object. Once the object is found by using the device camera, the users will get a reward in the game. By combining these features, the limits are only set by the developers' imagination.

3.5 Anti Cheat Control

All games need a mechanism that prevents players from cheating. This particular software piece should detect if the player is trying to achieve the goals by skipping the required exercises.

The game should have an algorithm mix that uses devices such as the GPS, the gyroscope, and the accelerometer to measure how fast the player is traveling. In fact, these mechanisms can detect if the movements made by the users are possible for human beings.

In this sense, the module should cap the maximum possible velocity of the players to detect if they are traveling by car instead of walking or running. By using the previous devices, the system detects more accurately if the user is doing exercise or not.

3.6 Notifications

Notifications remind users to stay active (Brauner et al., 2013). For instance, notifications let players know when they have to move either because they have been inactive for a long time or because they have to look for bounties or upgrades. Socially speaking, notifications can tell users when friends are asking for help, when they want to compete, or when a cooperative mission is needed.

Notifications should be customized in order to give users the option to enable or disable data. The players should decide what kind of information they want to receive after completing the tasks included in the notifications in order to avoid any unpleasant experiences. By providing this possibility, users will not feel overwhelmed or annoyed if they receive notifications of activities that they do not want to see.

3.7 Data Collector (Device)

One of the most relevant aspects to consider when creating a health-based video game is the device players need to use. The device has to be capable of tracking the movement of the users, their velocity and the places they visit.

In order to fulfill the previous requirements, the device should include at least a GPS to have the geolocation of the user and to create target points where they should go within a distance range. In addition, an accelerometer and a gyroscope are required to avoid relying only on a GPS connection and to help reduce the possibility of cheating in the game.

Finally, the augmented reality functionality can be used if the data collector has a camera and an API that developers can access and use.

3.8 Social Interaction

Social networks aim at giving more visibility to applications or games to help them go viral; hence, a social module—planned in two directions—has to be included as part of the game.

The first part is an outflow where users can post achievements, rewards, perks, and missions in different social networks. In addition, players can share with other players their real life progress,



Figure 2: Objectives of the Application Mockup.

traveled distances, and time spent in a workout. The second part is an inflow where the users can ask for help in order to complete cooperative and competitive missions.

4 IMPLEMENTATION

The model of the game that we implemented was based on the model described in Section 3. The model can be used in different game genres such as action, simulation, and role plays.

Because a role-playing game (RPG) was set, a story of a brave warrior trying to reclaim his family honor and lands was developed. These lands were stolen by the evil wizard Magrathea. To reclaim them, the warrior needs to go through different dungeons. When going into the dungeons, the warrior has to meet some requirements like having a specific level and having a special gear in order to access different places in the game. In these situations, the user is required to do some kind of physical activity.

The game, with the help of AR, will spawn points of interest for the player to get different rewards—an armor, weapons or magical powers. The game also rewards persistency because if the players exercise every day, their virtual character becomes more powerful; otherwise, the virtual character becomes weaker and loses his or her lands.

The game includes competitive and cooperative elements. The players can conquer unclaimed lands and defend their lands from being conquered by other friends. The players can get better gear or upgrades for their gear by completing missions that may require some kind of help from friends.

We presented six mockups to illustrate the design of the game. Figures 2, 3, and 4 include three of them. Figure 2 shows the objectives screen. This screen includes the position of the players in the map and the nearest targets. Targets must have different levels of difficulty and should be selected prior working with near landmarks and sights (i.e. historic sites, fountains, monuments, statues, among others).

Figure 3 works with the augmented reality component. Once the player achieves the goal, a similar screen will be displayed. Figure 4 shows some sample statistics. The remaining mockups (not included in Figures 2, 3, and 4) are events related to the game.

5 EVALUATION

Fifty participants, aged from 18 to 42, were interviewed for this project. Sixteen of them were women, and 34 were men. Basic information—age, physical condition, and mobile telephone habits—was gathered. All the participants owned a smartphone and, after the required explanation, were familiarized with the key attributes of the game.

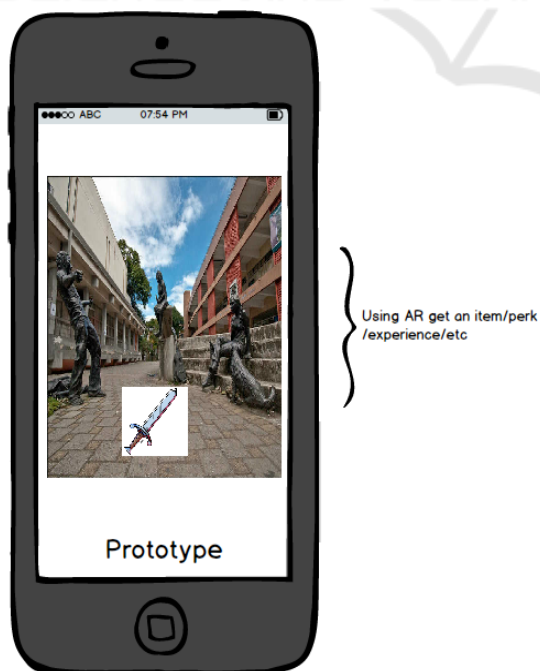


Figure 3: Rewards of the Application Mockup.

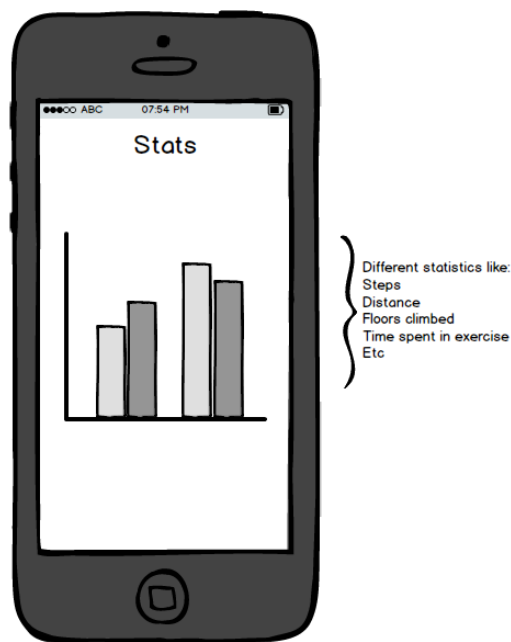


Figure 4: Statistics of the Application Mockup.

The game mechanics were also explained to each participant by using the mockups (see Figures 2 and 3). Then, the participants provided basic data that included the frequency in which they exercise, their mobile game interests, and the mobile fitness apps they use.

In terms of how often they do physical activity, 52% (26 participants) do not exercise regularly. Approximately 85% (22 of 26 participants) reported some kind of interest in the game. Participants who exercise regularly (i.e. walk or run at least twice a week) were interested in the game. Figure 5 displays that 86% of the participants support the game as an instrument to promote physical activity by using AR components while eight participants indicated that they do not use mobile telephones to play.

When asked if they would play the game while exercising, seven participants (14%) provided a negative answer. The main reasons they provided to support their decision include one of the following: (1) “I prefer to practice different types of exercises (i.e. swimming, going to the gym, and riding a bicycle);” (2) “I feel insecure using the mobile phone outdoors in some places;” and (3) “I exercise but without any mobile application.”

Five participants (62.5%) indicated that they like a game that uses AR. These participants correspond to the ones who regularly use smartphones to play. Only three participants answered that they were not interested in this type of game.

From the total number of participants interested in the application, 100% mentioned that having access to statistics over time to see their monthly or quarterly progress is extremely useful. Approximately 92 % considered that they need daily statistics, and 85% of the participants need the application to tell them when to do exercise.

The participants were asked if they knew what AR is. For those who were unsure or did not know, a video with concrete examples was used to explain the concept to the participants. After seeing the mockups of the game and claiming that they were interested in it, 85% of the participants said that the AR component was essential and attractive in the game.

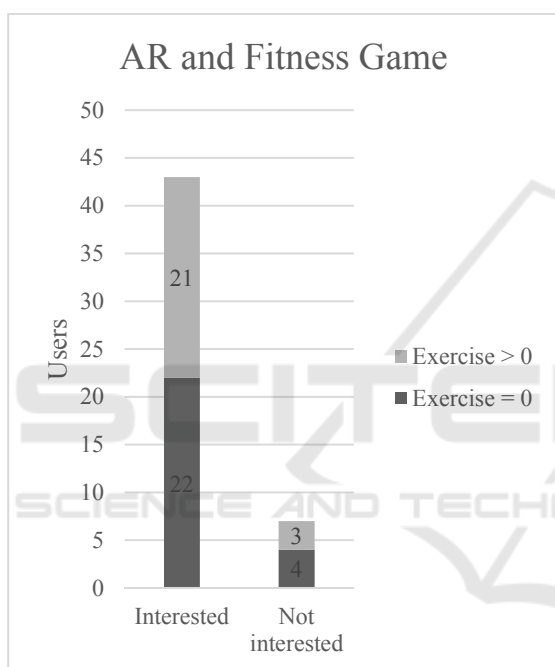


Figure 5: Participants' Interest in the Game.

6 DISCUSSION

The results revealed that people who do not exercise are more willing to change their routine if they find a strong reason to do so. In this project, 'this reason' is called the AR game. Similarly, people who already have an exercise routine also feel attracted to this kind of game application.

Based on the results obtained, the massive use of these technologies (AR and Smartphones) should be taken into account by many developers because they incentivize people to change their sedentary lifestyle. By changing users' habits, other problems such as diabetes and hypertension can be avoided or at least

decreased. Due to the fact that being attracted to video games is not based on age or sex, new technologies have the possibility of reaching more people.

The findings also state that the proposed model provides the main components that a game should have in order to incentivize people to do exercise. This is possible because of the mechanics proposed in the game design section, which provide an overview of what a game should have in order to increase the number of engaged players. Users are attracted to a game when it has a high-replay value, an interesting story, and cooperative and competitive elements.

The participants also highlighted the importance of having player statistics which help to gather data of the users' real life progress in short and medium term. This part of the module is fundamental because if data is not quantified, users cannot determine if they are making progress in the game.

Some participants were really worried about the idea of playing in public places due to security problems. One possible solution is to consider places with low crime rates to be part of the game.

When developing a AR and Fitness Game, the lack of guidelines to design this kind of software increases the cost of the project and the effort that is needed to finish it. Therefore, having a model in mind will definitely help developers to design and to build AR games.

Finally, this model can be used in other types of exercises. For instance, roller skating, cycling or any other sport that involves moving from one place to another. For future projects, more participants can be included to test a possible prototype.

As shown in this article, new technologies can be used to reduce some of the most common problems related to a sedentary lifestyle.

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