
Games, Health and the City: Developing Location-aware Games for Leveraging the Most Suitable Places for Physical Activity

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Abstract

Location is increasingly gaining strength in the world of games, resulting in a new genre of games called location-aware games. This type of games can be applied to various areas such as medicine, psychology and education, as location and spatial characteristics are horizontal to many application domains. This work tries to increase the number of tools available for psychologists by developing location-aware games for promoting physical activity. It also takes advantage of the urban features that make an area an appropriate place for practice moderate physical activity. The paper presents the methodology followed to identify these healthy urban attributes, describes the technical development of the game and the design of an experiment with real users.

Author Keywords

location-aware games, health, promoting physical activity, urban environment, cities

ACM Classification Keywords

H.5.m. Information interfaces and presentation

GeoGames: “Location-based games involving body movements beyond figural space—that is, beyond the space of computer screens and small 3D objects. They focus on locomotion in vista space, typically a single room or sports field, or in environmental space, such as a neighborhood or city.” [4]



Figure 1: PokemonGo Logo

RPGs: Role Playing Games.

Introduction

User interfaces for games have been constantly evolving, going well beyond of traditional gamepad, keyboards and mouse, to leverage new forms of contextual interfaces such as Virtual Reality [1], motion detection devices using infrared cameras capable of detecting depth [2], accelerometers [3], and user's own location in the real world. Games that use the player's location in real urban spaces along with the spatial characteristics of the surrounding environment have been given various names such as location-aware games, pervasive games or geogames [4]. Possibly the best known example of this type of games is PokemonGO [Figure 1].

Thanks to the increasing availability of open source game engines [5], the development of game applications have become commonplace in multiple areas and disciplines (e.g. education [6], medicine [7], psychology [8]). Using these two realities as a premise –new forms of interfaces and the great diversification of application areas-, the potential use of games is simply enormous.

Recent studies show that there is a generalized problem of sedentarism in urban contexts: the dedication to physical activity is much lower than that recommended by international organizations such as WHO. This problem is suffered especially by teenagers. In fact, childhood obesity has become a problem in Spain. According to the 2014 “Informe Aladino” (Aladdin Report) [9] by the Spanish Ministry of Health, about 40% of Spanish children are overweight. This was identified as one of the main problems in cities [10] and the prevalence of physical activity is one of the main measures that can prevent sedentarism and

overweight. Nevertheless, the prevalence of physical inactivity is still dominant. [11]. This is due to many factors, but one of the most relevant is related to the spatial characterisation and distribution of the urban environment [12], in the sense that the configuration of the urban environment may make people perceive places more friendly for physical activity than others.

This work aims to develop a location-aware game that promotes physical activity. The target audience will be adolescents from urban areas. To achieve this, we work in two phases: we first identify the urban characteristics of an area or neighbourhood that makes them more favourable to physical activity. Second, we design and develop a mobile, location-aware game whose rules and game mechanics are intimately linked to the characteristics and spatial organization of the surrounding environment.

The paper is divided as follows: next section summarizes the methodology carried out for the identification of the most relevant urban attributes for incentivising physical activity, followed by the description of the game development phases and its integration with various technologies. Next, we propose the design of an on-going experiment that validates both the selected urban attributes and the utility of the game itself. Finally, we draw our conclusions and foresee future work.

Methodology for the identification and management of "Healthy" attributes of the urban environment

As indicated in the introduction, the characteristics of the urban features or attributes may directly influence how people perceive them for doing physical activity

Castellón:



Figure 2: Region of Castellón, Spain. Below demographic and geographic details of the city of Castellón.

- Country: Spain
- Population: 170.990 p (2016)
- Density: 1590.6 p/km²
- Area: 107.50 km²

[13]. From this point of view, several studies have tried to identify these urban attributes and to what extent they influence physical activity [14, 15]. One conclusion drawn from these works is that these attributes depend on the target city and context in which they are studied. In this paper, a concrete methodology, described below, has been applied to identify these urban attributes that might be more suitable for incentivising moderate physical activity in the city of Castellón, Spain [Figure 2]. It combines different social and research methods as follows:

1. Review of relevant literature.
2. Identification of all urban attributes that appear in the review (N=198).
3. Application of exclusion criteria: Duplicates, attributes not applicable in the city, attributes that do not contribute to differentiation, etc. The result was a preselected list of attributes (N=37).
4. Focus Group with experts. The meeting brought together architects, physical education teachers, psychologists, experts in geographic information systems and parents of teenagers to discuss ideas in the realm of physical activity, urban environment and location-aware games. Participants were asked to fill in a first (paper-based) questionnaire assessing the previously pre-selected attributes.
5. First questionnaire analysis. Responses were processed and ranked to select those that belong to the first quartile.
6. Locality analysis. Focus group participants were asked to fill in a second (online) questionnaire to rate the relevance of the eligible attributes in the realm of the city of Castellón. Responses

were processed and ranked to select those of the first quartile. The result was the final list of urban attributes for Castellón (N=9).

7. Final qualitative assessment. This final list was double-checked with assumptions, opinions, and discussion extracted from the video recording of the focus group meeting (Table 1).

Table 1 lists the most influential urban attributes to encourage physical activity, following the above methodology which is strongly based on the criteria of the experts panel. In the section related to the experiment later on, we will point out how these attributes may be used as input to select, a priori, the most suitable places for being integral part of the game mechanics and, therefore, encouraging players to achieve their game goals.

Attribute	Position
Access to Public Open Spaces	1
Bike Lane	2
Security	3
Presence of drinking water fountains	4
Absence of garbage	5
Air pollution	6
Correct facilities (not broken or damaged)	7
Traffic	8
Presence of Lights	9

Table 1: List of urban attributes sorted by relevance for physical activity in Castellón.

Development of the location-aware game

This section is divided into two parts. The first one describes the narrative, mechanics and conceptual design of the game, while the second gives some

Analytics Platform for location-aware games

metrics: Data about the user is collected, validated, stored and analysed using an analytics platform for location-aware games. It offers the tools needed for performing custom analysis on data collected, enabling the possibility of using custom metrics to study the players' behaviour. This is especially useful for analysing data using different methods for calculating the players' activity. Location data is supported in the platform by enabling a set of GIS related analysis.

Besides, the platform allows to define the data to be collected and offers an SDK for easily submitting data from the location-aware game.

specifications about the technology stack used in the ongoing development.

Game Design and Narrative

The objective of the game is to achieve goals by walking. A similar conceptual pattern has been used in many other RPGs, such as The Witcher 3 and Zelda: Breath of the Wild. In these examples, the player has a specific goal as, for example, to eliminate an enemy, to reach a point or to locate another character. To achieve this, the player generally needs to improve by exploring the world, gaining experience, objects or strength, and to finally go to the stated place to achieve the goal. If the player does not explore enough, the player cannot beat the difficulty of the encounter in the specified place. This game mechanic can be classified as the combination of the emerging genres Urban Adventure Games and Smart Street Sports ([16] [17]).

In the developed location-aware game, tentatively named Orc's Hunter, the main objective is to hunt three orcs. Orcs appear in places of the city and possess a value of strength and an area of influence. That strength is translated into the necessary distance (in meters) that must be walked in order to defeat them. The player knows the location of the orc and can go whenever he wants to face him. However, to be able to defeat an orc, a player must have previously walked the amount of meters corresponding to the strength of the orc. In addition, the player knows at all times the travelled meters and the remaining ones. When he reaches the orc, the game simply makes that comparison and resolves the combat. If he does beat the orc, the game ends without success, allowing the player to start over. If the player wins, a new orc with greater strength appears in a new place. The operation

is repeated three times. When the last orc is defeated, the game ends successfully.

Even though the narrative of the game might seem simplistic at first glance, it should be considered as a prototypical game application for testing the overall technical platform with real users in outdoor urban contexts, and for getting prompt feedback from players. Nonetheless, the game mechanics and its narrative already take into consideration well-defined concepts and hypotheses that we will explore and validate during the course of the experimentation phase. The analysis of the gathered data during the game would allow us to ask questions such as whether the structure and aesthetics of places chosen for the encounter with orcs have influenced in the players, what routes do players follow to reach these places and whether there are urban attributes that impact in the selected routes.

Game Development

The game is developed for the Android platform. The development follows an agile methodology based on sprints. The technologies used for development are the following:

- Android Studio (2.3.2): The IDE Java development for the GeoGame.
- ArcGIS Runtime SDK for Android (100.0.0): ESRI's proprietary libraries for interacting with maps, and computing distances and areas of influence.
- Analytics Platform for location-aware games metrics (1.0.19): This self-developed, server-side platform complements the mobile location-aware game by storing and analysing location-based data generated by a player. It enables the analysis, via metrics, of

gathered data to produce aggregated data or information. This metric outputs may either lead to valuable feedback for the user of the analytics system, typically game designer or developers, on how the game is going on, or trigger specific actions (notification, etc.) to players to attempt to incentive or encourage a change in their behaviour (e.g. walk more).

The coding of the game follows a modular approach so that the internal components are easily removable and interchangeable. For example, the characteristics of orcs (how many will come out, place of appearance, area of influence, strength) are defined by an external configurable JSON (JavaScript Object Notation) file. In case of a game designer wants to change or adapt the current behaviour of orcs to a random generation schema, for example, it is done by simple editing the configuration file accordingly. The same is true for other components of the game such as map generation and metrics used.

Experiment

Game design, narrative and development come together in the experimentation phase. The main objective of this study is to demonstrate our hypothesis: whether or not participants perform more physical activity in a zone of the city with high density of urban attributes from Table 1 compared to other areas with less density of these relevant urban attributes for promoting physical activity. In addition, the experiment will also provide us feedback to analyse how users interact with the interface created (the location, or the design of the game) as well as their perceived impression about the mechanics and pattern of the game.

For the design of the experiment, we are collaborating with a team of psychologists specialized in cognitive/behavioural therapy to guarantee that the methodology followed to recruit and approach players (potential patients) as well as to handle their sensitive information is compliant with international standards, in order to ensure that privacy and ethical considerations are managed correctly. Game participants will be a group of users who will be following some psychological treatment whose protocol in part involves some physical activation task. At that point, two random conditions will be generated, the one of low physical activity places as targets and the one of high physical activity places.

For these two groups of users, the game will have two different versions: in one the game goals (i.e. places to reach) will appear in areas of greater concentration of urban attributes (Table 1); in the other version, though, the game will account for places with lower presence of relevant urban attributes. These destination places will be defined jointly with the team of psychologists. It is expected to obtain the results that confirm the hypothesis, based on indicators such as the number of missions performed in each condition and travelled distance. Apart from the factual observation of successful or failed missions to achieve game goals, the experiment will also gather timely location-based data per player. For doing so, the Analytics Platform will keep track of the paths and movement patterns followed by players while the game is running, computing required (spatial and non-spatial) metrics to generate aggregate and comparable indicators. This will add value to the psychological protocols, giving more relevant and contextual

information to the therapists on how players/patients behave while moving through the city.

Conclusions and Future Work

This work-in-progress paper presents the development of a location-aware game that takes advantage of the characteristics of the city, influencing players in doing more physical activity. It really encompasses a larger project that aims to give healthcare professionals innovative tools to carry out their protocols where games, mobile and geospatial technology play a dominant role.

The analysis of the characteristics of the city as well as the use of the Analytics Platform for metrics computation provide the game with a context and a set of tools that, in addition to streamlining its development, give added value from the point of view of health.

Although a simple narrative has been included for the prototype developed as an excuse for further development, it is assumed that depending on the type of users or target players, it could be modified. The game is developed in a way that allows changing this aspect easily. The same can be applicable to other aspects of the game, as the location of the generated targets or the amount of meters needed, as part of the game mechanics.

In order for users (e.g. therapists) to customize an instance of the game application by selecting places, narrative or meters required, the idea of a location-aware games constructor appears as immediate future work. It is a web platform, on top of a supporting technological infrastructure, where non-technological users such as physical education teachers or

psychologists are able to create their own versions of the application and offering them the ability to create groups and monitor their "players" (students or patients, respectively). The ultimate objective is to extend the functionality of the tool to psychologists, physical education teachers and other professionals that can take profit of it allowing them to apply their knowledge to develop the best possible interventions without having to pay attention to the technical details that generally distance them from this type of resources.

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