Systematically Exploring the Design Space of Location-based Games

Peter Kiefer, Sebastian Matyas and Christoph Schlieder[1]

[1] Laboratory for Semantic Information Technologies
Otto-Friedrich-University Bamberg
96045 Bamberg, Germany

{peter.kiefer, sebastian.matyas,
christoph.schlieder}@wiai.uni-bamberg.de

Abstract. With the rapid integration of mobile devices and localization technologies like GPS in our every day life, the interest for using combined technologies for entertainment is also growing. This is the idea of location-based games, which take use of localization technology and integrate the player's position into their game concept to generate a pervasive game experience. For this class of games we provide a systemization method not solely based on the technological dimension but also from the game conceptual and spatial-temporal dimension. The systematization is further used to derive a game design method which utilizes these three game design dimensions. By variation of the parameter values in these dimensions new location-based games can be designed. As an example our proposed method is illustrated with an existing location-based game, GeoTicTacToe.

1 Introduction

The integration of localization technology into mobile devices, like PDAs, cell phones or smartphones, is one of the current trends in the mobile market. Location-based services, especially navigation systems, have found their way into everyday life. Another area with increasing market share is mobile gaming, allowing people to play their favorite games on their mobile devices wherever and whenever they want.

The combination of these two areas – games played on mobile devices using localization technology – can generate true pervasive game experiences and is called *location-based gaming.* This kind of gaming is still in its infancy and its success has so far rather been a scientific than a commercial one. Location-based games were successfully used for research on the principles of pervasive computing and as use cases for upcoming technologies, like augmented reality (e.g. ARQuake, Thomas et al. 2000). Although technology was (and still is) the driving force for the emergence of such games, and although high-end devices can significantly enhance the pleasure of gaming, the commercial success of a game not only depends on how a game is played, but also on what the game is about.

In this paper we intend to show that location-based games are of interest not only from a technician's perspective, but also from a game designer's point of view. We provide a new systematization of location-based games, which is, in contrast to previous systematizations of pervasive games (e.g. Magerkurth et al., 2005), not exclusively technology oriented. We identify three orthogonal dimensions spanning the game design space for location-based games. Finally, we show how to use our systematization for the design of new location-based games by varying an existing one.
While plenty of work on game design for traditional computer games exists (e.g. Salen and Zimmermann 2003), and while even some authors consider game design for mobile games (e.g. Davidsson et al. 2004), the conceptual design of location-based games has not received much attention so far. The integration of position and movement into the game concept offers a variety of new possibilities which go by far beyond the typical conversion-from-computer-game type often found for mobile games. Until now most authors have designed their games by intuition with trial and error (Björk et al. 2002). Another approach is the use of metaphors, like the Geogames framework (Schlieder et al. 2005a) which builds on the idea of mapping classic board games to geographic space. On the one hand, design by metaphors is more systematic than design by intuition, but on the other hand it stays limited to a certain subset of location-based games. The Geogames framework, for example, describes only the class of location-based games which has common elements with classic board games.

The rest of this paper is structured as follows: Section 2 reviews seven typical location-based games found in literature or on the market. We introduce three design dimensions in section 3 and categorize those games along these dimensions. In section 4 the design by variation game design method is illustrated on an example game. In the last section we discuss related work on game design and give an insight on future research issues.

2 Examples of Location-based Games

In order to obtain the dimensions critical for the design of location-based games, we systematically explore the design space of an undoubtedly incomplete list of games. We will consider location-based games played in a research context as well as commercial games. Unfortunately, we lack the space to give a complete overview on all the location-based games we analyzed at this point. We therefore will pick some of the most prominent examples with the goal to illustrate the broad spectrum of different design ideas.

Geocaching, one of the oldest and probably the widest known location-based games, is played by single players who try to find treasures (usually boxes with little gimmicks in it) hidden at certain geographic positions in the real world, called "caches". A player may trade one gimmick from the box with one he or she has brought along. The coordinates of caches are provided by a large web-based community. Due to the inaccuracy of satellite navigation, the task of the game is not only GPS navigation, but also a detailed search in the surroundings of a coordinate.

In *Can You See Me Now (CYSMN)* (Flintham et al., 2003a) from Blast Theory Studios, online players are chased by street players. The former ones play CYSMN on a normal personal computer, while the latter ones are moving in the real world using PDAs and connected GPS receivers. The street runners play collaboratively to catch the online players. Their position is projected on the computer screen on which the online players experience and play the game. On the other hand, the street players can observe the state of the game on a map displayed on their PDA. When the position of a street player is identical to that of an online player, the street player has successfully caught his adversary.

Uncle Roy All Around You (Flintham et al., 2003b), also from Blast Theory, lets a street player work collaboratively with an online player to look for the office of Uncle Roy. To find this building in a real environment, the online player poses the street player different tasks (or puzzles) leading him or her step by step closer to Uncle Roy.

GeoTicTacToe and *CityPoker* (see Schlieder et al. 2005a, Schlieder 2005b) combine the strategic appeal of traditional board games with the physical effort found in sportive activity like a hundred meter sprint. The first game is a location-based variant of Tic Tac Toe, a game where two players try to set three markers, X or O, in a diagonal, horizontal or vertical line. *CityPoker* lets the players search and exchange their poker cards in the physical world competing for the best final poker hand.

Human Pacman, realised by Choek et al. (2004), is a straightforward port of the classical arcade game Pacman. Players either play the role of Pacman or that of the ghosts. The latter ones try to catch Pacman who in return struggles to collect all virtual cookies distributed on the real world game board. When Pacman eats special items at specific locations, he turns from hunted to hunting and may eat the ghosts as soon as he is at the same position – just like in the original arcade game.

Journey I and II, designed for a term paper by Jakl (2004), is a single player adventure game. To proceed in the classical storyline of three acts, players have to move in the physical world. They enter a new chapter of this crime thriller as soon as a certain position change has been detected.

3 Game Design Dimensions

In the following we will explain the dimensions we identified to classify location-based games. Each dimension is scaled nominally and the dimensions are orthogonal to each other, so in principle each combination of values is possible, although not for all combinations examples of games exist yet.

3.1 Dimension of game environmental embedding

This dimension deals with the way the game world is embedded in the player's environment. We distinguish the classes *pure location-based games (LBG)*, *mixed reality location-based games (MR)* and *augmented reality location-based games (AR)*. Although there more or less exists a common understanding in the community about

the meaning of these three classes, it is hard to find precise definitions, especially for location-based games. For the extraction of common properties of location-based games, we found the following definition to be sensible:

Def.: A *location-based game* is a game which is supported by localization technology and integrates the position of (one or several) players as main game element into its rules.

This general definition of a location-based game is based upon the two criterions *technology* and *game rules*, whereas none of these criterions alone would suffice to constitute a location-based game. For instance, in soccer the players' positions obviously play an important role, but soccer is no location-based game, for it is not supported by localization technology. On the other hand, a mobile gambling game which adopts its availability or billing conditions to the legal context of the federal state (or country) where the player is currently located cannot be regarded as being location-based, because the gambling itself does not use the position in its rules. To clarify the second criterion, we can say that in location-based games the rules induce the necessity of moving to a certain location in a real world environment, which may be an absolute position (e.g. GPS coordinate) or a relative position (relative to the current location or relative to another player).

Def.: *Mixed reality location-based games* add a virtual game layer to the real world, which is embedded through cognitive reasoning.

The markers X or O a player drops in *GeoTicTacToe*, for example, are only virtual game objects and have no physical equivalent. The same is the case for Human Pacman, with the virtual cookie objects (the player does not physically eat cookies, although a variant with real bakery would probably be interesting, see Choek 2004), or for CYSMN where the online players' avatars have no physical counterparts in the game environment.

Most of nowadays' location-based games fall into the class of mixed reality location-based games, e.g. *CYSMN, Uncle Roy All Around You, GeoTicTacToe, CityPoker* and *Journey I/II*. *Geocaching* with the physical gimmicks, as a counter-example, is not a mixed-reality location-based game and would therefore be classified as a pure location-based game. The mapping of the virtual layer to the physical world in a mixed reality location-based game is achieved through reasoning and imagination. Cognitive assistance may be provided, e.g. by using a PDA screen like in *CYSMN*.

Def.: *Augmented-reality location-based games* are a real subset of mixed-reality location-based games, but here the game environmental embedding is experienced perceptually from a first-person perspective.

In other words, the mapping of the virtual layer to the physical world is not done by the player's imagination, but has to be solved by the mobile device. One typical issue arising in this context is the head tracking problem. From a technological point

of view, augmented-reality games require high-level hardware support, e.g. head-mounted displays. A prominent example for an augmented-reality location-based game is *Human Pacman* (Choek, 2004).

3.2 Game Conceptual dimension

Game concepts in our perspective are more specific than the commonly used game genres established for pc or console games (e.g. adventure, first-person shooter) and more general than game design patterns (Björk, 2003; Davidsson, 2004). We describe a game concept by the abilities a player must have and the tasks he or she must solve for winning the game. From our collection of analyzed games, of which section 2 only shows the prominent representatives, we derive the following game concepts. A location-based game can be instance of one or several of these game concepts.

Chase game: A location-based game incorporating this game concept requires players to have superior physical abilities for winning. In *CYSMN*, for example, players win by being fast.

Item hunt game: This game concept embeds a search for items hidden in the natural surroundings on the game board, e.g. a box under some bushes. The most prominent example is certainly *Geocaching*.

Puzzle game: Instances of this game concept are won by solving puzzles. These puzzles range from simple knowledge questions ("Who is buried in the cathedral in front of you?") to complex story lines like found in adventure games. An example for a puzzle game is *Uncle Roy All Around You* or the *Journey series*.

Strategy game: This type of game is won by superior planning capabilities. In *CityPoker*, for example, a player needs to plan his own actions to reach a good poker hand, while at the same time trying to cross the other player's plans.

3.3 Spatial and temporal dimension

This dimension describes a game in terms of when and where the actions relevant for the game can take place.

An example for a *spatially and temporally discrete game (sdtd)* is the Journey Series: the actions relevant for the game do not happen anywhere on the game board, but at certain predefined locations. Additionally, the player may only move when the game allows him to do so, e.g. when a new chapter of the game needs to be started.

A *spatially discrete, but temporally continuous game (sdtc)* also restricts relevant actions to a limited amount of discrete locations, but the player may undertake the actions at those locations whenever he likes. In *CityPoker*, for example, poker cards can only be changed at five discrete locations, but the players are free to choose the time for visiting the locations. In other words: A temporally continuous game does not have the typical turn-taking of board games like chess.

Finally, in a *spatially and temporally continuous game (sctc)*, actions can take place anywhere on the game board and at any time. In *CYSMN*, for example, a player can be caught at any place and whenever an online and a street player meet.

To our knowledge, no game implements the fourth value for the spatial and temporal dimension, which would be a *spatially continuous, but temporally discrete (sctd)* game. In this type of game players would be restricted to take turns, but be allowed to move continuously. Example: In his first turn player A may move 100 meters in any direction, while player B has to wait. Afterwards, player B does his turn by moving 100 meters, while A keeps standing, before it will again be A's turn. A location-based game may also be a mixed form like *Human Pacman*, where some actions (eating a cookie) are restricted to discrete locations, while others (catching Pacman) may happen anywhere.

4 Design by variation

Table 1 illustrates how our selected location-based games are classified in regard to the three game design dimensions of our systematization method, game environmental embedding, game conceptual and spatial-temporal dimension.

	Embedding	**Game Concepts**	**Spatial-Temporal**
Geocaching	LBG	Item hunt	sdtc
CYSMN	MR	Chase	sctc
Journey I/II	MR	Puzzle	sdtd
Uncle Roy	MR	Item Hunt/Puzzle	sctc
GeoTicTacToe	MR	Strategy/Chase	sdtc
CityPoker	MR	Item Hunt/Strategy/ Chase/Puzzle	sdtc
Human Pacman	AR	Chase	(sc-sd)tc

Table 1: Classification of the selected location-based games

With these three orthogonal and nominally scaled dimensions we enable the game designer to build new games by simple picking one value for each of the dimensions. Furthermore, it supports the easy creation of new games out of an existing one by varying the parameter values in one or several dimensions. For example, it is possible to take a location-based game with the game concepts {chase game, strategy game} and create a new one by adding some item hunt elements. In the following we vary the Geogame *GeoTicTacToe*.

a) Location-based embedding (MR → LBG): For turning the original GeoTicTacToe into a pure location-based game, we replace the virtual markers with physical objects, i.e. players now carry Xs and Os with them which they have to drop at the

locations. Additionally we remove the virtual layer from the mobile latter screen and do not show previously set markers.

b) Pure strategy game (Strategy/Chase → Strategy): Imagine we would like to play *GeoTicTacToe* with elderly or handicapped people by removing the chase aspects. This can easily be managed by forcing players to wait at a location until the other player has set his marker, i.e. we reintroduce strict turn-taking. The resulting waiting times should certainly be filled with entertaining content to keep players interested.

c) Multi conceptual game (Strategy/Chase → Item Hunt/Strategy/Chase/Puzzle): Introducing the additional game concepts item hunt and puzzle game, we now create a completely new game feeling. Before setting a marker, a player needs to search the surroundings of a location for a hidden RFID tag. After scanning this RFID, the mobile device poses the player a quiz that he has to solve (e.g. a simple multiple-choice question), before finally the virtual marker is dropped.

d) Spatial continuity (sdtc → (sc-sd)tc): Setting markers is still restricted to the nine locations, but events may happen on the way. Each player is equipped with a certain amount of (virtual) traps he can drop anywhere on his way. As soon as the adversary comes close to one of those virtual and hidden traps, he has to wait some minutes before moving on.

5 Related Work and Future Research Issues

Although game design is more and more recognized as an art form like film making, writing or painting, it still lacks proofed methods other art directions posses. Common methods like painting or cut techniques are not available for game designer. Although this is slowly changing for computer game design (for e.g. Rouse, 2005), it remains true in the field of location-based game design. In this paper design by variation was presented which enables the systematical design of location-based games along three game design dimensions. Varying a game along the dimensions of environmental embedding, game concepts or the spatial-temporal dimension, can create totally new game experiences.

Previous systematizations of location-based, pervasive or ubiquitous games (e.g. Magerkurth et al., 2005 or Rashid et al., 2006) have usually carried out classification solely by technological aspects. These systematizations were thought as overviews of existing games and technology, so no conclusions with respect to game design were proposed.

Davidsson et al. (2004) presented an enormous variety of game design patterns for mobile games by analyzing a huge collection of mobile games. But they considered location-based games only as one single pattern in their categorization, subsumed under the label pervasive games, and did not distinguish them any further. We think

the specific characteristics of location-based games need a deeper analysis to utilize the full potential of these games.

Our future research is concerned to incorporate other properties of location-based games in our game design method. For concepts like cooperative versus competitive game play or multiplayer experiences game design by variation needs to be further extended.

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