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Designing Location-based Mobile Games with a Purpose - Collecting Geospatial Data with CityExplorer

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ABSTRACT

The *games with a purpose* paradigm proposed by Luis von Ahn [9] is a new approach for game design where useful but boring tasks, like labeling a random image found in the web, are packed within a game to make them entertaining. But there are not only large numbers of internet users that can be used as voluntary data producers but legions of mobile device owners, too. In this paper we describe the design of a *location-based mobile game with a purpose*: CityExplorer. The purpose of this game is to produce geospatial data that is useful for non-gaming applications like a location-based service. From the analysis of four use case studies of CityExplorer we report that such a purposeful game is entertaining and can produce rich geospatial data collections.

Categories and Subject Descriptors

K.8 [**Personal Computing**]: General—*Games*

General Terms

Design

1. INTRODUCTION

"We authors, over the years, have felt many pangs of conscience as too much time is spent on games, wasting good effort on something largely unproductive." In writing this sentence, Peltola and Karsten (2006) [7] express a widely shared feeling about game playing. But what would happen if we combine game playing with some purposeful task? Luis von Ahn and his colleagues took exactly this step when they introduced their paradigm of *games with a purpose* [9]. With the help of browser-based games they motivate voluntary internet users to do rather monotone tasks that are relative easy for humans to do but difficult to impossible for computers, for example labeling of or locating objects in random images found in the web.

The main idea behind their approach is to use the computational capabilities of millions of human internet users, which, combined, easily match the computational power of most computer systems. But although internet users form a more than suitable target group for such an approach, we propose to look into quite another large user group: mobile devices owners. We are especially interested in games for users of mobile devices with some sort of localization technology (like GPS), known as location-based mobile games [6]. Naturally the kind of games and more importantly the kind of data able to collect with games aimed at that user group are quite unique.

Data acquisition has been identified as a potential field of application for location-based mobile games ([2] and [10]), but to our knowledge no actual geospatial data collection game has been realized so far. Following a suggestion made by Matyas (2007) [5] we describe in this paper the location-based mobile game CityExplorer in which players take georeferenced photos, localize geographic points of interest and categorize them semantically. It is the first location-based mobile game explicitly designed as a game with the purpose to collect geospatial data.

With four use case studies, three in the city of Bamberg (Germany) and one in the city Fujisawa (Japan, near Yokohama), we explore the following questions: (1) Is a game particularly designed for the purpose of collecting geospatial data still perceived as entertaining? (2) How much geographic and semantic data can be acquired by using CityExplorer? What quality level can be expected?

The rest of the paper is structured as follows: In the next section we give a short overview on related work, before we present our CityExplorer game in section 3. In section 4 we describe the four use case studies of CityExplorer in detail and evaluate the results. A conclusion and an outlook on future research in section 5 close the paper.

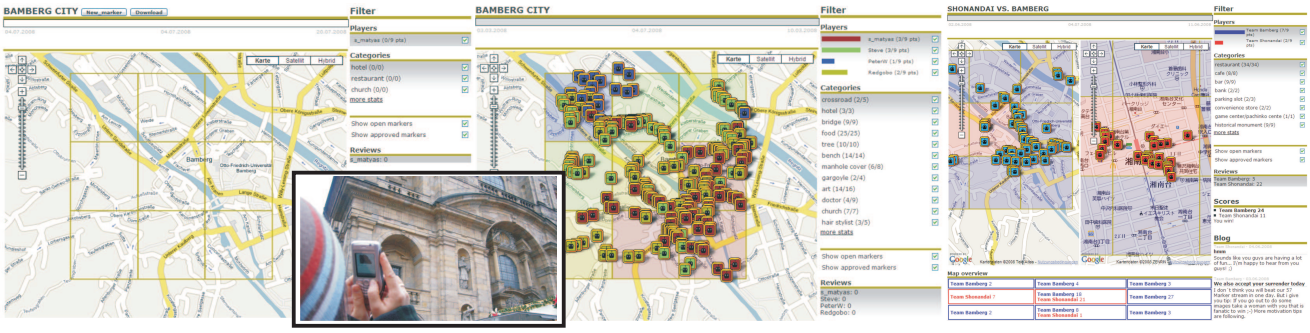

Figure 1: Single-city and multi-city game of CityExplorer (map images ©Google Maps)

2. RELATED WORK

Some sort of mobile device and some type of localization technology form the basis of any location-based mobile game. In principle, this makes it possible to gather primitive geospatial data like raw GPS tracks with any of such game. Matyas (2007) [5] shows that indeed considerable amounts of raw GPS tracks can be collected while playing a location-based mobile game. His evaluation reveals that enough data can be collected in around 74 hours of game play to replicate the road network of the city of Bamberg in digital from. Unfortunately, such event-based location-based mobile games require a high organizational effort and are limited in the types of geospatial data that can be acquired through them.

In location-based mobile games that focus on user-generated game play, like MobiMissions [4] or the Gopher game [3], players can build small mini games or missions which other players carry out. These games intend to animate the players to generate location-based missions in the first place. But the evaluation of such user-generated missions, for example in [4], shows that only a fraction (about 22%) are actual location-based in that they require a player to go to a specific place in the real world. Most missions produced are more of the kind "take a photo of your stinky feet", that is, missions which could be played comfortably from home or on some well-known surroundings like the college while e.g. lying in the bed or sitting on the coach. Also none geospatial data collection missions were created by the players of MobiMissions.

In a non-gaming context the productivity of location-based mobile applications is well known. A recent example are the increasing number of mobile geoblogger applications [1] that allow users to take georeferenced photos with their camera cell phones and upload them to a corresponding web site. But the particular focus of these application to mostly tourists limits their reachable audience and their capability to collect geospatial data of non-touristic regions.

3. THE GEOGAME CITYEXPLORER

CityExplorer, which belongs to the class of location-based mobile games called Geogames [8], was first introduced by Matyas [5] as a theoretic design example. The Geogames framework presented in [8] has been designed to systematically explore how the physical challenges (locomotion) of a location-based mobile game interact with the strategic elements (reasoning) and how each of them contributes to the game playing experience. This framework enables a game designer to turn almost any classical board or card game - together with its specific form of strategic reasoning - into a location-based mobile game. We will see now how the theoretic design example in [5] is turned into a working game with a purpose in the following.

3.1 General game design idea

The CityExplorer game is inspired by the award winning board game Carcassonne, originally designed by Klaus-Jürgen Wrede. A game of Carcassonne always starts with a single tile of the fragmented and hidden game board. Players take turns to draw a new tile and lay it down to extend the land of Carcassonne. After that, they have the choice to place one of their game markers (followers) on the tile just dropped. Followers can only be placed on locations of specific object categories, for example on churches, to control them. A player gets credits for the objects their followers hold under control. Once all tiles are laid down, the final scoring takes place. The player with the highest score wins.

For CityExplorer we adopt the main game elements and relocate the game play in the real world via mobile devices coupled with GPS technology and a corresponding website [1]. Therefore the game consists of an online (web-based) and an offline (mobile) component (see middle image in Figure 1).

3.2 Exploring the city

The primary way to win a game of CityExplorer is to set as many markers as possible in a typically citywide game area. To mimic the tile-based game play of the original and to add strategic depth to the game play, the game area is further divided into non-overlapping squares or segments (see leftmost image in Figure 1). In each of these squares the setting of markers is allowed, but only on predefined categories of locations like in the original. The player who holds the majority of markers in such a segment claims the domination of it and is assigned credits (currently two) at the end of the game. Now the problem we encounter is that not every city features the same location categories and we as a game designer do not know the exact coordinates for every possible object of a specific location category in advance. But players would expect that they can set markers for example on every church they find in the game area.

[1] http://www.kinf.wiai.uni-bamberg.de/cityexplorer/

To make the set up and relocation of the game as easy as possible and to increase the replay value, each player chooses an equal number of categories before a game session starts. No categories are predefined by the game so that players have to come up with whichever location categories they know of, resulting in more general categories like "food" or "art" or very precise categories like "bar" or "cafe". This way different knowledge levels of the players are balanced. The single restriction is that only non-movable objects are allowed as location categories. Players gain credits for placing the most markers to one valid location category on the entire game board. Consequently, in order to win the game players must not only keep close watch on the marker count within every game board segment, but also pay attention to which player currently is in lead for a particular location category.

The game starts with a completely empty game board without any predefined game locations, so that every real world location of a chosen game category can be turned into a game location. This design approach also makes games between geographically separated players - which we call multi-city games in the following - easily possible (see section 4).

As CityExplorer is especially designed to enable the collection of geospatial data the setting of a marker involves the following steps: (1) take a photo of the location you want to set your marker at, (2) type in the name of the location, (3) approach the location as close as possible and (4) select the correct location category. At steps (1) and (4) the current GPS coordinate is recorded - later allowing us to reconstruct the angle from which the marker photo was taken.

Having recorded a considerable number of markers, the player copies her photos and meta data (recorded in an XML-file) from the mobile phone to a computer, and uploads the marker collection to the CityExplorer web site.

3.3 Quality control

The online component of the game gives us the possibility to realize an asynchronous game play. As the players can choose for themselves how long a game round of CityExplorer lasts, which may last from a day to several months, players do not need to play the game at the same time but can play the game (mobile and online) whenever they have time slots left in their schedule. Nevertheless, they always have the possibility to check the status of the game on the web site. Additionally, with the online component they can play some parts of the game when, for example, the weather conditions are not good enough to play outdoors.

As the game software cannot check if an uploaded marker is correct - the location, photo, tag and the chosen category - we have implemented a community-driven review process for CityExplorer. While the game time is not over all players judge the correctness of all other players' markers anonymously, i.e. the information who uploaded the marker is kept hidden for the review process. In our current build of the game a player can either approve or refuse a marker of another player. Naturally, a player is not allowed to approve or refuse his own markers. If a marker is approved by any player, it is said to be correct and cannot be refused by another player anymore. If refused, the owner of the marker can correct his marker according to reviewers comments once. After a possible correction the marker is reviewed by a different player than the one who did the first review. If the marker fails this second review again, the marker does not count for the game. This way every marker is reviewed by two independent players.

The reviewing process in its current form serves two purposes. First it shall counter uploading of incorrect markers in great numbers and unjust or random refusing of markers. To motivate the players to review markers at all, the player with the most reviews gets a predefined amount of credits at the end of the game. The review process restricts the minimum number of players to three per game. It further assumes that either all players know the game area good enough to judge markers correctly or that they are motivated enough to check the correctness of a marker - especially the location - by exploring the game area physically.

4. USE CASE STUDIES AND RESULTS

To evaluate the design of CityExplorer several use case studies were carried out in the city of Bamberg (Germany) and Fujisawa (Japan). Overall three games were played in Bamberg as single-city games. In one additional game, a team in Bamberg competed against a team in Fujisawa in a multi-city game.

In the three games in Bamberg in total 14 players participated. All participants had knowledge about the GPS technology varying from "heard of" over "had a lecture about it" to expert knowledge. In total twelve of the participants completed a questionnaire and participated in a short answer and question round after each game.

In the CityExplorer game between the city of Bamberg and the city of Fujisawa (near Shonandai station) two teams, each with four participants, competed against each other. The game time was set to four days. For both teams the game area was located in their respective city as can be seen in right-most image in Figure 1. The overlaid virtual game board segments were mapped on each other by the game logics. So if a player set a marker in Bamberg in the upper left segment it counted also as a marker for the upper left segment on the game board in Fujisawa. Furthermore, out of fairness reasons for both game areas the same location categories were used.

As players of one team cannot judge the correctness of markers from the other team in the other city and to let players judge markers from their own team makes makes no sense as well. So for this particular set up we assigned neutral reviewers for each game area. Please note that this is only necessary when two teams compete against each other. If the players from the two cities would have been all playing on their own the review process could have been conducted as in a single-city game. Theoretically, the CityExplorer web site enables the connection of n game boards. Three of the four Japanese players also completed a questionnaire. The participants in Bamberg also participated in one of the three single-city games in Bamberg. Therefore we did not collect a second questionnaire from them. But they participated in the Q&A session for this game.

The 14 players in Bamberg collected a total of 772 markers over a period of 20 days: 276 in the first, 308 in the second, and 188 in the third game. Not surprisingly more general location categories like "food" (65 in game two) resulted in more collected markers than more specific categories like "hair stylist" (12 in game two). In connection with the high fun ratings for the mobile part of the game (mean 4.4 with a standard deviation of 0.5 on a five-point Likert scale) especially the integration of the data gathering task can be judged as successful .

The eight players in the multi-city game collected in total 106 markers in the four days the game lasted. The results of the questionnaire (mean 3.6 with a standard deviation of 0.6, fun factor of the mobile component out of the three questionnaires from the Japanese players) together with the answers given in the Q&A session support that distributed game play is possible and as immersive as in a single-city game.

Unfortunately, the online part of CityExplorer was not perceived as entertaining (mean 2.9 with a standard deviation of 0.9) as the mobile part. The Q&A sessions revealed that the reviewing step was seen a little cumbersome to handle. Here a redesign of the web interface was suggested to make it smoother to use. But the fact that the online reviewing was an integrated part of the game through which credits could be earned through motivated the participants to some degree to do it anyway. For a more detailed breakdown of the questionnaire results please refer to [6]

From a qualitative perspective the data shows mixed results. Although the review process got low scores in the questionnaire 388 markers (or about 42% of the 922 markers from all four games plus one pilot study conducted in Yokohama) were at least corrected a single time (145 of them also a second time). 345 markers (37%) were approved by the players to be correct, only 38 markers (0.04%) got refused. But 539 markers (58%) remained undecided, i.e. no player judged them to beright or wrong. But we note that 145 of these markers are of category types that are very hard to judge in a meaningful way - trees, benches, manhole covers and gates. From a visual inspection of the whole collection we can report that the position accuracy is sufficient for a thematic map view but only to some degree for a more detailed display.

5. CONCLUSIONS AND OUTLOOK

In this paper we have shown that a location-based mobile game with a purpose is possible. The results of our four use case studies point out that such a geospatial data collecting game is also entertaining and produces data of high quantity and of acceptable quality.

The CityExplorer game experience highlights three important aspects one has to take into account when designing a playful geospatial data set gathering application: (1) Designers should leave the game area as open as possible, with only a minimum set of predefined game relevant locations. This not only increases the portability to other geographic regions but it lets more data left that can be collected by the players, too. (2) Geospatial data from non-experts recorded with ordinary mobile devices are rarely of high quality. Therefore an in-game reviewing and correction step - a community-based data quality control - is needed. Here an integration into the game flow is most critical. (3) Players can be motivated to provide rich geospatial data sets (see section 3.2) through a location-based mobile game with a purpose.

As one our next steps we want to implement a version of CityExplorer for Facebook to evaluate our approach with as many participants as possible. Additionally, we are planning to set up a community-based location-based service to enable the players of CityExplorer to use their geospatial data collection outside of the game. Our future research aims at improving the online component of CityExplorer to raise its fun value and the quality of the collected data.

6. ACKNOWLEDGMENTS

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