

Street Art Gangs: Location Based Hybrid Reality Game

Paula Alavesa and Timo Ojala

Urban Computing and Cultures Research Group
Department of Computer Science and Engineering
University of Oulu, Finland
paula.alavesa@ee.oulu.fi, timo.ojala@ee.oulu.fi

ABSTRACT

We present a location based mixed reality game called Street Art Gangs that we have developed to explore the playful appropriation of the hybrid reality comprising of a city center and its detailed virtual replica represented as a 3D virtual model. In the real streets SAG is played with a mobile phone app that allows tagging predefined locations around the city to claim their ownership and busting nearby players of competing gangs. The virtual game world is viewed with a PC app that allows observing the current owners of taggable locations, the locations of other players, and the locations of patrolling virtual policemen busting players. We have developed two incremental versions of SAG that have been evaluated with tournaments in the wild. We conceptualize the findings of the tournaments with de Souza e Silva's theoretical framework for hybrid reality games. Our findings suggest that players preferred to play the game on real city streets while the added value of the virtual game world remained marginal. The size of the game both in terms of area and the number of taggable locations turned out to have a major impact on gameplay.

CCS Concepts

• **Human-centered computing~Empirical studies in ubiquitous and mobile computing;**

Author Keywords

Pervasive gaming; hybrid space; location based games; hybrid reality games; virtual worlds

INTRODUCTION

Modern urban space can be perceived as a combination of physical, social and digital information spaces, which is in constant flux as people move through the city. The concept of urban space has experienced fundamental changes due to the introduction of mobile devices equipped with wireless communication capabilities and sensors such as GPS for positioning, the Web as an infinite online archive of

applications, and the change in the philosophy on the concept of space itself, i.e. the idea of space being a fluent continuum produced by people and society [7, 8, 9, 10, 27]. An emerging representation of urban space all around the world are 3D virtual city models, as detailed digital replicas of the corresponding physical space [16]. These different spaces are connected by social interactions, resulting in a hybrid reality that provides a platform for many applications [7, 8]. One such application domain is hybrid reality games (HRG) which emphasize the social interactions that combine spaces and take advantage of the urban setting [7, 8, 9]. HRGs can also be regarded as a subgenre of pervasive games. Pervasive games that aim at expanding the boundaries of the magic circle where a game is situated. They often take place in an urban setting for the obvious reason that there is abundance of infrastructure and people, providing a rich base for staging a game that pervades into real life. Many pervasive games utilize positioning technology in gameplay. While there are plenty of location-based pervasive games, only few of them incorporate a parallel virtual 3D representation of the physical game world in the gameplay making them hybrid reality games [1, 2, 3, 13, 18, 20, 25, 29].

In this paper we present the *Street Art Gangs* (SAG) as a hybrid reality game that is played simultaneously in two parallel spaces, in a real (physical) city center and in its detailed virtual replica represented as a 3D virtual model (Figure 1). In SAG the 3D virtual model is not blended into an augmented or mixed reality experience but the virtual reality extends the real world space perceived by the players into a hybrid reality.



Figure 1. A bird's eye view of the virtual SAG game scene.

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In the following, we first discuss related work and the theoretical framework of HRG as introduced by de Souza e Silva [8]. Then we report the design and implementation of the two incremental versions of SAG, followed by their experimental evaluation with tournaments in the wild. We discuss empirical findings from our explorative research along selected dimensions of de Souza e Silva's theoretical framework and conclude with a summary of results.

BACKGROUND

While there are plenty of commercial and academic location based games, only some of them incorporate a parallel virtual model or a map of the game area into the gameplay. *Ingress*, *Can You See Me Now* (CYSM), *I Like Frank* and *Uncle Roy All Around You* are examples of pervasive games where the parallel representations of space are used in gameplay, so that the players' location data and communication bind the real and virtual spaces together. These games situate somewhere in between real environment and augmented reality, making them categorical HRGs [1, 2, 3, 7, 8, 13].

Ingress is a commercial map based location based game that is played on a global scale. In *Ingress* the reality is augmented with a strong background story of alien energy and two factions fighting over the dominion of portals and area on the game map. The physical environments are dynamically entwined into the story as new locations are added to the network of portals in the game. The game makes the players pay attention to their environment by giving new significance to physical landmarks. The gameplay is mainly situated on physical streets. The game's augmented map can be accessed via mobile phone. *Ingress* shows that location based street games can have a high appeal and that pervasive games can be played and orchestrated independently with the current technologies [1, 29].

In CYSM [10] the players have access to a low detail virtual representation of a limited area. They try to avoid runners who roam the physical city streets. The players on the streets are part of the game itself where the players in the virtual city scene are part of the game's orchestration. CYSM shows that a virtual environment can be combined successfully in pervasive gameplay. In the two closely related games, *Uncle Roy All Around You* [3] and *I like Frank* [13], the role of the player is fixed to either virtual city or the streets but the players are offered a free choice on which realm they sign in for the game. The player on the physical streets is trying to find to a specific location aided by the online player. Their coordination between the environments relies heavily on their communication as the game does not utilize GPS for positioning. These games show that virtual and physical city streets can be intertwined into a hybrid space. The games are though set up so that they would not work without anyone using the virtual scene.

Players' can use mobile game app as a window to the hybrid space like they do in *Mogi* [23]. *Mogi* is a simple mobile location based game where players gather items from varying locations, but can also observe other players' locations with

their game apps. The ability to observe other players creates a possibility for mediated encounters where the players are co-present in the hybrid space, but not necessarily in close physical space.

THEORY

In her theoretical framework for HRG, de Souza e Silva [8] integrates three particular design dimensions that she argues to have been neglected in the mainstream game theory due to the overrepresentation of classic videogames. What makes de Souza e Silva's framework especially suitable for studying a mobile game played on the city streets is that it is founded on theories stemming from urban mobile culture. The three dimensions of her framework and their underlying founding theories are:

1. The playful characteristic of everyday life: a. Ontology of play [11]; b. Street sociability [22].
2. The effects of gameplay and the organizations of social mobile networks in physical urban spaces: a. Collective action theory [5]; b. New mobilities paradigm [29]; c. Smart mobs [27].
3. The potentials of mobile technologies as playful interfaces: a. All of the above.

The first dimension is grounded on Fink's ontology of play and Lehtonen and Mäenpää's theory of street sociability. Street sociability highlights that the movement and interaction through game space bring unpredictability to the game that can either be exciting or scary to the players. The ontology of play describes social interaction and community that are a part of playful experiences of everyday life and hence become intrinsic part of games located in real or represented streets of HRGs.

The second dimension finds support from collective action theory, Sheller and Urry's new mobilities paradigm and Rheingold's description of smart mobs. Sheller and Urry's new mobilities paradigm states that in addition to giving new meaning to space, movement through and interaction in space result into game narrative and playful experience. By new mobilities paradigm normal mobility is replaced by displacement, which is an experience co-produced by people, places and activities. A smart mob is a phenomenon where mobile technologies and people together define a social network in urban space. The described theories and paradigms are used to establish the third dimension of mobile technologies as playful interfaces, as the use mobile devices and mobility are inherent in HRGs.

In defining her framework for HRG, de Souza e Silva uses as examples well-known pervasive games such as *I Like Frank*, *Day of The Figurines*, *Botfighters* and CYSM. Whereas pervasive games expand the scope of gameplay spatially, temporally and socially, de Souza e Silva specifies that HRGs contain the three design elements of mobility, social activity and the expansion of the traditional game space. The HRG specific expansion of game space means that the gameplay

takes place simultaneously in two or more different spaces that are connected through social actions. Furthermore, by definition HRGs take place in urban setting and use the city as a game board [7, 8, 10].

STREET ART GANGS

Overview of Gameplay

In SAG teams of players dubbed ‘gangs’ and named after colors (e.g. purple, green) compete for the dominion of predefined locations around downtown Oulu, Finland. In the real streets players wearing beanies of their assigned gang color claim the ownership of a location and 100 points by ‘tagging’ the location with a mobile phone app. A player can also ‘bust’ a player of another gang when that player is tagging a location, gaining 10 points for each successful bust. If the busted player does not interrupt tagging, which takes 30 seconds to complete, (s)he can be busted multiple times, yielding corresponding points for the busting player. A tagging player can also get busted by the virtual policemen patrolling in the virtual game world (Figure 2). A busted player loses playing time and 30 points and is not able to claim the ownership of the location. There is no delay in trying to re-tag a location after being busted, but one will most likely be busted again on that same location. Busting has no delay, but one can attempt to bust only at the three closest locations shown in the game app. The availability of locations for busting or tagging depends also on the precision of the location data, hence a player can be physically quite far from a location when attempting either.

On the streets the players wear a beanie in their assigned “gang color”. In the virtual game world viewed with a separate PC application the players are illustrated as avatars in their assigned gang colors that are placed in their latest real world locations as determined by the A-GPS on the mobile phone. When a player tags a location, street art graffiti of the assigned gang color is rendered at the location, hence the name of the game as “Street Art Gangs”. Figure 2 illustrates an incident during a tournament where a player of the green gang is busted by a virtual policeman when he is tagging a particular location. The graffiti, avatars and virtual policemen can be only seen in the virtual game scene viewed with the PC game application.

Development Process

SAG was developed iteratively and incrementally as follows. A beta version of the first mobile game app was tested in a lab on three separate occasions by adolescent subjects. Among other things, they were given a list of the taggable locations and were asked to find them from the virtual game scene, followed by a short interview on various game related aspects. These tests yielded improvements in the design of the game app and in the selection of taggable locations. Further field tests by the developers resulted in the fine-tuning of the coordinates of the taggable locations, given the spatial accuracy of A-GPS positioning at those locations.



Figure 2. Bust in SAG: (A) Virtual game world showing an avatar, a graffiti, a busted player and a virtual policeman encircled; (B) Simultaneous view of the real game world.

SAG version 1 was evaluated in late spring 2014 with a 4-day tournament dubbed “Pilot” involving three gangs of three players. The experiences and findings of “Pilot” resulted in improvements in the implementation of SAG version 2. A software bug of getting busted not resulting in losing points was fixed. The visualization of the avatar of a player currently tagging a location was enlarged. Flying above the virtual city was allowed, to make it easier to observe other players in the virtual game scene.

SAG version 2 was evaluated in late fall 2014 with a 2-day tournament dubbed “Trial” involving three gangs of four players. A major change in the experimental setup was that the virtual city model and thus the virtual game scene expanded from nine blocks to 24 blocks between the two tournaments. The number of taggable locations increased from 27 to 51, as well. This allowed us to explore the effect of the size of the game area on gameplay. The collection of quantitative research data was enhanced in version 2, including more accurate recording of player movements.

Technical Implementation

SAG is implemented using the classical client-server architecture, comprising of two clients (mobile phone, PC) and two servers (game server, virtual scene server).

Virtual game world

The virtual game world is implemented as a 3D scene atop the realXtend open source game engine for building collaborative 3D virtual worlds [12, 24]. The scene is viewed with dedicated software called Meshmoon Rocket.

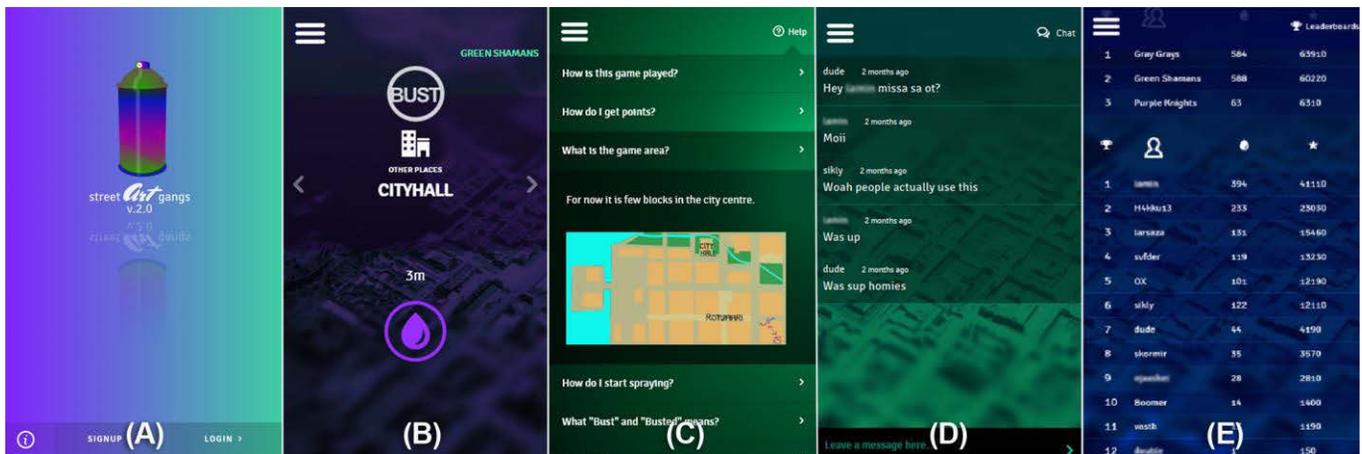


Figure 3. Screenshots of mobile game app. (A) sign up / log in; (B) taggable locations and busting opportunities with distance estimates; (C) help page that includes rules and the map of the game area; (D) chat; (E) real-time leaderboard. Each gang has a distinct color that is used as the background color of the UI. The icon at the upper left corner takes to a drop down menu of all the subpages of the game app.

The players can see other players' avatars and the virtual policemen in the virtual game world. There is roughly a two second delay in transmitting the location data from the mobile game app to the virtual game world via the game server. The avatars either jump or walk between location updates. When a player tags a location, the avatar jumps to that location, to make sure that other players can see that a player is active there (Figure 4). Virtual policemen are non-player characters in the virtual game scene, where they patrol along random routes. If they get within a predefined spatial reach (15 or 20 meters in our case) of the location of a tagging player, the player is busted.

Mobile phone game client

The mobile phone game client is a web-app developed for the Android platform. The app provides a number of UI views (Figure 3) for different purposes such as tagging locations, busting other players, real-time leaderboard, chat and help.

Versions 1 and 2 differed in terms of the design of the splash screen and the number of taggable locations visible (all 27 vs nearest 15). The client uses A-GPS for determining the

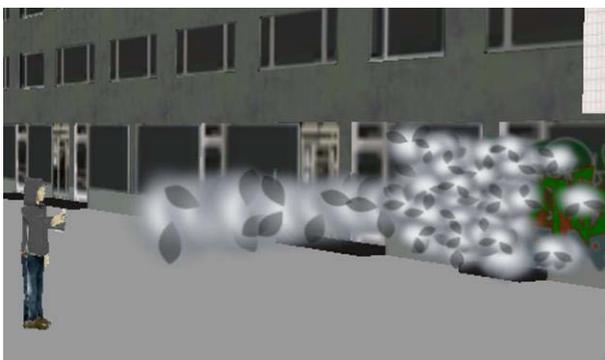


Figure 4. A player of the Gray gang is tagging a location in the virtual game scene.

location of the mobile phone which is also used as the location of player. The tournaments took place at fairly northern latitude, where GPS positioning is known to have low accuracy [30]. Players used mainly Motorola Moto G and Samsung Galaxy S4 mini Android phones provided by us. The players were allowed to install the game app on their own phones and some did use their own mobile phones from time to time.

Game server

The game server maintains game related data such as players' locations, scores etc. Both the virtual game scene and the mobile application poll and update data on the game server at regular intervals.

TOURNAMENTS

Experimental Setup

Both SAG versions were evaluated with their respective tournaments, version 1 with "Pilot" in spring 2014 and version 2 with "Trial" in fall 2014. The rules governing gameplay in the tournaments were few, to let the players concentrate on playing, and to allow community emergent rules that are a relevant aspect of pervasive games and HRG [8, 25]. First, players were expected to always wear the beanie of their respective gang color when playing inside the game area. Second, players were not supposed to neglect important daily duties such as school during tournaments. Third, players were expected to respond to online questionnaires in timely fashion. All players attended a preparatory event, where they were given an introduction of SAG, including guidance on how to access the virtual game world. Further, player IDs were created and players were given smart phones with a 4G mobile data plan and the game app readily installed. During daily tournament times a researcher was present inside the game area at a changing location dubbed the game base. Orchestration is commonplace in location-based mobile games. The dependence on real time data and Internet connection can

cause problems. Their severity depends on the level of technology dependence [1, 3, 25]. In SAG tournaments our objective was to minimize orchestration and hide tracking and observation from the players whenever it was possible. This was not just to make the game more enjoyable to players, but also to lessen the effect of interaction between the researcher and the players.

	SAG version and tournament	
	1. Pilot	2. Trial
Game area (km ²)	0.11	0.26
Game area (blocks)	9	24
Taggable locations	27	51
Locations visible in mobile game app	27	15
Virtual policemen patrolling in virtual game world (spatial reach in m)	2 (15 m)	5 (20 m)
Gangs / players	3 / 9	3 / 12
Duration (days/hours)	4 / 48	2 / 20
Weather	sunny, 29 °C	cloudy/rainy, 1 °C

Table 1: Experimental setups of SAG tournaments.

For comparison the key attributes of the tournaments are shown in Table 1. The notable differences between the tournaments are the size of the game world, the number of virtual policemen, duration and weather.

Participants

Players were all male of 13-30 years in age. They were recruited via social network sites and a web page dedicated for the tournament. Their sports and gaming activities and motivation for participation were mapped with initial questionnaires. The activity in playing computer games was determined on a scale where a casual gamer plays 0-15 hours a week; regular 15-30 hours a week, and excessive gaming is over 30 hours a week [17]. Most players reported playing digital games casually. The players mentioned curiosity and having fun as their main reasons for signing up to the game.

The Pilot had three gangs of three players: *Purple Knights*, *Blue Angels* and *Green Shamans*. Most of the players in gangs knew each other in beforehand, but they were not familiar with the players from the opposing gangs apart from two players. The Trial had three gangs of four players: *Grey Greys*, *Purple Knights* and *Green Shamans*. The members of grey gang knew each other beforehand. Purple gang comprised of university students who were acquainted with each other and who participated in the Trial as a part of their student project. Green gang was a mix between non players, student and one gamer community recruit. They did not all know each other before the game apart from two players.

Once again the players from opposing gangs did not know each other apart from two students who had met before.

In both tournaments each player received two movie tickets of combined value of 20 €. In the Pilot the members of the winning gang got the smart phones used in the tournament as the main prize. In the Trial the members of the winning gang received a 50 € gift voucher to a gaming store and a Nintendo Wii U bundle was raffled between all players.

Research Materials

The planning and execution of the tournaments followed the principles of conducting critical research and the guidelines for evaluating interpretive field studies in information systems [21, 26]. The research materials gathered during the tournaments included field notes, photos, screen shots, questionnaires, game diaries, email correspondence, and automatic logging of mobile game app use, virtual environment and player locations. Since the sample size was always going to be small in terms of the number of gangs and players, an attempt was made to compensate by collecting rich data from timely gameplay. The material was first structured into timelines to enable temporal tracking of events and to allow comparison of data from different sources. Then the material was subjected to eclectic coding and categorization [28] according to the theoretical framework of de Souza e Silva [8].

Activity, Busts and Difficulties

Table 2 shows the activity of the players in terms of the number of page launches in the mobile game app. Table 3 shows the number of log-ins to the virtual scene.

Pilot			
Days	Green	Purple	Blue
1-2	1407	886	30
3-4	782	880	2
Trial			
Day	Grey	Green	Purple
1	1985	1654	630
2	3832	1829	0

Table 2: Number of page launches in mobile game app.

Pilot				
Day	Green	Purple	Blue	Researchers
1-2	19	2	1	34
3-4	0	1	0	21
Trial				
Day	Green	Purple	Grey	Researchers
1	1	6	0	7
2	5	0	0	7

Table 3: Number of logins to the virtual game scene.

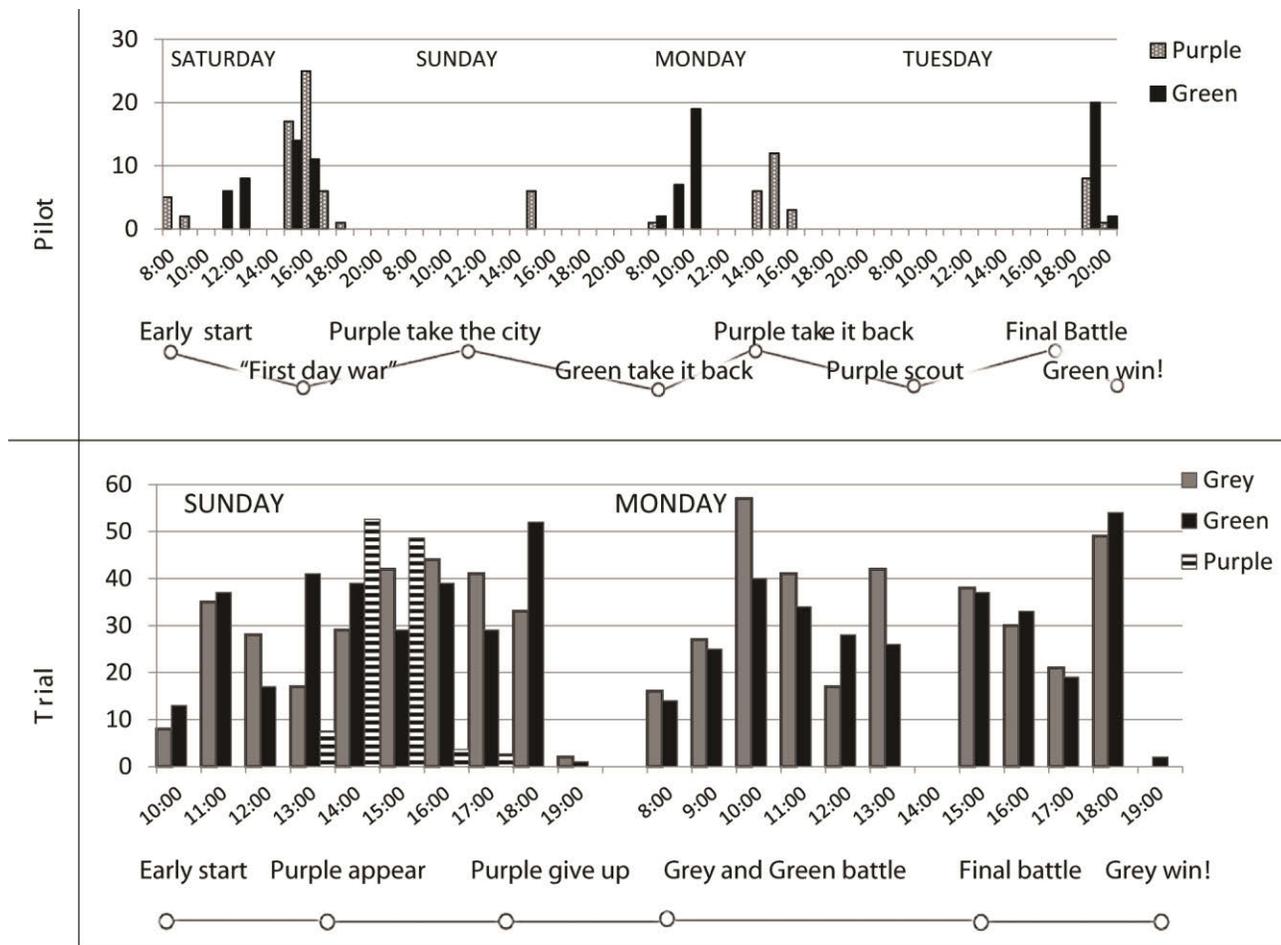


Figure 5. Overview of gameplay in SAG tournaments. Bars denote the hourly amount of tagged locations by each gang.

Figure 5 shows an overview of events and gaming activity in the tournaments. We see that one of the three gangs gave up fairly early. However, they did complete their game diaries, giving us insight on the drop in motivation. In the Pilot the Blue gang had difficulties in collaborating and synchronizing personal schedules, hence they did not even make an appearance on town. In the Trial the Purple gang did not aim for victory, but their main motivation was to familiarize themselves with the game for subsequent porting of the game to a campus environment as a student project.

Table 4 shows the number of busts by the virtual policemen, illustrating the significant effect of the virtual game world on gaming on the streets. In the table game time refers to the total time in hours that any single player was roaming at the streets tagging locations.

Although the players reported and displayed having fun playing SAG, they did also encounter difficulties. Table 5 shows the top five complaints reported in the game diaries where the players were specifically asked to report any problems they might encounter during the tournaments.

	Nr. of busts	Nr. of policemen	Spatial reach of policemen	Game time
Pilot	119	2 per 0.11 km ²	15 m	18 h
Trial	99	5 per 0.26 km ²	20 m	22 h

Table 4: Busts by virtual policemen in the virtual game world.

Pilot	Trial
Location inaccuracy (7)	Slow app due to weather (7)
Slow app (5)	Slow app (6)
All locations are tagged (3)	Bad weather (3)
Orchestration (3)	Lack of participation (3)
Bug affecting busting (2)	Location inaccuracy (2)

Table 5: Top five complaints reported in the game diaries.

Player Routes and Strategies

Figure 6 illustrates the relative increase in the size of the game area between the two SAG versions and tournaments. Red dots denote taggable locations whose number increased from 27 in the Pilot to 51 in the Trial. We verified before the tournaments that it was possible to tag each location, and removed all candidate locations that were empirically found to be too difficult to tag. The size of a dot is relative to how often the location was tagged in the tournaments. It should be noted that the game area contains many access points of the city-wide Wi-Fi network that play an important role in the positioning of the mobile phones.

We logged the players’ locations and their actions in the game app, and created visualizations of their movements and actions for qualitative spatial reasoning. Figure 7 shows selected examples of the location and mobile app log data gathered in the Trial. They illustrate how the players used the available game area to strategize. Empty dot on the maps denotes a taggable location and filled dots denote locations tagged by the player whose data is visualized. Figure 7(A) shows the movement of a particular player of the Green gang during the first hour of his gameplay and the second hour of the whole tournament. Figure 7(B) shows the route of a player of the Green gang who put on rollerblades to be able to roam the outskirts of the game area faster.

According to player feedback, the three encircled locations in Figures 7(A-B) were difficult to tag. In practice these locations had poor Wi-Fi coverage that affected the A-GPS positioning, which in turn made it challenging to get hold of these locations for subsequent tagging. Figure 7(C) shows a casual player tagging locations along his way through the city. While he frequently checked the leaderboard with his mobile game app, he only visited the game area three times and tagged locations on his way across the city. Figures 7(D-E) show examples of two players turning off fine locationing in their mobile phones which affected the accuracy of positioning which in turn affected their gaming options. The player with scattered path made 38 bust attempts and 9 successful busts but placed no tags. His team mate did 161 bust attempts, 96 successful busts and placed 3 tags at the same time. However, both players in fact sat at the game base for most of this time.

Figure 7(F) shows the complete route of one player during the second tournament day. The pedometer on his mobile phone logged approximately 18 km of walking that day.

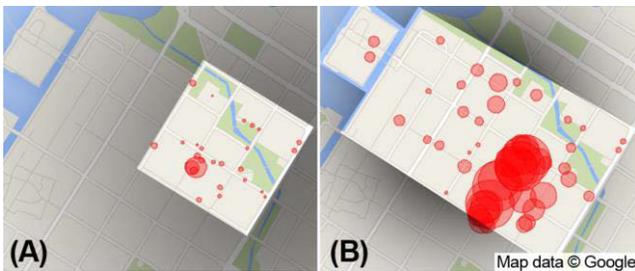


Figure 6. Game areas: (A) Pilot; (B) Field trial.

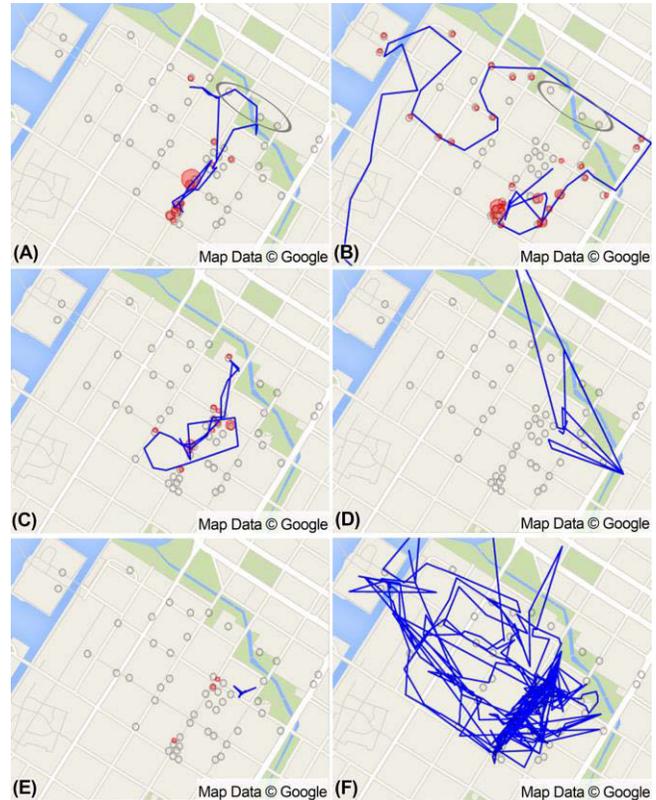


Figure 7. Visualizations of player routes and tagging activity. All taggable locations are encircled on the maps.

Field Observations

Communication, observations of other players and common strategies are examples of the social interactions coupling the parallel spaces in SAG gameplay.

In the Pilot the players of the two active gangs played only during few periods as illustrated in Figure 5. There was hardly any communication between competing gangs. In fact, in their game diaries players stated that they did not see other players in the real or in the virtual city. Although they did try to get in contact with other gangs to bust them, they also tried to avoid them, at times running away when they saw a player from a competing gang (Figure 8(A)) to quote a player diary: “I bumped into other players often, but not too often. I tried to stay far away from them”. It was not necessary to run to interrupt tagging, as the players could just tap their app and stay where they were. In contrast, in the Trial players stated having seen other players on the streets more and in some instances they sought each other out (Figure 8(B)). The players’ strategy for finding competing players changed as the game progressed: “At first we were more observant of our surroundings, but we saw no one, so we started estimating the locations of other players from the locations they had just tagged if we happened to be close by...”.



Figure 8. Example encounters: (A) A player runs away from a player of a competing gang; (B) Grey gang players surprised by a member of Green gang.

The players’ strategy for finding competing players changed as the game progressed: *“At first we were more observant of our surroundings, but we saw no one, so we started estimating the locations of other players from the locations they had just tagged if we happened to be close by...”*

The only observed incident of communication between the virtual and real streets took place in the first morning of the Pilot, when a player of the Green gang came to the base to get a power adapter for his mobile phone. He kept inquiring with his own phone from a gang mate currently viewing the virtual game world on a PC where the policemen were, because he was able to tag two locations from his current location. However, when the players noticed the bug in the Pilot that getting busted did not reduce points, they all focused on playing on the streets. This also led us to wishfully assume that once the bug would be fixed in version 2, the players would utilize the virtual game world more in the second tournament.

In the second day of the Trial a player was sitting at the base charging his mobile phone when three members from a competing gang arrived (Figure 9). The solo player started tagging nearby locations. He asked in hushed voice if the other players could see in the virtual game scene what he was doing with his mobile phone. He continued for few minutes and when the competing gang members did not notice he



Figure 9. Player stealthily tagging while being surrounded by competing gang in game base. The player is holding two smart phones.

Example of	Quote
Street sociability	<p><i>“Can you take the Makia -cafe?”</i></p> <p><i>“No, I cannot grab it”</i></p> <p><i>“Can you take...?”</i></p> <p>(Excerpt of discussion about 100 m away from the cafe)</p>
Displacement in accordance to new mobilities paradigm	<p><i>“Has your GPS broken again? You are all over the place”</i></p> <p>(Player came to the base to notice that the competing team had had a new player in town)</p>
Acknowledging the virtual scene	<p><i>“The policeman got me by Pukumies store”</i></p>

Table 6: Example quotes from the field Trial.

looked up and asked: *“Can you guess where I am?”* The competitors launched a series of bust attempts to locate the player. The phone app does not show if someone is tagging a location, but by attempting busting players immediately learn if they have succeeded in busting a player. Busting is a very low risk way of scoring some points, but also a quick way of observing if a player is tagging a specific location. This incident depicted the players’ displacement and acknowledgement of the virtual game world. It shows an example of street sociability where the communication between gangs and the unexpected use of the game app resulted in an emergent mini-game. Further example quotes from the field can be found in Table 6.

DISCUSSION

SAG as a HRG

SAG fulfills the de Souza e Silva’s definition of HRG in that it is a social multiplayer game, uses the city streets as the game board in both virtual and real spaces, and relies heavily on mobile technologies as well as the existing technological infrastructure of the city. One such infrastructure is the 3D virtual city model that can be accessed with a PC to observe players and virtual policemen busting players. The players can play the game with their own mobile phones and PCs without any special-purpose hardware. SAG tournament requires low orchestration, as it falls into the category of 2nd generation pervasive games [19]. SAG is characterized with a score of 2.3 out of the maximum of 6 in the conceptual framework for pervasive and social games (TeMPS) [14]. SAG’s score of 2.3 is at par with other basic location based games. SAG is not the most inventive in its use of perceptibility and environment in gameplay, but stands out with the use of virtual environment as part of the game design.

Unlike in the first generation pervasive mixed reality games discussed earlier, SAG emphasizes gameplay on the streets. SAG does not use augmented reality to bring the virtual environment to the streets. Instead, SAG relies on built-in mechanisms (visualization of graffiti and player locations in

the virtual game scene) and auxiliary communication channels (e.g. WhatsApp, Skype, email) to couple the two parallel realities into a hybrid reality. We believe that being able to run a game like this with hardly any orchestration and special equipment allows for a more realistic and a more timely depiction of the phenomena explored in this paper. The following discussion is structured according to the themes of the employed theoretical framework of HRG.

The Playful Characteristics of a Street Game

When observing the overall game events and player activity (Figure 5, Table 2 and Figure 6), we can conclude that SAG version 2 was more successful as a game. One significant difference between the two tournaments was that in the Trial the whole city was never tagged by just one gang. This occurred three times during the Pilot and resulted in a situation where the gangs did not have to be in the city at the same time (Figure 5). During the four days of the Pilot the two battling gangs were in the city simultaneously only on three occasions. In contrast, in the Trial members from at least two gangs were present at the city. This suggests that the area and the number of taggable locations matters in a location based game such as SAG. There even may be an optimal size for preventing a tug-of-war between two gangs. Only 9 blocks (0.11 km²) and 27 taggable locations did not seem to be enough for a tournament spanning four days. In addition to improving the dynamics of gameplay, the larger game area and listing only the nearest taggable locations in the mobile game app helped in dealing with location uncertainty. In the Trial it was also easier to observe emergent behavior in accordance to the new mobilities paradigm and the potential of mobile technologies as playful interfaces (Figure 9, Table 7), mainly because the players were at the city center at the same time and there was communication between competing gangs.

The Effects of Gameplay and the Organizations of Social Mobile and Networks in Physical Urban Space

In SAG the players' locations and consequently paths (Figure 7) were determined by A-GPS. The availability of A-GPS in conjunction with the city-wide Wi-Fi network and mobile data networks had a direct impact on how easy it was to tag a location. We saw that the players' paths differed depending on how the players strategized their game and tried to avoid the imaginary borders of their space. Spatial reasoning is often based on physical constraints, e.g. corners, objects and traffic. The hybrid space allowed expanding spatial reasoning to intangible entities in the hybrid space. Some locations were difficult to tag and some locations were far apart or at the outskirts of the game area. This had an effect on how the players moved and on what they complained about (Table 5, Figures 6 and 7). There was a clear difference in the complaints between the Pilot and the Trial. For example, in the Pilot one particular location proved to be very difficult to tag: some players reported having walked up and down the steps of a building entrance for 20 minutes before giving up. This location and few other difficult locations (Figures 6 and 7) were retained for the Trial, where the players did tag those

every now and then, but usually passed them and moved on to other locations. Although the players mentioned location inaccuracy in their game diaries, hardly any complaints about it was received by researchers during tournaments. In fact, the players used location inaccuracy to their advantage and turned off fine location detection from their mobile phones in order to be able to bust other players on a larger area. They also used this method to view taggable locations outside their immediate surroundings.

Hybrid Space Entwines Real and Virtual Streets

The real streets were more appealing to the players than the virtual game scene (Table 3). Encounters with other players, possibility to prevent point loss (Table 4) and bad weather (Tables 1 and 5) were not enough to keep the players off the streets. Nevertheless, we assumed that at least one player of each gang would also play in the virtual game world as it did offer small benefits in observing the locations of other players and the virtual policemen that could then be communicated to other gang members on the streets. However, players neglected this possibility almost completely. The fast pace of the street game may have contributed to the lack of interest in playing the game in the virtual scene, as one player stated in his game diary: "*It is just more fun to play on the streets*". It is though possible that the observation of players and virtual policemen did not affect the street game enough. But still the players who played actively on the streets had a sense of displacement and acknowledged their presence in the virtual world (Table 6), although the knowledge of being observed and having an offline avatar may have heightened this sensation [4]. We researcher(s) still found the virtual world useful for observing the players and keeping an eye on both real and virtual realms (Table 3).

When players did not have visual access to the taggable locations on the streets, they used the ownership of the locations, the leaderboard and busting as means to monitor other players with their mobile game app. The players formed a smart mob inside the magic circle of the game. They were connected by the game app to each other and to the game as they were able to use the app for viewing the status and the ownership of locations in real time. This organization also displayed street sociability as it resulted into an emergent playful behavior when the playing gangs bumped into each other as well as transformed their perception of the surrounding physical space.

Limitations and Future Work

This research could benefit from running additional tournaments with different experimental setups, to explore in more detail the issues related to the spatial scale that appears to be very relevant for a location based HRG. For example, the rules of getting busted were slightly different between the tournaments in terms of the spatial reach of the virtual policemen, but we did not get a chance to evaluate how this affected the gameplay. Busting of other players was in use in both tournaments, though it did not work completely in the

Pilot. The players also had the possibility to use busting to observe other players. Indirect observation was not as relevant in the Pilot due to its smaller game area where players had more often sightings of competing gangs. Although this further suggests that there are benefits in designing location based games for larger areas than just few city blocks, it also suggests that the smaller area made the players more cautious of each other.

Players and their communication highlighted the fact that although SAG took place in authentic urban setting, the game itself appeared to be isolated from the social setting of the city. Furthermore, some players already knew each other in advance which affected the communication and relationships between the players.

One interesting research question for future explorations of this kind of hybrid spaces is whether the use of the virtual environment should be forced in some way. However, while such policy might work in a HRG it might not work in everyday life. AR could be used to bring the virtual scene to the streets and even a lightly augmented map could be beneficial for utilizing the virtual environment. However, the opportunities for AR to truly improve immersion in the game world are grounded by the fact that the players already exhibited high engagement with SAG in its current form, playing for hours and adapting to problems and bad weather that would in everyday life situation restrict the use of a particular technology [31].

CONCLUSION

SAG merges the game space with the built city infrastructure. The mobile game app allowed the players to ‘see’ around street corners and to be at more than one place at a time. This affected the players’ perception of space and their strategies in gameplay. When players were given the choice between playing out on the physical streets and viewing the game in the virtual world, they chose the physical streets. Although these two alternate were not balanced in terms of gameplay, the players neglected to use the virtual game world almost completely. When it comes to gameplay strategies and the use of available game area, it was notable that a larger game area and a larger set of taggable locations seemed to mask many of the problems the players of location based games may have with location uncertainty.

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