My photos are my bullets - using camera as the primary means of player-to-player interaction in a mobile multiplayer game

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Abstract. Camera is becoming more common in mobile phones and it is commonly used for exchanging photos between people. The photos could be used for other purposes as well, such as gaming. This paper presents Assassin, a mobile multiplayer game using camera and photos as the main form of player-to-player interaction. The goal in the game is to catch other players in the game without them noticing this. The game is meant to be running in the background of the people's main activity, such as a working day, and not be played intensively all the time. The game was evaluated with 29 persons in four games organized during the participants' working days. The results suggest the camera is a very suitable game mechanics for gaming, and the participants in general did not find the game to be a violation of their privacy.

1 Introduction

Mobile phones with cameras have recently become widely used devices for taking and sharing photos. Photos are taken for private use, or they are shared with friends via the mobile networks using MMS or similar technologies. The camera is becoming a standard feature in mobile phones, and for example Nokia estimated that in 2005 the mobile industry shipped a total of 340 million camera phones [1], which has rapidly increased when compared to 90 million units sold in 2003.

Mobile gaming has been part of mobile phones for a longer time. Preinstalled games have been in mobile phones for over a decade, and new games can be downloaded over the air. Technologies, such as J2ME, allow one application to be run on many devices and downloadable Java games form a very large industry.

Mobile games often use the joystick as the main interaction device, but the joystick is of varying quality in different phones. The camera, however, relies less on the joystick, since taking a photo usually requires only a single press of a button. Camera and photos could offer an easy way to make games that work well in many devices.

Some examples exist that combine mobile gaming and the use of camera in mobile phones. Siemens SX1 mobile phone had a bundled game called Mozzies, which augments the video feed of the camera with bugs that the player needs to shoot. Another

example is the Mobile Maze [2], where the player controls a ball and steers it by tilting the phone.

In this paper we present Assassin, a mobile multiplayer game that uses the camera as the main form of player-to-player interaction. The camera is used as it is normally used, that is, taking photos of other people (or players in this case). The idea of the game is to take photos of other players, without them noticing this. The photos are then sent to the target player, who then awards points if they are in the photo. The photos are sent to the target player only, to avoid the problem of stalking that naturally arises in a game that tries to catch people unaware. However, this game is meant to be played in a group of friends, so there should not be a situation where the players feel stalked at. In addition, all players have subscribed to the game, and they are aware of the rules, and that they are being stalked at.

We arranged four games, where we studied the game, players, the environment and the technical implementation. The four games had a total of 29 players at their workplace in a normal working day. The results suggest, that the game is fun to play, but takes the players minds of the work. Privacy was not seen as a problem by the majority of players, and the technical implementation could be improved.

The paper is organized as follows. First we look at previous work done in mobile, and camera gaming. After that, we present Assassin in detail, followed by the experiments that we have conducted and technical analysis. Finally we conclude the work and present our future plans for using camera in games.

1.1 Related Gaming

Assassin has common features with many different games. Mozzies that was already mentioned uses the camera in a single player mobile phone game. Eyetoy [3] is one of the most well known games using camera. Eyetoy is a console game that uses the player movement as game input.

Pirates! [4] is one game with many common points to Assassin. In Pirates!, the players could locate other ships in the real world, that were controlled by other players. In the game, the players needed to be in the range of the hardware in order to interact, and direct line of sight was not enough.

Augmented Reality (AR) often uses video camera for aligning the real and virtual worlds. ARQuake [5] is a good example of an AR game, in which the players try to hunt down monsters projected onto the real world. ARToolKit [6] has been ported to standard mobile phones [7] which open up possibilities for video AR applications in mobile phones.

Laser tag [8] is a very popular game that is played with laser weapons in the real world. This game is very close to Assassin, although Assassin is meant to integrate seamlessly into a normal day, and not require any extra equipment than what people normally have.

The First Person Shooters (FPS), such as the Quake series [9], and first-person sneakers, such as Thief [10], found in the PC and console world are the digital equivalents of real world FPS games. Assassin uses exactly the same setup, but with the higher resolution of the real world.

2 Assassin the game

In Assassin, the player's goal is to take photos of other players so that the target does not notice this. The concept has many similarities to other games and applications. The first person sneakers are one example, picture messaging is another, and Killer – a game of assassination [11] is third. Killer is a live role-playing game, where all gaming happens in the real world. Assassin is meant to be a fun game that is played with friends to add something special to a meeting of friends, a working day, or any other social situation where people are occasionally meeting each other.

Assassin is meant to be a game that is constantly running, but not constantly played. In a normal working day, co-workers often meet during the day either planned, or unplanned, and these working days could be augmented with a casual game. The game can be played in any other social setting as well, and the game pace should automatically adapt to the number of these meetings. The more often people meet, the more photos are taken and vice versa. A study on camera phone use [12] suggested that a common social reason for image capture was to enrich a mutual experience between the people who were present. Assassin is designed to enrich such a situation.

2.1 Design

Although the game rules seem to support stalking, it is limited to people who are playing and are aware of this. The photos cannot be sent to any other player, except the target player, and the photos cannot be sent to anyone outside the game. The photos taken in a single game are strictly exchanged between players, so everyone knows who has taken the photo, and everyone knows who the possible photo takers are, when joining a game are.

Another design consideration was whether the game should notify players on assassination attempts, when the players are idle in the game. By idle we mean the players are actively doing their normal daily activities, such as work. We chose not to use any notifications and let the players decide when they playing. This means, that whenever players are in the game, they may receive all assassination attempts to their phone, but when their game client is turned off, there is no notifications (e.g. SMSes) about the attempts. The normal daily lives of the people should not be interrupted, and this approach lets the people decide when they are playing. The players can still monitor other players in the real world, but the digital device does not offer any help.

In Assassin, the players play themselves, that is, there is no virtual character that is being controlled. Each person has a virtual representation, but purely for targeting and point scoring reasons. The real world is the game arena, and real people are the game characters.

In the game, the players first create a profile of themselves. This profile contains their name, game icon, motto, and a photo of themselves. Only the name is compulsory, as this is how the target is selected. Motto is just for fun, in case players want to browse other players in the game. The icon is used on the UI next to the player name, but it is not necessary in the game. The photo is meant to remind the players who this person is, but the game does not work really well unless the players know each other

beforehand. If players need to constantly browse the faces of other players, they are most likely losing since it becomes difficult to track and target opponents.

2.2 Game mechanics: Attack, Defense, and Judge.

The assassin main UI consists of three screens, as seen in Fig. 1. The first one contains the main actions (Attack/Defend), the second one the current game status, and the third one the chat screen for non hostile interaction. The game UI is made as simple as possible, since taking photos should be as easy as possible. Players can browse the player information in the game status view.

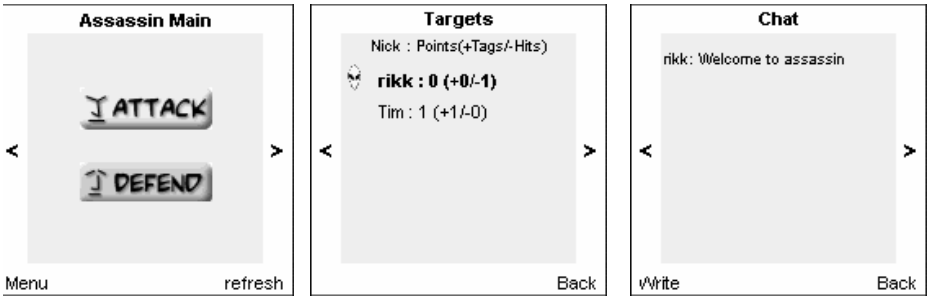

Fig. 1. The three main UIs of Assassin. The main functionality is attack and defense, and in addition the player can monitor the current status of the game and chat with other players.

In Assassin, the players have two actions: attack, and defend, and they also need to be the judges in the game. **Attacking** consists of taking a photo, selecting which target(s) are in the photo, and sending the photo for the target(s) for judgment. The photos are the bullets in the game, and the target selection is seen In Fig. 2.

Defending is a press of a button, that stops any attempt being made at you for three minutes, and it is meant for players who see someone making an attempt at them. This happens in the game, but there are other ways to defend in the real world, if players so agree. One possibility is to indicate in the photo that the attacker has been noticed, by for example using a rule: "when my hand is in front of my face in the photo, do not award a point".

Players are **judging** when they receive a photo taken presumably of them. In this case, the judge decides, whether he/she is in the photo and awards a point for the attacker. This judgment option relies on player's honesty. Players can choose not to award points even on good shots, if they so decide. There are other options to do the judgment, like peer review where any other player in game decides if a point should be awarded. However, the option of sending the photo to target is chosen for privacy. The game emphasizes, that the targets photo is the property of the target him/herself, not meant for distribution to others. An example judgment UI is seen in Fig. 2.

2.3 Implementation

The game is implemented with the Multi-User Publishing Environment (MUPE) [13]. MUPE is a client server application platform that supports end-user published content, as the name suggests. In Assassin, all content is end user generated. Player characters, player-to-player interaction, and point awarding are all end-user generated.

All instances of Assassin games are in a single server. The game contains a game lobby, where players can start new instances games. The games can be password protected to allow only friends to join. The Assassin server can contain as many games as possible, and the server should scale to very large number of game instances, since the game is a slow update game, with only occasional data transactions from players. The only data transmissions between client and server are photo UI download and updates, and photo uploads when attacking and download when judging.

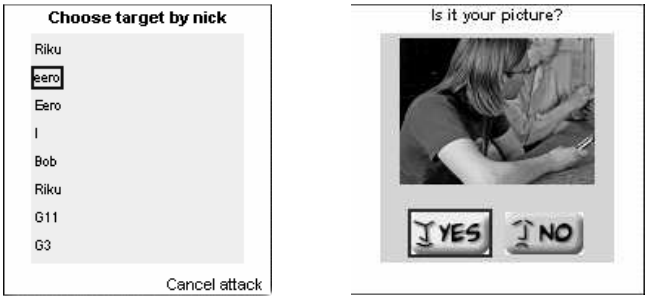

Fig. 2. The attacker selects the opponent, and the photo is sent to the target for judgment.

The data traffic should be always kept at the lowest possible level, in connected mobile games. In Assassin, this means keeping the size of the photos at a minimum. Even though there is megapixel or better resolution cameras in the current mobile phones, the mobile phone screen does not support such high resolutions. Due to this, we keep the image size in assassin at 110x82 pixels.

3. Experiments

The game has been played in four controlled games in the actual real world situation the game is meant to be played. The games had five to eight players in each, and the games have been played in different environments. The first game was organized in our company's premises, with eight participants who each worked in an office not shared with other players (1 was in open office space). The second and third games each had eight players all in a small building with open office space shared with other players. The last game was organized in a university, with five members of a department, each in their private room.

In all games, all players knew each other beforehand. In total, 29 persons started to play the game, and actually 27 players played the game. None of the players had played the game beforehand. Two players were too busy during the course of the game to play at all. Our main focus in the tests was on the battle system, that is, is it

fun to use the camera as the main game mechanics in player-to-player interaction. In addition, we studied how the game integrates to a normal day, what are the privacy implications and how well the game was implemented. The players were awarded a movie ticket (value 8€) for participation.

In total, the number of participants was even larger. We had agreed to arrange a session in an information technology company, but the company policy stopped us from entering. Taking photos in the company premises was forbidden, and the tests had to be cancelled. Still, this is a very valuable result, as one in five tests were forbidden by company policies. This will be a serious obstacle in the future for games based on taking photos.

3.1 Setup and instructions

All games were played in a similar fashion. At the start of the game, instructions to play the game were given. The participants were instructed to:

1. Create a player character using your own name as the name of the character.
2. Join a practice game.
3. Take a photo, and attack another player with it.
4. Judge the attacks they received.
5. Leave the practice game, and go back to the lobby room.

There were no difficulties in understanding how the game system works, and all players learned the game mechanics easily on the setup phase, and there was no need for assistance at a later stage. The problems were with occasional technological problems in the setup phase or during the actual tests.

After these preliminary steps were taken, players joined the actual game. Before the start of the game, players had a truce of few minutes, during which the players were instructed not to give points on attacks.

There was no observation of players by the test organizers, as this would have been impossible to setup. The organizers merely sat on a predefined location, and acted as technical assistance in case there were technical difficulties in the game.

The games were played with equipment provided by us. The first game was played with four different devices: Nokia models 6600, 7610, N70, and N90. The rest of the games were played with one Nokia N70 device, and the rest were Nokia 6600 models.

3.2 Rules

All games were played until a player got ten successful attacks. During the first game, the defense system provided by the game was found to be too slow. Pressing a defense button was sometimes seen as too slow, if the phone was in ones pocket and another player was well positioned.

To test another setup, the second and third games were played with defense in the real world, that is, in addition to the defense button in the UI, the players were instructed to place their hand in front of their face when taking a photo. If the players

received such a photo, they were instructed not to give points. In the fourth and final game the players were given a choice before the game between the two defense systems, and they chose to use the hand in front of the face.

3.3 Experiment results – the effect of the environment

The four games played revealed a lot of interesting facts about the game, and how the environment in which the game is played affects the game. The first game, which was played in an office where each player had their own room, was the longest lasting approximately two hours and forty minutes. In this game, two players were so busy with their work that they did not play the game at all during this time, as they felt other work was much more important. These players thought they still had time to play the game later, but they did not play before they were told the game is over.

In the second and third game the players at least partially shared the same working space. The game tempo was very fast, since the players felt they could not stay in the same place as another player was constantly seeing them. The second game lasted 50 minutes, and the third 20 minutes. All the players were shooting constantly until the end of the game, and no-one did any other work during this time.

The same result could also be seen in the first game, when the players went for a coffee break. At one point, there were four players in the coffee room at the same time, and they were unable to take coffee since they were constantly aiming at each other and hiding behind corners. The situation ended in a truce that was declared by the players themselves.

The fourth game had five players of the same department in a university. Each player did not share the same working space with the other players, and the game lasted two hours. This game was very similar to the first game. The players also declared a truce when entering the coffee room. This implies the game is really happening in the real world, and the players understand the rules are purely set by themselves. The key figures of the games are summarized in the following table 1.

Table 1. Summary of the key facts in each of the four games.

Game	Participants	Duration of game	Environments
1	8	2h 40 minutes	All in separate rooms
2	8	50 minutes	Players worked in the same room
3	8	20 minutes	Players worked in the same room
4	5	2h	All in separate rooms

3.4 Questionnaires

All participants in all games were asked to fill in a questionnaire with questions on their background, and about the game. With the questionnaire, we wanted to find answers to questions about the game system, on technical problems, game experience, and privacy.

The four games played had a total of 29 players, out of which 27 players played the game, and 25 players answered the questionnaire. Two players were not eligible to answer the game, since they did not play the game at all, and two players failed to submit their answers in time. From those who answered, 19 were males (77%) and 6 were females (23%). The average age of the players was 23, and two were native English speaking and the rest had Finnish as the mother tongue. The necessary UI consisted of two main buttons (attack and defense), and a simple question "Is it you in the photo" with Yes and No buttons, the language skills were irrelevant in this test. No-one reported of any language problems.

The main prerequisite questions concerned the photos, and sending photos to friends. The participants generally liked taking photos, since the average answer in a scale of one (definitely no) to five (definitely yes) gave an average of 3.9, and only one person answered no, and none definitely no. Participants were less keen on sending these photos to their friends, since the question "I think it is fun to send photos to friends" got an average of 2.9, the most common answer being "no". The problem is not in the difficulty, since the question "It is too difficult to send the photos" got an average of 1.9, the most common answer being "definitely no", and no-one answering "definitely yes". These answers indicate that taking photos and sending them to friends could be enhanced somehow, and in this paper we study how games could enhance the exchange of photos. Some key questions in the questionnaire relating to this paper are seen in Table 2.

Table 2. The key questions from the full questionnaire, and the average and median of answers.

	Question (answer 1 definitely no … 5 definitely yes)	Avg	Med
Q1	I liked the way the battle was made in game (photos)	4.0	4
Q2	If such a game were integrated to a phone, I would play it	3.6	4
Q3	I think it was fun to battle with others	4.2	4
Q4	Considering only the battle system, I would play this game again	4.2	4
Q5	If you think about the entire game, I would play it again	3.8	4
Q6	Playing the game was fun	4.2	4
Q7	The game provided additional fun to a working day	4.1	4
Q8	The game hampered my working day	3.5	4
Q9	Working hampered my gaming	3.3	3.5
Q10	People, who were not part of the game provided a fun addition	3.3	4
Q11	I was wary all the time	3.5	4
Q12	I think the game violates my privacy	2.0	2
Q13	The battle system supports stalking others	3.8	4
Q14	It was easy to take a photo of an opponent	3.1	3
Q15	The UI worked well	2.5	2
Q16	The UI was fast enough to be used while in battle	2.0	2
Q17	When judging, was it easy to recognize yourself?	2.8	3
Q18	The game functioned flawlessly	2.4	2
Q19	Fighting with others was social	4.4	4
Q20	I think other players cheated	2	2

The first main theme in the questionnaire relates to the game mechanics, that is, is it fun to use camera as the main form of interaction in the game. The player responses were very positive, as seen in the first six questions Q1-Q6. The questionnaire suggested that the technical implementation of the game was not optimal, since the ques-

tions relating to the using photos in game (Q1, Q3, Q4) had a higher average than those relating to the actual game implementation (Q2, Q5).

The second theme we wanted to study was how the game integrates to a normal working day. This game was not meant to be an intense experience, that is played constantly, but rather have it run in the background of your normal daily routines. The five questions (Q7-Q11) find answers to how the game related to a normal working day. One should note that the first game had two players virtually unable to play due to their workload, and thus we did not include their answers in the analysis. With them, the game was not at all compatible with their normal daily routine. Questions Q7 suggests that the game lightened up a normal working day. Q8 and Q9 suggest that work was affected by the game, and vice versa, which is more related to which the person finds more interesting. As the games were played in a normal working environment, there were more non players than there were players. Q10 gives positive feedback on such a setting, but this question is too vague and requires further study in more detail. Q11 relates also to privacy, but it suggests people's attention is diverged away from their normal daily routines, since they are more aware of other people and players around them.

The third theme in such a game is privacy. Since other players are followed constantly, this is a really serious issue in the game, but question Q12 gives very positive results in this regard. Only two players answered definitely yes, and two yes, which means the vast majority of the players did not find the game offending. One player commented: "How could it, all players joined voluntarily." Players agreed that the game supports stalking (Q13), but as one player stated in comments:"You must sneak to do well".

The fourth part of the questionnaire (Q14-Q18) concerned the implementation of the game, and this got the worst feedback from the participants. Especially the UI was considered to be a problem. This is mostly a problem of the network bandwidth. Although we kept the image sizes to a minimum it still takes time to upload images to a server over a normal wireless connection.

There were two important questions that do not fall under these categories. First, the social aspect (Q19) of the game is highly important, since the game happens in the real world. The game was meant to support the existing social networks already available in groups, and the game succeeds in this regard. Only one player was definitely sure that someone cheated (Q20), although cheating in the game was possible. One player reported taking a photo of a photo of the player, which is cheating.

3.5 Player comments

We asked the players to give freeform comments relating to all questions, or anything else in the game. Some comments proposed very good improvements to the game, some focused on technical problems, and some to the gaming experience.

One obvious fault found in the first game was the easy targets. Some players were playing the game not very intensively, and thus were easy prey for the hunters. To counter this, one player suggested a game form in which players can gain points only

once for each other player. In this game, the first player to take a good photo of each other player first wins.

The second and third groups were annoyed by the fact that the game was over so fast. They proposed that only one photo per hour (or other fixed time) could be taken, in order to allow playing the game casually even if working on the same open office space. This could add another layer of excitement to the game, and should be considered seriously.

The fourth group thought there could have been more players, since they were only five players. One player was teaching a student group for a part of the game, and was easy prey for the other players. One player also suggested a delay for taking the pictures, as also proposed in the previous group.

4 Technical performances

Connected mobile games always cost money. Data is being moved over a wireless cell network, and this often has a price tag directly proportional to transferred bytes. Assassin was designed to move as little data as possible.

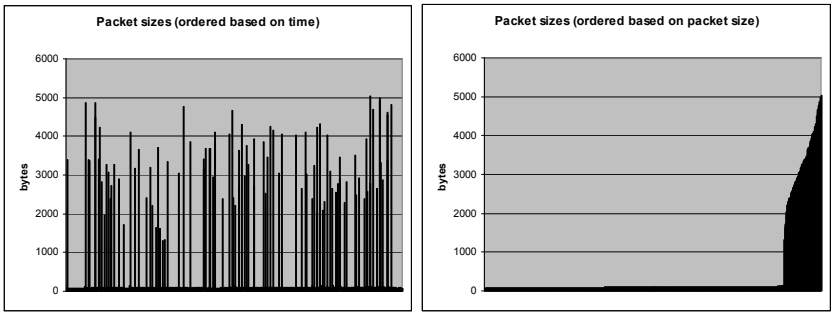

Fig. 3. Data upload traffic in the game during game 1.

Data traffic for each player consists of downloaded and uploaded data. Both were analyzed from test games of Assassin. From analysis, we can see that the traffic consists of large number of small requests to the server and few big ones when images are uploaded onto the server. These requests are illustrated in Fig. 3., first over time and then ordered by size to show the portions of messages of different sizes. 89% of the sent requests are small ones, while remaining 11% include an image upload. Overall median request size was 91 bytes, while largest single request was nearly five kilobytes in size. Summing these requests up for each player of Assassin, average upload traffic per player was 24 kilobytes during the test game session, where amounts varied between 4 and 69 kilobytes based on player's activeness in the game.

Download data includes the same images that others have uploaded, as well as more application data as game UIs are downloaded. Excluding the image downloads, median download package size was 738 bytes, where largest package was nearly five kilobytes. This traffic summed up per player resulted in average download of 64 kilobytes, plus the image downloads which averages to about 19 kilobytes per player,

bringing grand total to 83 kilobytes per player, as seen in Fig 4. . Again, player activity affects this a lot, as download amounts between players varied from 7 to 217 kilobytes, plus image downloads.

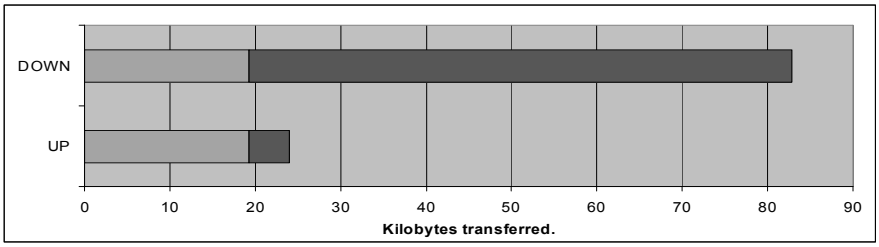

Fig. 4. Average data uploads per player. Images take about 19 kilobytes per player, and the rest is application logic.

5 Discussion and Future work

Assassin can be improved in many ways, and many possibilities were proposed by the participants of the experiments. One obvious improvement that would change the tactics in the game is the use of digital zoom in the phone, that is, implements a sniper scope to the game. This would allow players to better stay unnoticed.

It is not certain, that the game could be played in all countries. It is forbidden or at least not polite to take photos of other people without telling them about this. Assassin tackles this problem with application design. In Assassin photos are not taken in the normal way, since they are not stored in the device that takes the photo. Further, the photos are sent to the target, who does not store the photo either. Only subscribed players are part of the game, no other can receive the photos taken in the game. We do not consider the game to be a violation of privacy more than the normal camera is. Any technology can be abused, if so desired, and Assassin only works inside a group, to not encourage misuse.

Photos can be used in many other ways in gaming, and we are implementing other camera games that do not take photos of other people. The four games also provided us a lot of further data in the form of user comments, which we will be analyzing next.

6 Conclusions

This paper presented assassin, a mobile multiplayer game that uses camera as the main form of player-to-player interaction. The game is constantly running, but it is only played whenever the players meet, and thus should adapt to the social rhythm of a normal day. The more players meet, the more opportunities there is for playing.

The game was tested in four games with in a varying environment during a normal working day. The results suggest that the environment in which the game is played has a great affect on how the game is played. The number of social meetings had a direct

effect on opportunities for taking photos, and this directly impacted how quickly the game ended.

The camera was seen as a good way to play a game, and the players were very pleased with using the camera as the main form of interaction. The game did not integrate perfectly with a normal working day, since the game took sometimes too much time and did not allow players to concentrate on their main task that was work. Some improvements were suggested, such as limiting how often players can attack. Privacy was not seen as a problem, and the implementation got the most critique.

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References

1. Nokia. The mobile device market. Available online at http://www.nokia.com/link?cid=EDITORIAL_803
2. Bucolo, S., Billinghurst, M., and Sickinger, D. 2005. Mobile maze: a comparison of camera based mobile game human interfaces. In Proceedings of the 7th international Conference on Human Computer interaction with Mobile Devices & Services. MobileHCI '05, vol. 111. ACM Press, New York, NY, 329-330.
3. Sony. 2003. Eyetoy. Available online at http://www.eyetoy.com
4. Björk, S., Falk, J. , Hansson, R. , and Ljungstrand., P. 2001. Pirates! – using the physical world as a game board. In Proceedings of the Human-Computer Interaction INTERACT'01, 2001, 423–430.
5. B. Thomas, B. Close, J. Donoghue, J. Squires, P. D. Bondi, and W. Piekarski. First person indoor/outdoor augmented reality application: Arquake. Personal Ubiquitous Computing, 6(1):75–86, 2002.
6. ARToolKit. Available online at: http://www.hitl.washington.edu/artoolkit/
7. Henrysson, A. and Ollila, M. 2004. UMAR: Ubiquitous Mobile Augmented Reality. In Proceedings of the 3rd international Conference on Mobile and Ubiquitous Multimedia. MUM '04, vol. 83. ACM Press, New York, NY, 41-45.
8. Laser Tag. Available online at: http://www.lasertag.org/
9. Id software. Quake series. Available online at: http://www.idsoftware.com/
10. Eidos Inc. Thief 3. Available online at: http://www.thief3.com/
11. S. Jackson. Killer – the game of assassination. Available online at: http://www.sjgames.com/killer/
12. Kindberg, T., Spasojevic, M., Fleck, R., and Sellen, A. 2005. The Ubiquitous Camera: An In-Depth Study of Camera Phone Use. *IEEE Pervasive Computing* 4, 2 (Apr. 2005), 42-50.
13. Suomela, R., Räsänen, E., Koivisto, A., and Mattila, J. 2004. Open-Source Game Development with the Multi-user Publishing Environment (MUPE) Application Platform. In proceedings of the Third International Conference on entertainment Computing (Eindhoven, The Netherlands, September 1-3, 2004). ICEC 2004. Lecture Notes in Computer Science. Springer-Verlag GmbH.