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A Survey on Pervasive Mobile Games

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Abstract. Pervasive games in a recent research field that proposes a new form of entertainment. The literature on pervasive games presents viewpoints from game studies, storytelling, design, social studies, pervasive computing, mobile computing, and ubiquitous computing. Such broad scope makes it difficult to define what a pervasive game is. This work presents a survey on selected projects considered as "pervasive games" in the literature. More specifically, we are interested in a subset we defined as "pervasive mobile games" - context-aware games that necessarily use mobile devices. We believe this collection can work as a starting point for researchers interested in exploring the world of pervasive gaming.

Keywords: pervasive games

Resumo. Jogos pervasivos representam uma área recente que propõe uma nova forma de entretenimento. A literatura de jogos pervasivos apresenta diversos pontos de vista, que variam de estudos de jogos, narrativa, design, estudos sociais, computação pervasiva, computação móvel e computação ubíqua. Considerando esse vasto escopo, é difícil definir o que seria um "jogo pervasivo". Este trabalho se propõe a fazer um levantamento de projetos considerados como "jogos pervasivos" na literatura. Mais especificamente, nós estamos interessados em um subconjunto desses jogos que definimos como "jogos pervasivos móveis" – jogos com ciência de contexto que necessariamente usam dispositivos móveis. Acreditamos que esta coleção pode servir como um ponto de partida para pesquisadores interessados em estudar jogos pervasivos.

Palavras-chave: jogos pervasivos

1 Introduction

Pervasive games are a new form of entertainment that differs from traditional computer games. They include certain aspects that expand the gaming experience from beyond the device that runs the game. In its general form, pervasive games blends computing technologies (mobile devices, cell phones, networks) with features from old children's games (as "blind man's bluff", "hide-and-seek", and others) and fictional narratives.

One of the most notable characteristics of pervasive games is the focus on the real, physical world. Unlike traditional computer games, pervasive games try to incorporate the real world in the game somehow, on purpose. This intention may lead to many consequences. For example, common objects from everyday living can become part of the game. These objects may be embedded with some sort of computation, in this case, making them part of a "tangible interface" (Ishii and Ullmer 1997). In other cases, players may have to locate an object in the real world, demanding that players walk to the place where the object resides, exploring the world physically. This approach to gaming opens up opportunities not possible to be carried out in traditional computer games.

The definition of "pervasive games" is not a consensus in the literature. Some approaches focus on gameplay elements and how the games related to the everyday life. Other approaches focus on technology aspects that the games use for its realization, relating them with pervasive/ubiquitous computing paradigms. The general literature focuses on pervasive games as neither required to use technology, nor to be centered on it. This makes the definition and characterization of pervasive games excessively broad and without adequate support for development.

In "cultural" approaches, the authors (from design, game studies, social studies, theater) are more concerned with aspects of gameplay and the game itself, not emphasizing technology aspects (such as pervasive computing). Examples include "cultural, theater, technology"(McGonigal 2006), "game studies" (Montola *et al.* 2009; Davies 2007). In "technological approaches", authors often discuss pervasive games as applications of pervasive and ubiquitous computing. Examples include "technology, ubiquitous & pervasive computing, sensors" (Magerkurth *et al.* 2005; Linner *et al.* 2005; Capra *et al.* 2005; Walther 2005; Hinske *et al.* 2007; Benford *et al.* 2005), and "computer-augmented game" (Magerkurth *et al.* 2005; Schneider and Kortuem 2001; Saarenpää *et al.* 2009).

We are interested in a subset of those games that are based or realized through mobile devices. We are also interested in the technological aspects of pervasive games and their implications – meaning how technology supports or makes it possible the realization of pervasive games.

In this sense, we will use the term "pervasive mobile games" to refer to the games we are interested. In a nutshell, we consider "pervasive mobile games" as context-aware games that necessarily use mobile devices. More specifically, here are the criteria we used to select game projects for study of pervasive mobile games:

1. Games using mobile devices (e.g. smartphones, tablets):   mandatory

2. Games that are context-aware: mandatory

3. Games that access remote data1 on the move: optional

4. Multi-player games: optional

Condition 1 is mandatory because many pervasive games share the concern of "bringing games back to the real world". This means having game activities out in open areas or at least not confined to the static nature of using desktop computers. This relates to moving in space, being either small ("restricted", as a room) spaces or large urban areas. In this sense, we consider mobile devices like smartphones, tablets, and PDAs as the main devices. We give more emphasis to smartphones, as they are able to make Condition 3 possible due to the widespread availability of mobile phone networks.

Context-awareness means the game is able to adapt the gameplay according to the current environment conditions. This involves sensing the environment, and using this information as source for game content or to provide customized experiences. One of the often cited references for context (Dey 2001), defines it as:

> "any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves"

Existing research on Human-computer interaction as (Schmidt *et al.* 1999) suggests that the concept of context can be boarder enough to consider the ways a user interacts with a device (on the hand, on a table, etc.) as context information.

Context-aware applications are able to create the integration between the virtual and physical worlds that many pervasive games present, by sensing the environment and incorporating those data in the gameplay. We see this as an essential characteristic of pervasive games, so Condition 2 is mandatory.

Condition 3 relates to the ability of pervasive games to access remote resources while players are located anywhere. This relates to single-player games (where the game data is remote) and multi-player games where players are not co-located. However, not all pervasive games use networking; hence this is why Condition 3 is optional.

Condition 4 relates to the social nature of pervasive games, by integrating many players into the game. This distribution can be local (players are co-located) or global (players are not co-located), or both. We consider players as "co-located" when they are able to interact inside an area defined by a local network (like Bluetooth and WiFi). In case of players not being co-located, Condition 4 also implies Condition 3. However, not all pervasive games are multi-player games, hence Condition 4 is optional.

With that being said, this work describes briefly 24 games that can be considered as "pervasive mobile games" according to our criteria. The games are sorted by year.

This work aims at being a general collection of pervasive mobile game descriptions that other researchers can use as a starting point for their research works.

Section 2 provides the game descriptions, while Section 3 presents the concluding remarks.

2 Game descriptions

This Section provides descriptions of pervasive game projects from 2001 to 2011. Table 1 summarizes the game list.

Name	Platform	Year	Sensors	Network	References
Can you see me now?	PDA, web	2001	GPS	WiFi	(Benford *et al.* 2006)
Pirates!	PDA	2001	proximity	WiFi	(Björk *et al.* 2001)
Pervasive Clue	PDA	2001	proximity	WiFi	(Schneider and Kortuem 2001)
Botfighters*	phone, web	2001	GPS	SMS	(Sotamaa 2002)
Uncle Roy all around you	PDA, web	2003	self-reported	WiFi	(Benford *et al.* 2004b) (Benford *et al.* 2004a)
Mogi*	phone, web	2003	GPS, cell-id	operator	(Joffe 2007)
Songs of north	phone	2004	cell-id	operator	(Lankoski *et al.* 2004) (Ekman *et al.* 2005)
The Journey*	phone	2004	cell-id	-	(Jakl 2004)
Tycoon	phone	2005	cell-id	operator	(Broll and Benford 2005)
Ere be dragons	PDA	2005	GPS, heart-rate	-	(Davies 2007)
Epidemic Menace	cross-media	2006	GPS, soft-sensors	WiFi	(Lindt *et al.* 2006) (Lindt *et al.* 2007)
Hitchers	phone	2006	cell-id	operator	(Drozd *et al.* 2006)
Manhattan story mashup	phone, web	2006	camera	operator	(Scheible *et al.* 2007) (Tuulos *et al.* 2007)
PAC-LAN	phone	2006	RFID	operator	(Rashid *et al.* 2006)
Feeding Yoshi	PDA	2006	WiFi	WiFi	(Bell *et al.* 2006)
Day of figurines	phone	2007	-	SMS	(Flintham *et al.* 2007a) (Flintham *et al.* 2007b)
Insectopia	phone	2007	Bluetooth	operator	(Peitz *et al.* 2007)
REXplorer*	phone	2007	GPS, camera, Bluetooth	-	(Ballagas *et al.* 2007) (Ballagas and Walz 2007) (Ballagas *et al.* 2008)
GPS Mission*	phone	2008	GPS	operator	(Orbster 2008)
Mythical: The Mobile Awakening	phone	2008	Bluetooth, "software-sensors"	operator	(Korhonen *et al.* 2008) (Paavilainen *et al.* 2009) (Saarenpää *et al.* 2009)
Seek n' Spell*	phone	2009	GPS	operator	(Retronyms 2009)
Gbanga Famiglia*	phone	2010	GPS, cell-id	operator	(Gbanga 2010)
Gigaputt*	phone	2010	GPS	operator	(Gigantic Mechanic 2010)
GEO Hunters*	phone	2011	GPS	operator	(YD Online 2011)

Table 1: Analyzed games list. The asterisk denotes commercial projects

Apart from game descriptions, we have included the following information:

- Which sensor technology the game uses;

- Which network technology the game uses (if any);

- If the game requires a support staff while the game is happening;

- Other miscellaneous remarks that we found important to mention.

A "software sensor" is a software component responsible for gathering real-world data to use in a game. For example, this would be the case of using the current date (e.g. time, day of the week, day/afternoon/night status), stock exchange information, information about real sports leagues, weather information, among others.

A support staff is a team that monitors the game in the background while it is happening, in order to foresee and correct issues that might interrupt the game. This is typical of "event games", and is referred in the literature of pervasive games as "orchestration". For examples on orchestration, please see (Benford *et al.* 2006).

Some games use the mobile operator network (e.g. GPRS, EDGE, 3G) for accessing remote data. In these cases, the "network" property has been indicated as "operator".

2.1 Pervasive Clue (2001)

Sensors	:	proximity (RF sensors and beacons)
Network	:	-
Support staff	:	-
Others	:	-

Pervasive Clue (Schneider and Kortuem 2001) was the first game labeled as "pervasive", is a live-action role-playing game inspired on the board game *Clue* by Hasbro. In this game, players act as detectives trying to solve mysterious murders. They have to find several clues to be able to solve the mystery.

The players use a PDA equipped with RF readers, and a magnifying glass. The magnifying class has cosmetic nature and the game uses this to transform the PDA into the "clue finder", a way to make the PDA look more like a "game object". The game uses physical objects to represent clues (knives, books, etc.). The objects are equipped with RF beacons, so a player is able to capture a clue by getting closer than 1 foot from the object.

2.2 Pirates! (2001)

Sensors	:	proximity sensors (short-range RF sensors)
Network	:	WiFi
Support staff	:	-
Other	:	requires place configuration

Pirates! (Björk *et al.* 2001) is a game where players are captains of their ships, and have to sail around visiting islands, collecting resources, and sometimes battling other players and virtual characters. Players begin the game with simple and low-powered ships and improve their vessel over time while they complete missions.

The game takes place on a pre-determined area, and the ships correspond to the player devices. Players have to walk physically in the game area to "sail around" and visit places.

The player's equipment corresponds to PDAs fitted with WLAN cards and proximity sensors. The game implements a client-server architecture, where the clients access the server through a WLAN.

The game area (named "game arena") is a small physical place augmented with short-range radio beacons. Those beacons represent game elements like the virtual islands. The game uses proximity sensors in the client devices to detect the islands (beacons) and other players. Hence, the players have to get closer to the beacons to visit islands. If a player wants to battle another player, he has to get physically close to this player. Likewise, the player has to run away from other players to avoid getting caught in combat situations.

Another interesting design decision relates to have players focus on the environment and social interaction, rather than their devices, as they describe (Björk *et al.* 2001):

> "All interactions within Pirates! are initiated by players. That is, nothing happens in the game unless a player gives the game input. This input can be choosing one of the buttons on the hand-held device or moving oneself across the area where the radio beacons can detect senders. The decision not to include system-initiated actions in the game was necessary in order to allow players to focus their attention on physically navigating in the real world. It also had the advantage of letting players move smoothly between playing the game and socializing with other people in the game environment."

2.3 Botfighters (2001)

Sensors	:	cell-id
Network	:	operator (SMS)
Support staff	:	-
Others	:	pioneer commercial pervasive game

In *Botfighters* (Sotamaa 2002), players control robots and their mission is to locate and destroy other robots (players). The game offers a web module where players are able to customize their robot. The mobile phone is the interface for searching and battling other players.

The "game arena" takes place on the entire city, potentially. Players have to wander around to interact with other players.

Players interact with the game by sending text messages (SMS) to the game server. There were specific text messages corresponding to command to search for nearby players, shoot a specific player, and others. Players would be warned if they were being hunted by other players.

The game relied on GSM cell-ids to calculate if players were close to each other, and the success of the attacks depended on several variables like player shields and weapon power.

In this game, players did not have to meet physically to play. Players interacted with other through nicknames, although they could guess the location of other players based on how frequent they found that player in the same places.

2.4 Can you see me now? (2001)

Sensors   :   GPS

Network   :   WiFi

Support staff   :   yes

Others   :   event game, mobile and web modules

Can you see me now? (Benford *et al.* 2006) is a research project by the Mixed Reality lab at the University of Nottingham and the artist group Blast Theory. This is game of hide-and-seek, but not as the traditional one. Here there are two teams (hiders and seekers), where one team (seekers) plays in the physical world and the other team (hiders) plays in the virtual (online) world.

The seekers (runners) play on the streets with PDAs accessing WLANs and using GPS receivers. Their job is to chase online players.

The online players navigate through a 3D model of the city, and are able to interact with other online players (through text messages) and see the location of street players represented on the city model.

The street players are able to see the position of their teammates and online players represented on the PDA screen, and also access online player communication. They also have walkie-talkies to communicate with other street players. The game streams this conversation to online players, which makes it possible for online players to have a perspective of what is happening on the streets.

The street players actually were performers from Blast Theory, while the online players were end-users. In order to keep the games happening, it was necessary to perform orchestration. There was a supporting team on the backstage helping the street players to better shape the experience of online players. This process was necessary to deal mainly with issues related to technology limitations and to keep the mixed-reality consistent.

Another interesting aspect of this project is that it could also be characterized as an "event-game".

2.5 Mogi (2003)

Sensors   :   cell-id, GPS

Network   :   operator

Support staff   :   -

Others   :   mobile and web modules

Mogi (Joffe 2007) was massively multi-player mobile role-playing game developed by the French company Newt Games. Mogi was deployed commercially in Japan, 2003.

The game corresponds to a treasure hunt where the main goal is to collect virtual items. Those items are laid over a map representation of Tokyo. The players have to roam around the streets of Tokyo to collect those items located at the correspondent

map locations. A player is able to capture an item if he gets close around 400m of the item. The game has two modules, a mobile one (runs on the phone) and a web module.

The web module displays a map of the city and also the positions of collectable items. Players using the web module are able to communicate with mobile players through text messages. So, this opens up possibilities to create collaborative activities for the players using different kind of devices.

Players can meet physically to exchange items to grow their collections. The goal is to build up collection and amass the largest possible score.

There is not many works explaining the inner works of Mogi. However, this is an important example of pervasive game deployed commercially. It seems that *Mogi* uses a combination of GPS and cell-id to locate the items (Joffe 2005) where cell-id can be used to make gross assumptions about localization where GPS can be used to fine-tune the results. Mobile players also used the operator data services to connect to the game server and to other users.

2.6 Uncle Roy all around you (2003)

Sensors	:	- (self-reported, manual positioning system)
Network	:	WiFi
Support staff	:	yes
Others	:	mobile module and web module

In *Uncle Roy all around you* (Benford *et al.* 2004b) , players collaborate in order to find the mysterious character Uncle Roy that is hiding somewhere in the city. This game was developed by the Mixed Reality lab from the University of Nottingham and the artist group Blast Theory.

Similar to *Can you see me now?*, the *game* divides players into two groups: street players and online players. The online players navigate a virtual model of the city, where they are able to explore it in many ways and perspectives, maybe helping street players, maybe not. The street players start the game by heading to the game headquarters. There, they receive a PDA that they use to play the game, leave their belongings, and receive instructions on how to play. Now they have one hour to find Uncle Roy's office in the city. The game is designed around the social theme of "trust in strangers" (remote players, passers-by, anyone), and this reflects for street players as they go around the city with only the PDA and at the mercy of (unknown) online players and the mysterious Uncle Roy.

As street players progress in the game, they are instructed to go to certain places in the city. When they arrive there, they receive clues and messages from Uncle Roy. The PDA displays a fraction of the city map, and the players have to follow it and keeping on dragging an "I'm here" icon over it as they walk on the streets. The game uses this system as a way for players to provide positioning information – the game uses a manual positioning system ("self-reported"). The game designers divided the map intro regions of interest, and whey the players interact with the map, they "know" that the player is likely to be inside that region. In this regard, the game uses a "low-tech" positioning system, but it must trust players. However, the messages delivered to players

from Uncle Roy references local context so that they make sense only if players are at that place.

The game supports 12 street players and 20 online players simultaneously. There is also a support team on the backstage to handle issues that might arise during the game event.

The online players can interact with street players by receiving short audio messages from them and sending text messages in return.

Uncle Roy's office is a standard apartment located in a building somewhere in the city, decorated as a game scenario to support the game narrative. When street players arrive at the building, they ring the buzzer and are allowed to enter the office (this is automatic, they do not interact with people in this activity). Once there, online players are able to join the experience: a live video stream is broadcasted online through a web cam. This is the first time online players see the street player. The street player is asked to write a postcard, and in the meanwhile the game asks the online player if they would be willing to support a stranger that was having a personal crisis anytime over the next 12 months.

After the street player finishes writing the postcard, the game asks the street player to go outside and reach a telephone cabin. The player receives a phone call instructing him/her to go to the other side of the street where a limousine stands, and to get into it. Once inside, a man (an actor) asks the player the same questions the online player has answered. The limousine drops the player near the headquarters, and the postcard is dropped into a game box.

Later, if the street player agrees (in the question), they are paired with a random online player who also has agreed, and personal details are exchanged between them. What happens next as a consequence of this is up to the players.

After that moment, the online player is free to continue exploring the city and helping other players.

Some noteworthy features of this game are their nature as "event-games". Also, the gameplay unfolds in a way for street players (based on Uncle Roy's clues) that cannot be sure at some moments of who is playing and who is not. The game transforms the physical place into a mystery environment reinforced by using physical objects (places, cars, phone calls) and actors as live non-player characters, contributing to make the mixed-reality connection stronger.

2.7 The Journey (2004)

Sensors	:	cell-id
Network	:	-
Support staff	:	-
Others	:	commercial (free)

The Journey (Jakl 2004) is a game available for Symbian mobile phones. Andreas Jakl (2004) describes the game:

> "The Journey is a location–based adventure game. The user plays the role of a detective that has to solve a case, commissioned by a mysterious man. The player has to move in the real world with the mobile phone to continue the story and to progress in the game."

The story starts in the bureau of the detective. The next part plays out a bar. To continue, the player has to change his location. The phone tracks the movement using cell–ids of the GSM network and continues the story once the player has reached a new location. Those ids are also stored so that the game remembers locations where the player has already been before. That functionality is being used in the game, which requires the user to return to the place where the whole story has started to participate in the showdown.

How far the player has progressed in the story is automatically saved; the player can resume the game if one is active. The story is visualized using text and a picture, which either shows a scene related to the story, or the general location picture."

The game is highly adaptable to many places, as it structures the story using relative positioning. An interesting thing about the game is the way it handles uncertainty, by providing guidance and information ambiguously, as for example: "continue searching for the bar. It has to be close to your current location".

2.8 Songs of north (2004)

Sensors : cell-id

Network : operator

Support staff : -

Others : -

The game description by the authors (Ekman *et al.* 2005):

> "The song of north is a multiplayer enhanced reality game. The game draws on inspiration from the Finnish mythology, especially the epic Kalevala. The background story revolves around the legendary Sampo, a machine that is able to produce all the riches of the world. Sampo has been destroyed in the battles between the Northmen and the sons of Kaleva, and now its pieces have become scattered all around the world. The pieces of Sampo are powerful magic elements, but they also cause energy to flow away from the earth. The players, the few Shaman heroes left in this world, now have two options: As they find the pieces of Sampo, they either return them to the earth by dropping them into swamps. With the magic of Sampo returned to the earth, the world will become a better place and nature will flourish again. However, a shaman can also choose to keep the pieces of Sampo and use the magic to gain personal power (at the expense of the state of the world).
>
> In addition to either destroying or keeping and protecting pieces of Sampo, shamans can also find other things to do in the game. The elder gods of the Finnish pantheon have left different quests to be performed by the heroes of the spirit world. These quests may be about finding and combining items in order to gain more power, rescuing non-player characters out of peril, or killing evil monsters. Some of these quests cannot be performed alone, and require co-operation with other shamans. The spirit world is manipulated by casting spells. The shamans cast spells by drumming a virtual shaman drum, which is implemented in the mobile interface.
>
> Players can also interact with each other as well as with the many non-player characters (NPCs) of the world through their mobile devices. The interaction can take the form of fights or collaboration. The game also supports messaging between players.
>
> The spirit world exists in parallel with the physical world. A schematic overview of the game world is presented in Figure 2. Some places in the real world have significance to the game. For example, a portal to the underworld may be situated in a graveyard, water spirits inhabit areas near lakeshores, and so forth.

To be able to interact with an item or character in the spirit world, the player has to be within a spell's reach of the object of his/her interaction. To get to the right position in the spirit world, players move around in the physical world.

The movements of players are detected by means of GSM cell positioning and transformed into spirit-world movement [11]. Game data and information regarding each player's actions is communicated via HTTP-requests between the client and server."

2.9 Ere be Dragons (2005)

Sensors   :   heart rate, GPS

Network   :   -

Support staff   :   -

Others   :   -

Ere be Dragons (Davis *et al.* 2005) is a game for PDAs that shares a social concern to stimulate people to have healthier habits, through physical activities.

The player uses a PDA, and the game uses heart-rate and GPS sensors as input methods in the game. The heart-rate sensor is attached to players and sends data to the PDA over the air.

As the player go to the streets with the PDA, the game renders a "map" on the device screen, where the colors and format depend on heart-rate data.

When the game starts, it asks the player about his age. The game uses this information to calculate the heart-rate range it uses, mainly the minimum "acceptable" value (for game performance reasons), the maximum (a safe value) and an optimal value that the player should strike to maintain.

The game uses the GPS to keep track of locations, so when the player comes back to a previously visited place, the game displays the new map overwriting the previous one.

If the player does well, the map becomes more colorful and expressive, and if the players does not perform well the map becomes darker. By "doing well", the game understands the player keeping the heart-rate around the optimal value. Walking too slow or too fast make the player "do bad".

The game also provides feedback through a set of music tracks, which vary in rhythm ("slow to fast"). The game switches the current track based on the player heart-rate.

2.10 Tycoon (2005)

Sensors   :   cell-id

Network   :   operator

Support staff   :   -

Others   :   seamful design

Tycoon (Broll and Benford 2005) is a multi-player mobile phone game where the goal is to collect virtual items and climb the high-score list. The game takes place on the city streets, and it uses GSM network cells as a way to divide the city into virtual locations.

The game locations can be either "mines" or "broker". The mines are sources for the game currency ("virtual gold, silver, and copper") that player uses to acquire items that brokers hold.

The mines have unlimited resources, and players do not compete for them. However, the existing items in brokers are of limited availability. The game defines items of different values and kinds. A player is able to buy an item when he reaches the item location, and holds the item price in virtual currency. Once bought, the players receive points related to that item. Once there are no more available items in the game, the game is over.

The game has a client-server architecture. The client is responsible for telling the player where /she is (the virtual location), helping in player navigation and informing the amount of currency the player holds. The server maintains the global game state (available items, items bought, etc.). The clients can access the global game state by placing a request to the server for his information.

The game designers have identified some possible issues related to technological limitations and availability, mainly network cell location handling, network availability and data service price. In order to handle those issues, they employed a paradigm known as *seamful design* (Broll and Benford 2005; Bell *et al.* 2006; Chalmers and Galani 2004). This design approach recognizes technological limitations and incorporates them as part of the application (instead of trying to fight them).

For example, mobile network cells have varying size and their position fluctuates over time. In order to minimize uncertainties related to mobile network cells, the game does not display a precise map of the locations. Instead, the game mere alerts the players when they enter another "virtual location".

Another example is the cost to use mobile connections (required to access the global game state), which was very expensive at the time (and still is on some places). To handle this issue they designed a game mode that encouraged players to stay offline, where they can collect a greater amount of currency. For example, the game would grant more points if the player buys an item using more valuable "coins" (like gold ones). However, staying offline would raise the chances of getting inconsistencies (like trying to buy an item that has already been taken by another player). This trade-off now becomes part of the game strategy (instead of an annoying game issue).

2.11 Epidemic menace (2006)

Sensors	:	GPS, software sensor (weather)
Network	:	WiFi
Support staff	:	yes
Others	:	cross-media, event game

Epidemic Menace (Lindt *et al.* 2007) is a cross-media game, where players collaborate to stop a villain scientist from spreading a deadly virus into the world. The viruses are out in the real-world, growing and moving according to weather conditions.

Players are divided into teams and have several devices at their disposal, each one with a distinct role in the game. The teammates play on different places and have dif-

ferent roles. There is a control room where part of the teams envisions the game globally through a display to analyze and observe the virus, and communicate with other players. Other team members have to go outside to find and destroy the virus. Those players use other mobile devices: a PDA fitted with a GPS sensor, a mobile phone, and a mobile augmented-reality system. The players use the mobile AR system to see the virus in the real-world. The game uses the PDAs to track the players outdoors. The mobile phone is the "mobile assistant", which players use to scan and capture viruses, and also to communicate with the control room. There is also an audio mobile interface to interact with the viruses, mainly to hear about the positions and other properties of viruses.

2.12 Feeding Yoshi (2006)

Sensors	:	WiFi
Network	:	WiFi
Support staff	:	-
Others	:	seamful design

Feeding Yoshi (Bell *et al.* 2006) is a game for PDAs that uses WiFi access points as sources for content. The game applies the seamful design approach to handling technology limitations. Here is the game description by the authors:

> "The aim of Feeding Yoshi is for each team of players to collect as many points as possible, by feeding Yoshis the fruits they desire. Yoshis are creatures that players find scattered around the city and which are constantly hungry for five fruits, of seven varieties. In order to collect fruit, players must first collect seeds from the Yoshis themselves—each Yoshi always has a seed for the fruit it most often enjoys. These seeds can then be sown at plantations that can be found scattered around the city, just as Yoshis are. Once a seed is sown, the plantation will begin to generate fruit, which can then be picked and used to feed Yoshis
>
> As a player moves through the city, nearby plantations and Yoshis appear as names in a pull down menu and as icons on a map (Figure 1). An audio alert is also made when a plantation or Yoshi is detected so that the player does not have to continually visually attend to the PDA screen.
>
> The Yoshis and plantations that are detected while playing the game are actually wireless access points. As a player moves around in the city, their PDA continually scans for the presence of wireless networks. Secured wireless networks become Yoshis and open networks become plantations."

2.13 Hitchers (2006)

Sensors	:	cell-id
Network	:	GPRS
Support staff	:	-
Others	:	-

The game description by the authors (Drozd *et al.* 2006)

> "Hitchers is a location-based game for mobile phones that utilizes GPRS networking and positioning using the cell-IDs from the players' phones to create an experience based around the metaphor of digital hitch-hiking.
>
> In Hitchers, initially the world is empty but as the game is played the streets fill with characters who are trying to hitch-hike their way across the city or up and down the country. They have been created and released into the wild by their owners and are trying to find their way home, reach a specific destination, carry out a mission, or just share a journey with a stranger.

Once created, the player can 'drop off' their new hitcher, releasing it into the world to begin its journey. Metaphorically, the hitcher is now removed from their phone and waits in their current location for other players to come by and give it a ride. Whenever a player drops a hitcher they are prompted with the question "Where are we now?" which encourages them to enter a text label describing their current location in the physical world

… In this way, hitchers make their way from phone to phone, player to player and place to place, trying to reach their destination and gathering answers to their question as they go.

… Hitchers currently has no specific goal, scoring mechanisms or game play beyond creating hitchers, moving them around the world and answering their questions."

2.14 Manhattan story mashup (2006)

Sensors   :   camera

Network   :   operator

Support staff   :   yes

Others   :   event game, mobile and web modules

The game description by the authors (Scheible *et al.* 2007):

"Manhattan story mashup (MSM) combines the web, mobile phones and one of the world's largest public displays in Times Square to a large-scale pervasive game.

In Story Mashup, individual keywords of textual stories written by web users are presented, one word at a time, to mobile users for the purpose of taking a matching photo with their camera phone. Each resulting keyword-photo pair is validated by presenting the photo together with the original keyword and three other words to two other mobile users, who are asked to choose the most appropriate word given the photo. If either of the two chooses the original keyword, the photo is approved into the resulting visual story. All resulting stories are displayed on the web and selected best ones on a large public display. The players are awarded points for taking photos and for choosing the original keyword.

… The best stories were shown on the Reuters Sign in Times Square in real-time."

2.15 PAC-LAN (2006)

Sensors   :   RFID

Support staff   :   yes

Network   :   operator

Others   :   event game

PAC-LAN (Rashid *et al.* 2006)is a mobile phone game inspired on the classic *Pac-Man*. In this version, the game arena takes place in the Lancaster University (England) campus. The game designers had chosen that area because they claim that it shares similar physical traits to a maze.

The game supports five players. One of them is the main character (PAC-LAN) while the others are the ghosts. As in the original game, the main player has to collect the pills and run away from the ghosts, and the ghosts have to catch the main character.

All players wear clothing fitted with radio-frequency (RFID) tags. The game uses those tags to sense when a player is close, so a player is able "to capture" another player.

The pills correspond to plastic discs fitted with RFID tags. Before the game session begins, game staff spreads the discs over the campus, putting them at key locations.

Those discs act as tangible objects. The players have mobile phone equipped with RFID readers, so they can interact with all game objects.

The main character "collects" a game pill by having the mobile phone read the RFID tag attached to the pill. A player "captures" another player when his mobile phone detects the RFID tag attached to the other player clothing.

The game has a client and a server module. The client module runs on mobile phones and is responsible for displaying information about the players. The client communicates with the server through the cellular network. The position of PAC-LAN is determined implicitly when the player interacts with a pill. The ghosts interact with the pills to have information about the position of PAC-LAN.

2.16 Day of the Figurines (2007)

Sensors   :   -

Network   :   operator (SMS)

Support staff   :   yes

Others   :   -

The game description by the authors (Flintham *et al.* 2007b):

> "Day of the Figurines can perhaps best be envisaged as a massively multiplayer board game that is played using text messaging on mobile phones. The game follows twenty four hours in the life of a small virtual town. Each player chooses and subsequently controls (via their phone) a small plastic figurine that represents their character, journeys through the town, meets and talks to other figurines, visits destinations, finds and uses objects, resolves dilemmas and undertakes missions.

> The twenty four hours of virtual game time are mapped onto twenty four days of real time. Unlike most simulation games in which game time is usually accelerated relative to real-time, in DoF it is slowed down so as to deliberately create a slow game that unfolds in the background of players' ongoing lives, perhaps only involving the exchange of a few text messages each day.

> The objective is deliberately ambiguous; players are released into the town and told that their goal is to help other players, the rules that govern the virtual city have to be discovered, and there is a strong emphasis on emergent game play in which players construct elements of the game through the exchange of SMS messages.

> The back story to the game is that the players are refugees who have arrived in a British Town. The players have to learn how to survive, get to experience various events within the town and ultimately have to decide whether or not to side with an army of soldiers who enter the town towards the end of the game. Players can become more or less healthy and can even die, but beyond this there is no explicit winning or losing. Rather the game is concerned with exploring and constructing a shared narrative through role play, hopefully resulting in an engaging and even provocative experience. In this sense, it is a blend of artistic performance and computer game.""

A curious fact about this game is that there was a game board (like a city mock up) on a public venue, which was a physical representation of the game (Flintham *et al.* 2007a):

> "Another performative aspect of DoF can be found in the use of a physical game board which is housed in a public venue (the National Museum of Singapore in the most recent deployment).

> The board is a large and distinctive physical structure which shows the destinations within the town and the positions of the figurines that are playing at any moment in time. Players have to visit the board to register and it is therefore their first point of contact with the game

> The board is continually tended by a team of human operators throughout the ten hours of every day when the game is active. These operators register players and manually move physical figurines across the board, following instructions from the game engine, projected onto the table as a series of visible augmentations.

Operators are therefore publicly performing the operation of the game, revealing its inner workings for new players and passing spectators, serving to attract attention, generate interest, and frame the overall experience for new players."

2.17 Insectopia (2007)

Sensors : Bluetooth

Network : GPRS

Support staff : -

Others : -

Insectopia (Peitz *et al.* 2007) is a game for one or two players where the goal is to wander around collecting virtual insects, and then building the most valuable collection. To reach this goal, players compete among themselves or collaborate in pairs for collecting. Another for players is to trade insects among them.

The game uses Bluetooth devices to represent the virtual insects. Any Bluetooth device is eligible as game content source. This could be the player's neighbor, some stranger on the streets, or the office printer. The game assigns uniquely insects to the devices, meaning that a given device is always associated with the same insect.

The insects have a life span, defined in the game as eight days. After that period, the insects die and the players have to find them again. This makes playing the game a constant activity to maintain the insect collection.

The game does not use location information. The players have to wander around sensing Bluetooth devices with their mobile phone. The game also does not provide direct player interaction, which they can achieve through other external media (web sites, emails, social networks, etc.).

The game client and server communicate through the cellular operator network.

2.18 REXplorer (2007)

Sensors : GPS, camera, Bluetooth

Network : -

Support staff : -

Others : place configuration, tourist game, tangible objects

The description of the game by their authors (Ballagas *et al.* 2008):

"REXplorer is a mobile, pervasive spell-casting game designed for tourists of Regensburg, Germany. The game uses location sensing to create player encounters with spirits (historical figures) that are associated with historical buildings in an urban setting. A novel mobile interaction mechanism of "casting a spell" (making a gesture by waving a mobile phone through the air) allows the player to awaken and communicate with a spirit to continue playing the game. The game is designed to make learning history fun for young (and young at heart) tourists and influence their path through the city."

The game does not require supervision while it happens, but it requires personnel to sell tickets and rent devices to players.

The game device is a mobile phone augmented with a GPS sensor disguised as the game object with a protective shell. This shell also provides a physical interface (a customized keypad) for player interaction.

The game detects the gestures using the mobile phone camera. The external GPS sensor was necessary as at that time mobile phone with internal GPS sensors were very rare.

The developers also have spread Bluetooth beacons across the game locations to improve the performance of the game when dealing with locations

2.19 Mythical: The Mobile Awakening (2008)

Sensors	:	Bluetooth, software sensors
Network	:	operator (internet), SMS
Support staff	:	-
Others	:	-

The game description by the authors (Korhonen *et al.* 2008):

> "Mythical: The Mobile Awakening is an asynchronous slow-update multiplayer game where players access a magical world through their mobile phone. The magical world is divided into four factions (Dawn, Sun, Dusk, and Moon). The players gain experience and learn spells by completing rituals either alone or together with other players. The spells are then used in encounters to battle against AI opponents or other players (Figure 1B). The game content is based on folklore mysteries and local history for creating an exciting atmosphere.
>
> The game features context-aware gameplay where the real world phenomena have an effect in the game world. Context information derived from the real world is used in the rituals where the reward of the ritual depends on how well the player has met the context conditions set initially (Figure 1A). There are three types of context information used: spatio-temporal, environmental and proximity. Spatio-temporal context is used in two ways: players select a home base from the predefined list and the game content and some environmental context information is then validated against information on that location. Time of the day is frequently used context information that defines when some rituals can be completed. Environmental context information is based on temperature, cloudiness and astronomy. Temperature is used in a breakpoint manner; some rituals require that the temperature is either above or below 0 degrees Celsius. Cloudiness has three possible options: clear, partly cloudy, and cloudy. Astronomy information is related to the Moon and Sun positions over the horizon and to the phases of the Moon. The proximity context is based on scanning Bluetooth devices. Rituals can require scanning either a specific or a given number of Bluetooth devices."

2.20 GPS Mission (2008)

Sensors	:	GPS
Network	:	?
Support staff	:	-
Others	:	commercial (free), mobile+web module, multi-platform

In *GPS Mission* (Orbster 2008) players access "missions" that mainly consist of going to checkpoints guided by GPS. When players get to checkpoints, they receive "virtual gold" that they use to claim special virtual trophies.

While playing missions, players might have to solve riddles, and also to leave "marks" indicating that they have been to that place.

The game has a web-based mission builder where players can build new missions and share them with other players. The game web-site has a ranking of engaged players.

2.21 Seek n' Spell (2009)

Sensors   :   GPS

Network   :   operator

Support staff   :   -

Others   :   commercial

Seek n' Spell (Retronyms 2009) is a commercial game available for iPhone and Android mobile phones. This game uses the GPS sensor in phones to place virtual letters in the physical world locations. The goal of the game is to gather the virtual letters and form words with them.

There are not many throughout analysis of this game, but it seems this game suffers with placing virtual content (letters) in unreachable places, like inside buildings on an urban city.

2.22 Gigaputt (2010)

Sensors   :   GPS

Network   :   operator

Support staff   :   -

Others   :   commercial, tangible object metaphor

Gigaputt (Gigantic Mechanic 2010) is a commercial game for the iPhone. The game definition by the authors (Gigantic Mechanic 2010):

> "Gigaputt is an iPhone app that transforms any cityscape into a virtual golf course. Using the GPS capacity in the iPhone, Gigaputt builds a three-hole golf course situated within a two-block radius of the players' location, set onto a satellite map view of the area. Virtual fire hydrants acting as obstacles for the ball and virtual coins that can be collected for extra points add to both the urban flavor and gamesmanship. The iPhone serves not only as course display and locator but also as the golf club, logging the speed and force of players' swings to calculate the distance their virtual balls travel. The app tracks the players' location, so after teeing off, players walk down the block to where their virtual balls have landed, often tracing and retracing their paths throughout the course of a game. The app will not let a player take their next swing until they are within 75 meters of their ball, granting that leeway in case the ball has landed in a neighbor's fenced yard or inside a closed building. "

2.23 Gbanga Famiglia (2010)

Sensors   :   cell-id, GPS

Network   :   operator

Support staff   :   -

Others   :   commercial, multi-platform

Gbanga Famiglia [http://gbanga.com] is a mixture of pervasive game for mobile phones and social networking. In this game, players can start Mafia Famiglias or join an existing one. The main goal is to take-over establishments from rival Famiglias. Those establishments are virtual content placed on the real-world. More about the game by the authors (Gbanga 2010)

> "Gbanga is a virtual world, which is connected to real-world locations you visit. Access to Gbanga's virtual world is via your mobile phone, which you carry around whilst going about your daily life. When your physical location changes, so does the virtual world of Gbanga. By walking around your city you, likewise, move between areas of Gbanga, exploring new places, discovering cool items, meeting other players and... Gbangoos.
>
> What can I win? You score points for completing quests and collecting special items. Rewards range from worldwide leaderboard rankings to sponsored contests with real prizes.
>
> Gbanga is a global community of friends and players connected through location-based quests. At any time of day, anywhere in the world, mixed-reality adventures are awaiting nearby. The platform also features a free alternative to mobile messages (SMS)."

The game has different clients for each supported platform (iPhone, Java ME, Windows Mobile, Android, and Blackberry).

2.24 GEO Hunters (2011)

Sensors	:	GPS (?)
Network	:	operator
Support staff	:	-
Others	:	commercial

GEO Hunters is a commercial game for the iPhone. Game description by the authors (YD Online 2011).

> "GEO Hunters is a location-based role playing game that lets users defend their neighborhood and, ultimately, the world from monsters, while competing against other players for top rank.
>
> Set against Maps backdrops, monsters have invaded the Earth, threatening your neighborhood and the planet itself. But don't despair; you're a GEO Hunter who can launch bombs at the monsters and capture them. Once a monster is defeated, you own that monster but must feed and strengthen it or risk losing the creature to other hunters. The more monsters you own, the higher your rank in the game."

3 Concluding remarks

This research work presented a summary of 24 projects labeled as "pervasive games" in the literature. We selected game projects that fell in our criteria for "pervasive mobile games", which comprised four conditions:

1. Games using mobile devices (e.g. smartphones, tablets):   mandatory

2. Games that are context-aware: mandatory

3. Games that access remote data1 on the move: optional

4. Multi-player games: optional

Apart from the game design descriptions, we included information that we found interesting for our purposes – we were interested in the technological aspects of pervasive games and their implications. The information is:

- Which sensor technology the game uses;
- Which network technology the game uses (if any);
- If the game requires a support staff while the game is happening;
- Other miscellaneous remarks that we found important to mention.

Although the literature define "pervasive games" through different viewpoints, it is possible to highlight some common patterns in the games, as:

- Spatial mobility on a physical "open" environment, the "game world boundary" is not "well-defined", sometimes it can be unconstrained;
- The players use mobile devices (e.g. smartphones, tablets, custom hardware);
- Focus on promoting social interaction among the players;
- An emphasis on "mixed-reality". The physical world (places, objects) is integrated as part of the game, combining it with the virtual world;
- The idea of "Games coming back to real-world", which suggests that computer games are the dominant form of gaming, and pervasive games appear as an alternative to this scenario.

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