Design Implications for Context Aware Mobile Games

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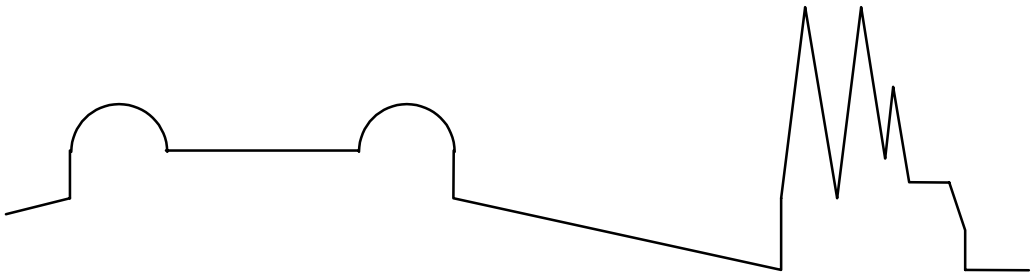

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Abstract

Computer games on stationary computer systems have been around for a long time and the design issues are fairly well understood, but there is very little research on the design issues of mobile games. Many mobile games are exactly the same as their stationary counterparts -- however, there is a class of mobile games being developed that incorporates things such as the player's direction, speed, location, or proximity to objects in the physical world into the game play itself. So far, very little research has been done on incorporating mobile properties into game-play, which means that there are many unanswered questions on how such properties can contribute to an enhanced game experience.

In this thesis a study was conducted in which a prototype of a mobile game called Ghost Catcher was evaluated to examine the user reactions when playing this game. The game was evaluated and the players' reactions, comments and concerns when playing it were examined by letting them play the game in its proposed setting. The test sessions were recorded with video cameras and qualitative interviews of the users were also conducted.

This thesis has resulted in a list of design implications for mobile games. This list consists of a number of different insights: how the physical and virtual objects that the players interact with should appear, the importance of an introduction and feedback in a game and finally how the device that is used the game should look like and appear.

1 Introduction

Computer games on stationary computer systems (desktop computers, game consoles etc.) have been around for a long time, but the development of mobile games is fairly new. Mobile games are, broadly defined, computer-based games that can be played "on the move", whether on hand-held or vehicle-mounted devices. Many mobile games are exactly the same as their stationary counterparts -- however, there is a class of mobile games being developed that incorporates things such as the player's direction, speed, location, or proximity to objects in the physical world into the game play itself. So far, very little research has been done on incorporating mobile properties into game-play, which means that there are many unanswered questions on how such properties can contribute to an enhanced game experience (i.e. what the users find fun, interesting, compelling, enjoyable etc. in a game).

In this thesis a prototype of a game called Ghost Catcher[1], which has been developed at the mobility studio at Interactive Institute, will be evaluated to examine the user reactions when playing this game. This game is supposed to be played while being mobile and it uses the different mobile properties while trying to bridge the gap between the virtual world and the physical world in an effort to heighten the player's game experience. The game will be evaluated in its proposed setting i.e. the backseat of a car while the car is traveling on the road.

For the purpose of this thesis, mobile properties are defined as the characteristics that appear and are present when moving or traveling. These different properties affects the relation a person has to his or hers surroundings (environment, different objects etc.) and are location, direction or speed. There are a number of other properties that can appear as a result of being mobile, for example carsickness, thirst, hunger and fatigue. This thesis will limit itself to the mobile properties that are relevant in this case, i.e. game-related mobile properties.

1.1 Summary of Related Work

There are mainly three areas of interest: Location-aware systems, Mobile games and Backseat entertainment. These systems are supposed to aid the user in different tasks, for example navigation (i.e. an interactive car navigational tool etc.) with the use of position. Mobile games can be used in almost every environment and the games primary function is to entertain the user, not to be used, like location-aware systems, as a utility to aid in certain tasks. Backseat entertainment systems consist of a VCR or DVD and a small screen fitted in the backseat of a car. These systems also support compatibility with different game consoles so the passengers can play computer games while on the road.

1.2 Summary of the Problem Statement

There are entirely new phenomena that need to be explored when playing a mobile game like Ghost Catcher. This game benefits from certain mobile properties (the positions of the player

[1] The real name of the Ghost Catcher game is actually Backseat Gaming but the name is changed from here on to avoid confusion with other relevant concepts mentioned in this thesis, for example Backseat Entertainment.

and the speed and heading at which he or she is traveling) and is therefore not like most traditional mobile games that do not take the context of the player in mind. The Ghost Catcher project can be viewed as an evolution based on the three different areas of interest mentioned in the related work section. It combines these different categories into a mobile game, which is played in the backseat of a car and it uses context aware information to enhance the game experience.

1.3 Summary of the Method

To get an insights how the player's used the game, it were evaluated and the players' reactions, comments and concerns when playing it were examined by letting them play the game in its proposed setting. The test sessions were recorded with video cameras to gather as much material possible and to provide a rich material for analysis. The users were also interviewed in connection to their participation in the test. The interviews provided information to establish their prior computer and computer game experience. The interviews were also used to gather information that did not appear in the filmed material (for example different thoughts and concerns).

1.4 Summary of Conclusions

This thesis has resulted in a list of design implications for a mobile game. This list consist of a number of different insights: how the physical and virtual objects that the players interacts with should appear, the importance of an introduction and feedback in a game and the interaction between players and finally how the device that is used to play the game should look like and appear.

1.5 Limitations

The Ghost Catcher project is a prototype. This is an early evaluation of the reactions from the players when playing the game. It is not a full user test and evaluation of the complete gaming concept and every aspect of the users behavior when playing.

2 Related Work

This chapter reviews, in detail, three different areas of interest: Mobile games, Location-aware systems and Backseat entertainment. The chapter also provides a history of mobile gaming.

Mobile games can be used in almost every environment and the games primary function is to entertain the user, not to be used, like location-aware systems, as a utility to aid in certain tasks. There are a couple of distinguishing characteristics of mobile games: they are portable (the user can carry them at almost all times), the devices that they are played on, for example a PDA or a mobile phone, have a limited performance (small display, limited memory and controls) and due to the limitations in performance, the game's graphics and complexity are also limited, when compared with games developed for stationary computers and game consoles. Mobile games can, in general, be thought of to derive from the class of computer games, while mobile games that uses context-aware information derives from mobile games in general.

Location-aware systems take the users position in mind to enhance the user experience and the usability of the system. These systems are supposed to aid the user in different tasks, for example navigation (i.e. an interactive car navigational tool)

Backseat entertainment systems consist of a VCR or DVD and a small screen fitted in the backseat of a car. These systems also support compatibility with different game consoles so the passengers can play computer games while on the road. They do not take the fact that the user is mobile into account at the current stage of development; they simply move the living room into the car. They are mainly concerned with the issue of how to provide entertainment in the car for people in the backseat.

2.1 A Brief History of Mobile Gaming

Mobile games have been around and been developed during a period of over twenty years, one of the earliest examples are the handheld Game&Watch games from Nintendo that was manufactured during 1980-1991 (see Fig. 1). The games were quite simple with few controls and a limited game story. For example, in the game Greenhouse (released in 1982) you play a farmer who protects his crops against spider and worms by spraying them with pesticide. You control the farmer with one button and spray the bugs with another. These games were mobile in the sense that they could be use in almost every environment; the game is not limited to a single surrounding. These games can only be played in single player mode; there is no support for a multiplayer gaming experience.

Fig. 1: Game&Watch games from Nintendo

The development of mobile games continues with other handheld devices like the Nintendo Game Boy in 1989 (see Fig. 2). These games were more advanced than the early Game&Watch games. They had better graphics and audio, more advanced controls and an extended style of gaming. These games are also mobile in the sense that they can be used everywhere. The Game Boy later supported multiplayer use by connecting the devices with a cable; the multiplayer gaming experience is, in this case, dependent on other Game Boys in the vicinity of each other (see Fig. 3).

Fig. 2: Game Boy, released in 1989
(Source: http://www.nintendo.com)

Fig. 3: Game Boy Advanced, released in 2001
(Source: http://www.nintendo.com)

Games in mobile phones are also mobile games in the sense that they can be played almost everywhere and are not limited to a specific setting. The games are fairly limited and the graphics are often monochrome and the sound scheme is very basic. Some examples of these games are Tetris, Space Invaders and Worm. The games are no longer played with typical game consoles but with devices that can be used for a number of different things. The games can also provide a multiplayer experience with infrared transmission between two players. With the introduction of WAP (Wireless Application Protocol) enabled phones and mobile phones with Java support, the players got a bigger choice of more advanced games and games with multiplayer support that were independent of physical proximity of the players.

Recently there has been a huge explosion in the development in games for Personal Digital Assistants (Gartner, 2002). These handheld computers have contributed to more people being mobile, number and range of games and mobile computing performance. These computers fit right in your pocket and can be brought with you at almost all times.

2.2 Location-aware systems

Location-aware systems take advantage of the users change of location to aid the user in certain tasks, for example navigational tools for a PDA, and the development of this kind of systems have also increased in the last couple of years because people are becoming increasingly mobile. The company Gartner Dataquest projects that 15.5 million PDA: s will be shipped in 2002, an 18 percent increase from 2001 (Gartner, 2002). There are a number of projects in this category for example virtual tourist guides, mobile awareness devices and systems that place virtual post-its. This category of systems will be further examined below. This area of research is important because it consider the mobile situation of the user and uses this situation to enhance the usability and experience of the system.

GeoNotes (Espinoza, Persson, Sandin, Nyström, Cacciatore & Bylund, 2001) is a system that works like a mobile notice board; users can place messages in the form of "virtual post-its" at a specific location with a PDA. Other users that pass in the vicinity of the location can then read the messages. A user that has an apartment for rent in a particular building can place a message about this at the location of the building. Other users that pass this particular building can read the message and then contact the other user if he or she wishes to rent the apartment. Another example is the possibility to place messages at, for example, a restaurant that you have visited and recommend it to others, a form of social navigation. The system makes extensive use of different filtering techniques so the user can choose which messages he or she wants to read, the messages can be filtered by subject, area of interest, popularity, sender etc.

The GUIDE systems (Cheverst et al, 2000) and the Cyberguide system (Long, Cooper, Abowd & Atkeson, 1996) are examples of location-aware systems used as tourist guides. The GUIDE system has been developed to provide city visitors with a hand-held location-aware tourist guide. The system combines mobile computing technologies with a wireless infrastructure to present city visitors with information tailored to both their personal interests and environmental contexts. The Cyberguide system developed by the Future Computing Environments group at the Georgia Institute of Technology is one of the earliest examples of a location-aware system (Long et al, 1996). The Cyberguide system uses infrared beacons to send wireless transmissions to detect a tourist's position and orientation. The beacons transmissions can be translated into a map location and orientation.

There has also been some research about devices that provides awareness among a set of users with the use of relative position (i.e. the position of a user in comparison to another user). The Hummingbird (Holmquist et al, 1999) is a hand-held device designed to support awareness and collaboration between a set of users that are in the physical vicinity of each other. The Hummingbird is designed to supply awareness to users in any environment without relying on an underlying infrastructure. The device gives users continuous audio and visual feedback when other users are in the vicinity. The Active Badge system (Want et al, 1992) locates users in a building by determining the location of the users device (i.e. the wearable badge). The system consists of a number of sensors located in the particular building. The badge transmits a unique infrared signal every 10 seconds. Each office within a building is equipped with sensors connected by a network, which detect the transmissions. The location of the badge can then be determined by the information provided by the sensors.

The Lovegety (Wired, 1998) developed by the Japanese company Erfolg, is a commercial "ice-breaking device", intended to match users of the opposite sex. The devices come in two different forms, a male and a female version, and when two devices of different kind are close

to each other they make a sound. Additionally, users can chose the preferred type of interaction (e.g. talk or karaoke), and a visual signal indicates when there is a match.

These projects are all fully implemented and The Active Badge system for example has been a commercial success and is extensively used at a number of different companies (Want et al, 1992). GeoNotes uses location to bridge the virtual and the physical world in an interesting way. This system is a mobile system and it uses mobile properties to increase the user experience, but it is not a mobile game i.e. its primary goal is not to provide a gaming experience. It can be classified as more of a utility. They all use the change of location (the movement between different locations) to a certain extent to heighten the user experience. But, as in the case of the mobile games mentioned above, there are a number of other mobile properties that also can be used to give the user a greater experience when using the particular device.

2.3 Mobile Games

The field of mobile gaming have expanded a lot in the last years and the global market for mobile gaming will reach $17.5bn by 2006 (Datamonitor, 2002), mainly because a lot of people are using mobile devices like cellular phones and Personal Digital Assistants and with the introduction of new techniques like WAP (Wireless Application Protocol), Java support for cellular phones and mobile Internet techniques (Wireless LAN etc.). Most games developed for handheld devices do not appreciate the mobile situation of the user. The games are in the same stage of the evolution that games for a stationary computer were in fifteen to twenty years ago[2]. The games are often quite trivial, for example card games or puzzles, and they do not take advantage of any mobile properties. There are a couple of exceptions though and I will list some of them below.

Pirates! (Björk et al, 2001), is a gaming project developed for a mobile gaming environment. In the game, players travel as captains of a pirate ship between different islands with their ships represented by a PDA. The islands are different locations in the physical room and when the ship, the player with his or her PDA, has moved to an island the player can take advantage of what is located there (e.g. commodities for trading with other players). The goal of the game is to carry out different missions, while avoiding things like cannibals and other players that will attempt to sink your ship (see Fig. 4). The game uses location to support interaction between players. The players use the PDA to explore the game world and interact with each other by approaching other players. The game uses both position between objects and relative position (between players).

[2] This conclusion has been reached by conducting a brief study of mobile game developed and currently under development at the following game companies: Digital Bridges (Digital Bridges, 2002), Picofun (Picofun, 2002) and Blue Factory (Blue Factory, 2002).

Fig. 4: A two-player battle scene in Pirates!
(Source: Björk et al, 2001)

ARQuake (Thomas et al, 2000) is also a position-based game. This game puts the traditional action game Quake in a physical environment and in that way tries to bridge the physical and the virtual world. ARQuake is an outdoor/indoor augmented reality first person game application. The game is an extension of Quake, and as such, the researchers are investigating how to convert a desktop first person application into an outdoor/indoor mobile augmented reality application. The game uses GPS, digital compass and vision-based tracking. The keyboard and mouse interaction with the game has been completely replaced with the users movements and a functional toy gun (with recoil and sound effects).

BotFighters (BotFighters, 2001) is an example of an SMS-based mobile game. The players of BotFighters use mobile phone positioning (i.e. GSM triangulation) in this combat game. While moving around in a city the players receive SMS messages on their phones, these messages contain information about other players in the vicinity and their attack status. By replying to these messages the player can attack the other player or simply, physically, choose to run away from the attacker.

The games that have been described above have certain things in common. They all attempt to bridge the physical world with the virtual world to a certain degree. They all make extensive use of location and movement between different locations, but there are a number of other properties that most certainly can be used in a game to increase the gaming experience. Some of these properties are: speed, direction, timing, changing surroundings, fast movement of manipulative objects and multiple entries and exits.

Another thing in common with mobile games are the lack of evaluation and user testing that they have went through. Pirates!, for example, have only been subjected to a very limited user evaluation. The game, at this point in time, has only been tested at a conference. The developers invited conference participants to play the game. 31 players took part in the game demonstrations and 13 agreed to fill out a questionnaire after the game session (Björk et al, 2001). The majority of these participants had a positive gaming experience. The results of the test are mainly focused on issues concerning playing the game and the story of the game. The results do not present any findings in the area of how, and if, the mobile properties included in the game contribute to a more fun and exciting gaming experience and how the users react to these properties. There are little research on the subject of evaluation and testing the user experience when playing games in general and very little research about playing mobile games with mobile properties in particular. The research that exists about computer games mainly deal with the violence in the games and how this affect the players (for example Anderson and Bushman, 2001).

A problem with many mobile games is the fact that the games are mobile versions of games developed for a stationary computer platform. The games are then simply ported[3] to the mobile device with little concern about the limited screen size, the limited performance and the limited methods of interaction with the mobile device (no keyboard, stylus, few buttons). The action game Quake (see Fig. 5 & 6) has been released in a Pocket PC version (Pocketmatrix, 2001), and there have been virtually no consideration taken about the limitations of a PDA when transferring the game to a handheld device. In its original stationary form, the game relies heavily on the computer mouse for the quick movements and reactions that the player has to perform to be successful when playing the game. The game also uses a number of keys on the keyboard to perform different actions in the game, e.g. jumping, running and using different items. In the Pocket PC version of Quake, the player has to tap the stylus in the game interface to control the game, i.e. to control the movements of the game character. This limited method of interaction makes the game hard to control and severely limits the playability and the game experience.

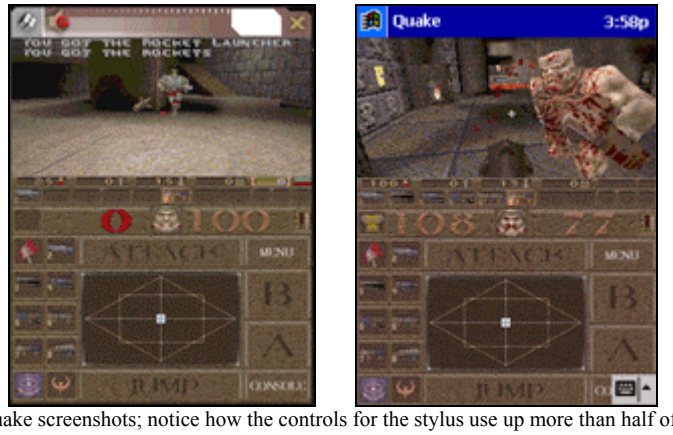

Fig. 5 & 6: Pocket PC Quake screenshots; notice how the controls for the stylus use up more than half of the "screen real-estate". (Source: http://quake.pocketmatrix.com)

Another common denominator for games that have been developed for a mobile device is that when they use a mobile property they mainly use position (both ordinary and relative) for example BotFighters and Pirates!. There are many other mobile properties, for example movement, direction, timing and changing surroundings, which could be relevant to the gaming experience and the illusion of a merging between the world that we see on the screen and the world that the user is in when he or she uses the game (the physical world). The majority of games developed for a mobile device do not use any mobile properties at all. They do not use or take advantage of the very fact that the user, when mobile, is in a quite different environment.

2.4 Backseat Entertainment

Backseat entertainment is the field of incorporating existing concepts like VCR, DVD, game consoles and television into the backseat of a car. They do not take the fact that the user is mobile into account at the current stage of development. They do take in account the fact that there is a need for entertainment in the backseat, especially for children that have to endure

[3] To port a game is to transfer a game, originally developed for a particular platform, to a different game platform. For example, to transfer a game developed for a game console (e.g. Sony Playstation or Nintendo Gamecube) so it can be played on a PC.

long car trips, but as mentioned earlier they have only incorporated the entertainment in the backseat. It is not clear if the manufacturers of these systems are trying to incorporate the games with the car in some other way, for example using a car navigational tool to receive location data to be used in a game. The system consists of a television monitor that you can connect to other devices like your Sony Playstation. The reason for mentioning this area of research is because that there are visions to incorporate systems in the backseat of the car to entertain the persons that are traveling.

There has been quite some work in the field of backseat entertainment. Two companies, Delphi (Delphi Automotive Systems, 2002) and Visteon Corporation (Visteon Corporation, 2002) have produced products in this field. These, and similar products from other companies, usually consists of a small screen and a VCR or DVD player that is fitted into the backseat of the car. The systems also provide compatibility with different game consoles (Nintendo Gamecube, Sony Playstation etc.). This is of course a form of mobile gaming but the only thing it does, is to bring the gaming situation from the home to the car. It uses the same games that you use at home and these games do not use the various mobile properties. Another example of backseat entertainment is FleetNet (FleetNet, 2002). This is a project mainly for driver safety, but they do have a vision about mobile backseat gaming. The users can chat with other users and play interactive games.

3 Problem Statement

There are entirely new phenomena that need to be explored when playing a mobile game like Ghost Catcher. This game benefits from certain mobile properties (the positions of the player and the speed and heading at which he or she is traveling) and is therefore not like most traditional mobile games that do not take the context of the player in mind. The Ghost Catcher projects can be viewed as an evolution based on the three different areas of interest mentioned in the related work section. It combines these different categories into a mobile game, which is played in the backseat of a car and it uses context aware information to enhance the game experience.

This thesis investigates the user experience when playing a mobile game under these preconditions. Recordings of different user reactions, such as facial expressions, gestures and comments have been coded and analyzed. The results from this work will hopefully contribute to a deeper understanding regarding design and implication of mobile games in this context. The aim of this thesis is also to make conclusions about design implications for mobile games in general.

3.1 Problem Statement

This thesis focuses and limits itself on four aspects of mobile gaming: The player's relationship with the objects that he or she interacts with, the player's progress when playing the game, how the player handles the game when playing and the cooperation between players during the game. By focusing on these four aspects, which covers some areas of the activity of playing a mobile game, this thesis will result in a list of insights and design implications for mobile games.

The objects that the player interacts with when playing the game have different properties and differ in a number of areas. In Ghost Catcher the objects are categorized by interaction, proximity, duration, preparation and uniqueness (see 4.2). This thesis investigates the player's reaction and behavior when interacting with objects that differ in the mentioned properties. This investigation will lead to conclusions about which objects could be appropriate to use when developing a mobile game.

The player's progress will be examined by looking for patterns of different behavior between the first game session and the second. The player's comments and reaction to the energy bar (the equivalence to score in Ghost Catcher) and the feedback it gives will also be investigated to come to a conclusion of its importance in a mobile game. This is a very general aspect of playing a game and is not only applicable on a mobile game; this aspect is also true when playing a game on a stationary computer or game console.

The player's handling of the game has been divided in the following four areas: exploring, scanning, aiming and firing. Exploring is the activity of the player when he or she is trying to make sense of the game and figuring out what to do. Scanning is the activity of the player when he or she is using the PDA to search for ghosts in the environment outside of the car. Aiming is the activity of getting the ghost in the sights when scanning the surroundings has discovered it. Firing is the activity of pressing the button to catch the ghost when it is in your

sights. These four categories are quite specific for Ghost Catcher and its style of handling and play mode but it could be generalized to fit other mobile games.

Cooperation between players will be examined to get some insights in how the players work together to solve different problems and discover things together and how one players understanding of the game will shape another players understanding by comments, gestures etc. The examination of cooperation will hopefully lead to some important insights of playing computer games in an environment with many different players in the direct vicinity of each other.

3.2 What is Original about my Contribution

Ghost Catcher is a different kind of game and it uses technology that newer has been incorporated into a game before. These kinds of games have naturally never been subject to a user evaluation before.

3.3 What is Important about my Contribution

There is a serious lack of research into game evaluation and development in general and mobile games in particular. Malone is one of very few that has done serious research in this area (see 4.2.3). This thesis will result in a number of issues to keep in mind when developing a mobile game. These issues are the importance of cooperation and feedback between the players, which objects and its particular attributes can contribute to a better mobile game and how important is the handling of the game for a player. These issues will hopefully prove to be important when designing, implementing and developing other mobile games.

4 Method

This chapter describes the Ghost Catcher project and the method used when evaluating this game. To get an insights how the player's used the game and how the four aspects (relationship towards objects, progress, handling and cooperation) affected the game and the user experience, the game were evaluated and the players' reactions, comments and concerns when playing it were examined by letting them play the game in its proposed setting. The evaluation took place in the backseat of a car outside Stockholm in May 2002. The test sessions were recorded with video cameras to gather as much material possible and to provide a rich material for analysis. The children were also interviewed in connection to their participation in the test. The interviews provided information to establish their prior computer and computer game experience. The interviews were also used to gather information that did not appear in the filmed material (for example different thoughts and concerns).

This chapter consists of four main parts. The first part describes the Ghost Catcher game and how the evaluation was conducted. The second part describes why this method was chosen and used. The third part of this chapter is a compilation of the results of the user evaluation and the final part is a description of the framework used for analyzing and compiling the data gathered during the evaluation sessions.

4.1 Method Description

4.1.1 Ghost Catcher

Ghost Catcher (Brunnberg, 2002) is a game that have incorporated several mobile properties in the game in an effort to give the user a more fulfilling and fun experience while actually being in a mobile environment. The game is supposed to be used in a highly mobile situation, the situation of being a car passenger. The properties used in the game are: speed, direction, position, timing and changing surroundings. The system consists of a Compaq IPAQ Pocket PC with a GPS (Global Positioning System) card to receive location data and a Honeywell digital compass module that provides heading, pitch and roll output. The PDA is fitted in a casing made of silicone and this casing hides the technical components of the system and provides a more appealing look. The PDA is supposed to be an "energy radar" and the children playing the game will use it to scan for ghosts in the surroundings. When they find a ghost they will attempt to catch it to absorb its energy. The current energy level of the player is shown on the screen.

Fig. 7: The PDA with the compass and GPS attached

Fig. 8: The PDA with the outer casing attached

The target group of the project is children in the backseat of a car while traveling. Normally they have to endure hours of boredom in the backseat on a long drive. To make the journey more tolerable, children often resort to play games. These games can be, for example, to count number plates of passing vehicles or spotting different brands of cars. They also play electronic games such as Game Boy, but electronic games like the Game Boy never take the mobile situation in mind. The games do not try to connect the content in the game with events that take place outside the car window.

The prototype is connected to a road in the suburbs of Stockholm (see Fig. 7) and the game content that develops while traveling along the road has clear connections to the environment seen outside the window of the vehicle, the user will for example pass an old oak tree, a electric power plant and a gas refinery that are of great importance.

Fig. 9: Map of the Ghost Catcher route

The story of the game is as follows[4]:
"On this day the scientist Kalle Kula worked in his office in the outskirts of the town, just like he would any other day. Kalle Kulas big passion was to try to create a special kind of energy that would astonish and revolutionize the world. On this particular day something weird happened when he was performing his experiments. All of a sudden big lightning bolts filled the laboratory and the whole house began shaking. After a while these strange things stopped and everything went quiet and dark. Kalle Kula wobbled down the stairs and scratched his head; everything was just like before except that the air around him had gotten a blue, jelly-like shade and everything looked blue. His otherwise so white and round laboratory looked like a huge blue lump of jelly. All of a sudden a strange phenomenon came sliding through the air towards him, the phenomenon stares angrily at him with its evil eyes and passes right through his body. Kalle gets a shock of electricity and tumbles down the stairs. Kalle looks in amazement and realizes that his revolutionary new energy has managed to open the gateway to a parallel universe where other creatures rules. He runs up the stairs to get into his laboratory but the door has been slammed shut and Kalle has no key. Your mission is to bring this key to Kalle Kula so he can get back. But beware; other creatures are trying to get their hands on the key so they can invade our world. The only way to see them and defend yourself

[4] This story is also told to the players at the beginning of the game.

against them is with your radar so you need to keep the energy level high otherwise you are defenseless…"

Sections

The game story is divided into 5 different sections and the player will be introduced to each section and what to do in that particular section by an animated intro that is triggered before the start of the section (the game calculates the cars speed and the length of the introduction to be played and triggers it, so it can be seen before reaching the particular section). The sections differ in some ways for example proximity to the road, size, number of ghosts to catch and time spent at each section.

Fig. 10: Section 1 - The Power Plant

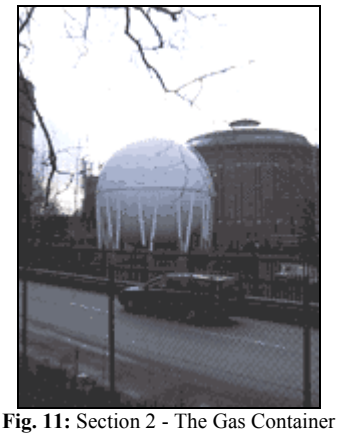

Fig. 11: Section 2 - The Gas Container

Fig. 12: Section 3 - The Old Oak Tree

Fig. 13: Section 4 - The Old Cottage

Fig. 14: Section 5 - The Allotment

In the first section (see Fig.8) the player is supposed to scan for ghost with the radar and then catch them, when passing an electrical power plant. The borders of the power plant are clearly defined because there is a metal fence around it. There are a predetermined number of ghosts that will attack the player and the player is informed of this in the introduction to the section. The player has to use the PDA and catch the attacking ghosts. The ghosts in this section appear inside the bounders of the power plant, floating around in the space surrounding it. The player has a considerable amount of time to engage the ghosts in this section of the game because the road is situated around the power plant.

In the second section (see Fig. 9), the player passes a gas container at the gas plant. This container is introduced to the player as Kalle Kulas laboratory and the player has to catch a non-defined number of ghosts that is floating around the container and in the vicinity of it.

The ghosts in this section are not placed directly at the gas container, they can appear around it and on both sides of the road. The gas container looks quite futuristic and unusual (it is not a common element in the urban landscape) and this is one of the reasons for choosing it, the players will hopefully detect it as a part of the game.

In the introduction to the third game section (see Fig. 10) the player is told to pick up a map that Kalle Kula has dropped behind the old oak tree. The players have to point and aim the PDA at the map and click a button to pick it up. The tree is situated directly at the side of the road; there are a number of other trees around it (the road goes through a forest). The player is shown a picture of the tree in the intro and it is quite different from the others because of its size and age, the oak tree is also situated in a glade in the forest so there is a distance to the other trees. The player will not spend much time (approximately 15 seconds) in this section because the tree is passed quite quickly, but the there are time for the player to prepare.

The fourth section (see Fig. 11) takes place at an old cottage situated at the side of the road. A ghost lives in this cottage and the player has to catch it with the PDA. There is only one ghost to shoot in this section in opposite to the first and second scenario where there are a number of ghosts. The cottage is also situated almost directly at the side of the road so it is passed quite quickly during the game. The ghost will appear in the direct vicinity of the house and the player has to be quite quick if he or she is going to succeed. The cottage can be seen from a distance so there is more time to prepare in this section than in the previous sections.

The fifth and last section (see Fig.12) takes place in an allotment. The road, where the player is traveling, goes right through the allotment so the ghost will turn up on either side of the car (the player has to turn PDA to get them in his or hers sights). There is more than one ghost in this section and the player has to catch as many as he or she can. This section, together with the power plant, is where the player spends the most time during the course of the game (approximately 30-40 seconds). The appearance of ghosts in this section are quite vague; the ghosts are not situated at a particular object in the allotment, they can be anywhere inside the borders of the allotment.

For a compilation of the different sections and their characteristics see 7.1.

4.1.2 Study Protocol

The method used during the user evaluation is based on the framework develop by Joseph S. Dumas and Janice C. Redish (Dumas and Redish, 1999). Their method is a very detailed framework for developing user evaluations and tests. The reason for using this framework is because it is very sensitive to needs and concerns of the users and this is imperative when testing the users experience with a system, especially children who can feel quite insecure in a testing environment.

The evaluation of the Ghost Catcher prototype took place in the games' proposed setting i.e. the backseat of a car. The players played the prototype when traveling on a road in Stockholm. The test participants traveled in a mini-van fitted with two digital video cameras. The first camera was fitted in the seat behind the test participant, the camera looked "over the shoulder" at the person playing the game and captured images of firstly, the player and the PDA screen and secondly images of the environment outside the car. The second camera was

fitted in the seat in front of the test participant in an effort to capture the movements, expressions and behavior of the user when he or she played the game.

Before the test, the participants were interviewed in an effort to establish their prior experiences with computers and handheld devices in general and games (mobile and stationary) in particular. This information was very helpful and useful when analyzing the gathered test material. For example, if the participant is used to play computer games with a high performance stationary computer fitted with the latest 3-D graphics card, the participant are probably used to games with excellent graphics and performance (frame rate, speed etc.). The participant could very well be disappointed with the limited performance and visual effects of the prototype. This disappointment could lead to an unaware bias and a negative attitude towards the game being tested. The pre-test interview is also an important tool to use when trying to establish the participants' expectations with the game they are going to play. This was helpful, when interviewing the participants after the test, to examine if and how the game reached their expectations.

During the test session, before the actual testing of the game prototype begins, the participants were briefed about the test in general and about the prototype. This briefing explained to the users that it is the game that is going to be tested, not their ability to play it. The users were also encouraged to talk out loud during the test and try to explain what they are thinking and why they do the things they do. Another way to get the users to explain their actions and talk out loud during the test was to have them play the game together; the participants' cooperation and joint exploration of the prototype forced them to talk with each other. Care was taken not to reveal too much about the game prototype because the users exploration of the game needed to be captured on video. This exploration could be biased if the user knows too much about the prototype and what will be tested and evaluated before hand (Dumas & Redish, 1999). The participants did two test runs to get used to the testing environment, video cameras etc.

Another reason to do several test runs with each participant was to examine the issue of cooperation between the users of the game and how this contributes to the users understanding and experience or vice versa. Will a more experienced player, that have played the game several times, help the more inexperienced player to play the game? Will the users try to solve the different tasks in the game together?

The post-test interview took form of an informal discussion. The reasons for this was that test participants, especially children, are more inclined to reveal interesting and useful information if the interview is performed this way, according to Dumas and Redish (Dumas & Redish, 1999). Templates of the most essential and interesting questions that need to be answered were prepared in advance. The reason for this is twofold. First, to make sure that the questions will be raised in the interview. Second, to make sure that the discussion does not stray too far from the topic.

The video material gathered from the test sessions and the interviews were transcribed and then analyzed. The analysis of the transcriptions was examined for common patterns in the users behavior when they are playing Ghost Catcher and the new technology and different game concept that this game consists of.

4.1.3 Framework for Analyzing and Compiling Results

This chapter describes a number of heuristics for designing an enjoyable game, developed by John W. Malone (Malone, 1981). This list consists of three basic groups of heuristics: challenge, fantasy and curiosity. Malone says that for a game to be enjoyable it need to be challenging, a game needs to have a goal whose outcome is uncertain. Fantasy is an important part of a game, if the game has emotionally appealing fantasies it will be more enjoyable. Curiosity is also an important part of the game because games that evoke the player's curiosity are more appealing.

Malone's heuristics have been used when analyzing the results from the evaluation to examine if certain aspects of Ghost Catcher agree with Malone's findings and research. The reason for using Malone's heuristics is because he has an extensive empirical material that supports his conclusions. There is also very little research done on evaluating games and Malone is one of the few that has come to some concrete insights in this matter and developed a usable framework.

1. **Challenge**

    A. *Goal*. Is there a clear goal in the activity? Does it provide performance feedback about how close the user is to achieving the goal?

    B. *Uncertain outcome*. Is the outcome of reaching the goal uncertain?

        1. Does the activity have a *variable difficulty level*?
        2. Does the activity have *multiple level goals*? For example does it include *score keeping*?

2. **Fantasy**

    A. Does it embody *emotionally appealing* fantasies?

    B. Does it embody *metaphors* with physical or other systems that the user already understands?

3. **Curiosity**

    A. Does the activity provide an *optimal level of informational complexity*?

        1. Does it use *audio and visual effects*: (a) as decoration, (b) to enhance fantasy, and (c) as a representation system?
        2. Does it use *randomness* in a way that adds variety without making tools unreliable?
        3. Does it use *humour* appropriately?

B. Does it capitalise on the users desire to have *"well-formed" knowledge structures*? Does it introduce new information when users see that their existing knowledge is: (1) *incomplete*, (2) *inconsistent*, or (3) *unparsimonious*?

Challenge

Malone means that for an activity to be challenging, it needs to have a goal whose outcome is uncertain. He concluded in his research that games without an explicit goal were less enjoyable than games with goals. The user also needs some kind of performance feedback to know how well they are achieving the goals. In a game this feedback can be provided by, for example keeping score.

The uncertainty of the outcome of the game is also important, if a user is either certain to achieve a goal or certain not to achieve it, the activity will not become more challenging. For a game to be challenging, the outcome of achieving the goal must be uncertain. One way of making the outcome of computer game uncertain for many different players is to have a variable difficulty level. For example, the player could be able to choose a difficulty level at the start of the game or the game could monitor the player's progress and adjust the difficulty level depending how good the player is.

Multiple level goals are also a way to provide an uncertain outcome in computer games. For example, long before there is any hope of the player to shoot every object at a particular level, the player can still be challenged by hitting only one object. Another example is if the player are experienced and catches all the ghost he or she can still be challenged by trying to do it as quickly as possible.

Fantasy

Malone defines fantasy in a computer game as something that evokes mental images of physical objects or social situations that are not actually present. Fantasies have two important aspects for designing games: emotions and metaphors.

According to Malone, fantasies in computer games almost certainly derive some of their appeal from the emotional needs they help to satisfy in the people who play them. It is very difficult to know what emotional needs different people have and how these needs might be partially met by computer games. Designers of games that embody fantasies should either be very careful to pick fantasies that appeal to their target audience or they should provide several fantasies for the same game so that different people can select different fantasies. Some users might like to play in a world of wizards, dragons, and trolls, others might prefer a world of dogs, cats, and rabbits.

In addition to being emotionally appealing, fantasies that are similar to things with which the players are already familiar with can help make the games easier to learn and use.

Curiosity

The final category of features that make computer games appealing includes features that evoke the users' curiosity. According to Malone, environments can make the player curious by providing an optimal level of informational complexity. This means that the environment

should not be too complicated or too simple. They should be new and surprising, but not completely incomprehensible. An optimally complex environment is one where the player knows enough to have expectations of what will happen, but where the expectations are sometimes not true. A way computer games can contribute to this curiosity is by using audio and visual effects.

Malone also says that people try to make their knowledge structures complete, consistent, and parsimonious, and one can evoke curiosity by making people think their current knowledge is incomplete, inconsistent, or unparsimonious. Computer system designers can take advantage of this principle by; for example, introducing new features of a system only when users see a need to do something they don't know how to do.

4.2 Results

The evaluation was conducted with three children and they played the game two times each, except for the two girls that had to play one half of the game each, in their second game session due to lack of time. There were one boy (Alex – 9 years old) and two girls (Linda – 8 years old and Fredrika – 10 years old)[5] and they were all present in the car during the evaluation of the game. The children all had experience of computer (they used the Internet on a daily basis) and also had experience in playing computer games both on a stationary computer and on a mobile device (Game Boy). They were all told about the evaluation procedure, the game and what they were going to do before the game. After each game session they were asked about their views of the game, what was difficult, what was easy etc.

This chapter presents the results of the user evaluation of the Ghost Catcher game and the users behavior at the different sections of the game. These results consist of a compilation of the transcripts. Some non-essential things are left out and the transcriptions are shortened for space. The format of the transcripts is in the form of a "story". The reason for this is that it gives a bettor flow when illustrating examples, especially how the players use of the game evolved with time. The results in this chapter are the phenomena that were observed and documented during the evaluation sessions of the game. The interpretations of these observations and its impacts on the four aspects discussed in the problem statement will be discussed in chapter 6.

4.2.1 Section 1 – The Power Plant

The goal of this section is to shoot the three ghosts that live in the power plant. They will only appear in the direct vicinity of the plant. The power plant is to the surface fairly limited and its borders are clearly marked with fences. The energy bar on the PDA screen will increase for every ghost that the player manages to catch. The introduction gives the players the following information:

"Watch out! You're getting close to the power plant and this is the home of a family of electrical monsters. There are three of these creatures and they'll love to get their hands on all the energy they can find. But if you watch you're back and catch them, you'll get a lot more energy for yourself."

[5] This is not the children's real names.

Alex (1st game session)

The sessions starts with an extra explanation of the game, how the PDA should be used etc. After the explanation, the player looks a bit confused; he immediately raises *[This is his first time playing the game, he has quickly learned to use the PDA and scan the surroundings]* the PDA in front of his face and scans the surroundings for ghost and says:

- Alex: "Are there any ghosts here?"

The intro starts and the player gets ready, the PDA is still raised in front of him, he listens and watches the intro carefully. While the intro is playing he occasionally lifts his eyes from the screen and looks out the car window *[The power plant is mentioned in the introduction and he is probably looking for it]*.

- Alex: "Where is the power plant?"
- Alex: "Is that it?"
- Alex: "Wait, there it is!"

He locates the power plant and aims the PDA in the direction of the plant *[As mentioned above, he quickly adapts the usage of the PDA]*.

- Alex (to the driver): "Please, drive the other way around" *[He does not appear to be very happy with the thought of shooting from any other side than the right one]*

Alex points the PDA towards the power plant and he follows the movement of the car. He aims at the same point in the power plant at all time, he does not scan the surroundings of the plant. He is very concentrated on the PDA screen and he raises his eyes from the screen, towards the environment outside, only occasionally. After a while he sees a ghost appearing on the screen and tries to aim the PDA at it. He turns as far as he can to the right, but the ghost gets away. He fires a couple of shots. No more ghosts appear at this section of the game due to technical difficulties *[Probably a magnetic field caused by the power plant]*.

Linda (1st game session)

Linda holds the game in her lap and watches the introduction *[She is very concentrated on it and seems interested]*. Linda appears to become confused during the introduction and says:

- Linda: "How? Where should I shoot? Does the thing show where the ghosts will appear?" *[Insecure of what she should do]*

The sound of the radar starts, Linda is still holding the game in her lap and watches it. She raises the PDA towards the window after a while and starts shooting when a ghost appears on the screen. She eventually lowers the PDA and keeps it in her lap. She does not scan the surroundings with the PDA and she keeps the game in her lap all the time. She keeps the firing button pressed down. Linda doesn't look out the window; she keeps her eyes fixed on the game *[She does not seem to be very concerned with the outside world]*.

- Alex: ”You can hit them if you hold up the thing against the window and move it!” *[He has played before and tries to help her by sharing his understanding of how to play the game]*

Linda holds the PDA towards the window and looks rather confused. A technical error occurs *[Due to the magnetic field generated by the power plant]*. This section of the course ends and the car continue to the next stage. At this stage the player gets an explanation of how to use the PDA *[By one of the researchers]*. A discussion starts between the other children in the car about how to use and play the game and it appears that Linda listens to it.

Fredrika (1st game session)

Fredrika plays around with game before the introduction has started *[Appears that she tries to get a feel of the weight etc.]*. The introduction starts and she immediately raises the game towards the car window. She watches the intro and keeps the PDA up against the window. When the sound of the radar starts, she starts to turn and tilt the game *[Appears to be scanning for ghosts]*. She doesn’t aim the PDA against the location of the power plant; she just aims it through the window closest to her. One of the other children in the car instructs here where and how to shoot *[She looks confused]*.

- Fredrika: ”But, there are no ghosts here!”
- Alex: ”Never mind that, just shoot!”

Fredrika starts firing, has her eyes fixed on the screen and she does not scan the surroundings with the PDA. She fires multiple shots *[She does not keep the button pressed down]*.

- Fredrika: ”Can I put this down now?” *[Appears that her arm is tired from the weight of the PDA]*

She continues to fire at the ghosts but she does not hit anyone of them. The car is leaving the power plant and the first part of the game. Her score for the power plant appears on the screen.

- Fredrika: ”You caught 0 of 3 ghosts” *[Somewhat disappointed]*
- Fredrika: ”Go away. Why does it have to be here and make fun of me?” *[About the score]*
- Fredrika: ”No, I am going to get game over, didn’t I tell you so!”

Holds the game against the car window and moves it about. *[Seems like she wants to shake off the score from the PDA]*

- Fredrika: ”Is the score sign supposed to be here?”
- Fredrika: ”It is mocking me!”

The other kids in the car start to pick on Fredrika because she did not capture any ghosts. She plays around with the plastic cover for the PDA and looks a bit gloomy.

Alex (2nd game session)

Alex raises the PDA towards the window and looks outside. He focuses on the screen when the introduction starts. He glances outside a couple of times during the introduction *[He has learned that the power plant is coming up and searches for it]*. Spends some time targeting and shooting pedestrians *[He probably tries to kill some time until we reach the power plant]*. When the radar sound starts he is really concentrated and is very active when scanning the environment for ghosts. He fires continuously and does not seem to wait for the ghost to appear in the sights before shooting. Has his eyes fixed on the screen when he is firing.

- Alex: ”Alright, my energy bar is full!”*[Feedback is important to him, measure of how good he is, the girls hasn’t mentioned or noticed the energy bar]*
- Fredrika: ”Can you turn of the sound?” *[Seems annoyed by Alex’s constant shooting]*

Alex holds the PDA towards the window and looks outside.

- Alex: ”Where is the power plant?” *[Has lost sight of it because he stares at the screen when he is firing, tries to locate it again]*

He is still firing and scans the environment with the PDA. He turns the PDA in all directions and does not appear to concentrate on the screen *[Does not know what he is firing at]*. After a while he looks more closely at the screen and notices that he has not gotten a score.

- Alex: ”What, I didn’t get a score this time!” *[Due to a bug]*
- Fredrika: ”Nope, because you missed them all” *[Sarcastic]*
- Alex: ”I caught them all. I hit them all. My energy bar is full!”
- Alex: ”I’m the first one that got full energy at the power plant!”
- Fredrika: ”But, that’s because it’s the second time you’ve played!”

Linda and Fredrika (2nd game session)

Fredrika raises the PDA towards the window when she hears the introduction. When the radar starts she fires to her right hands side even when the power plant has not appeared yet *[She knows what do to, has played it once before and watched the other children play]*. Does not seem to notice the power plant, because she has her eyes fixed on the screen at all time. She focuses on the screen and moves the PDA both in depth and in height. Does not shoot as much as the earlier players and she tilts the game in different direction *[Appears to be more systematic, should be more successful than the others]*. She looks insecure and does not see any ghosts *[She is probably uncertain if the section has ended]*. She looks at the screen and occasionally raises her eyes and looks outside. She does not fire at anything *[Doesn’t fire if she doesn’t see any ghosts]*.

- Fredrika: ”Isn’t it supposed to stop now?” *[About the radar]*

Puts the PDA in her lap and does not look very entertained.

- Fredrika: ”It didn’t say that I hit 0 of 3 ghosts, it didn’t say anything!” *[Technical error, it means that she hit them all]*.
- Linda: ”The same thing happened when I played”
- Alex: ”Me to”

- Linda: ”Maybe it means that you hit all of the ghosts?”

She plays with the casing to the PDA and feels it.

- Fredrika: ”What am I supposed to do know?”
- Fredrika: ”Oh right, that thing!”
- Fredrika: ”Where did you get this thing, it’s funny?” *[About the casing]*

4.2.2 Section 2 – The Gas Container (Kalle Kulas laboratory)

The goal of this section is to shoot ghosts that appear both directly at the gas container and in the vicinity of it. They can appear on both sides of the road. The gas container is quite easy to locate, it has a very unusual shape (it looks like a big white egg) and has a “futuristic” feel to it. The gas container is partly obscured by a building and a fence when approaching it. The introduction gives the player the following information:

”You are getting close to Kalle Kulas laboratory. But, Kalle has left; he has wandered off along the road. You have to keep searching for Kalle Kula but beware; the area has been invaded by curious creatures and monster that also wants to get their hands on the key.”

Alex (1st game session)

The introduction starts. Alex leans forward and looks at the screen. When the introduction tells him that he is close to the laboratory he looks up and start to search for it with his eyes out of the window at the right side of the car *[Looks through the right side by chance, this is his first time playing this section he should not know on which side the gas container will appear]*.

- Alex: ”Where is Kalle Kulas laboratory then?”*[Doesn’t think of it as a gas container, the illusion has really worked]*
- Alex: ”Oh, there it is!”

The radar sound starts; Alex raises the game towards the laboratory

- Alex: ”Ok, now I have to aim towards the laboratory” *[Is very confident of what he is supposed to do]*

He moves the PDA around very little and cautious to look for ghosts. He stills aims it directly towards the gas container, does not scan any other directions for ghosts *[The introduction clearly states that the ghosts also can appear in the vicinity of the container not only directly on it]*. He does not find any ghosts and he holds his fire. Occasionally he looks out to confirm that he is still pointing the PDA towards the laboratory when the car is turning. The view of the laboratory is obscured by another house in the turn. When the laboratory appears again, he immediately concentrates to search for ghosts.

- Alex: ”Shouldn’t a ghost appear soon?”

Has his eyes fixed on the screen and shoots at a ghost that suddenly appears, does not move the PDA. Has some problem, to hit the ghost so he starts to move the PDA to get the ghost in

his sights *[One of the first time when he really tries to get it ins his sights before shooting]*. A technical error occurs, Alex waits for the error to be fixed. When the car starts to reach the environment for the third game section he looks out and reacts:

- Alex: ”Stop, this were where we saw ghosts!”
- Alex: ”I think”
- Alex: “Yes, it was!” *[Recognition]*

He holds up the PDA in front of him and waits for the next section.

Linda (1st game session)

She immediately focuses on the PDA when she hears the introduction and she seems interested. She stares at the PDA and does not look up. The radar sound starts.

- Alex: ”Look! That’s Kalle Kulas laboratory!”

He points and raises the game towards the window for Linda. She looks both at the screen and outside the window.

- Alex: ”Aim towards the laboratory. There it is!” *[Points towards the laboratory]*

Linda aims but does not fire. She begins to scan the surroundings for ghosts and aim the PDA in other directions. She locates a ghost and starts to fire. At first she shoots very few shots. She has no luck in hitting the ghost so she resorts to firing all the time, she keep the fire button pressed down *[Change of tactic]*. A technical error occurs and the section comes to an end. She looks out the window and keeps the PDA in her lap.

Fredrika (1st game session)

The introduction starts. She lifts the PDA and aims it outside, through the right window. She looks both at the screen and through the window *[Has learned that things occur outside the context of the screen on the PDA]*. She starts to shoot at a ghost that appears on the screen. She has her eyes fixed on the screen but points the PDA towards the laboratory *[She sees the laboratory in the background]*.

- Alex: ”Towards Kalle Kulas laboratory. Destroy!”

Fires all the time, turns the PDA both clockwise and counterclockwise, does not move it in height or in different direction *[Experiments with different movement patterns]*. Has her eyes on the screen and eventually manages to hit the ghosts.

- Alex: ”Your energy bar is full!” *[Very important to him]*
- Fredrika: ”Yes! It says 3 of 3! What!” *[Disappointed when she does not get at sign that says how many she has shot]*
- Alex: ”The energy bar has disappeared. That sucks! There is no sign that can congratulate you.”
- Fredrika: ”Who’s the best!”
- Alex: ”When the energy bar is full, it disappears.”

- Fredrika: ”That’s good, then you’ll know that you’re the best!”

Puts the game in her lap when the radar sound has stopped, does not give the game much attention *[Has learned that when the sound stops there will be no more ghosts]*. Looks occasionally at the screen when she waits for the next section.

Alex (2nd game session)

The introduction starts and he focuses on the screen. He and the girls smile when they see the introduction *[Seems to enjoy it]*. When the radar starts he immediately raises the PDA towards the window and starts shooting. He moves the game around and keeps the fire button pressed down. Occasionally, he does not even watch the screen *[Almost like he is searching for ghosts in the real world*]. When he aims the PDA he only aims towards the laboratory, he newer aims it at other directions *[Doesn’t concentrates as much on the screen like before]*. When the sound from the radar stops he stops concentrating on the game and puts it in his lap. He aims the PDA towards Fredrika and shoots.

- Alex: ”I’m scanning you!”
- Alex: ”To the old oak tree!”

He leans his head to the seat, looks at the car roof and sighs deeply. *[Like he is waiting for some action]*.

Linda/Fredrika (2nd game session)

When the introduction start she keeps it in her lap and watches it for a while. After a while more she raises the PDA and watches it while occasionally glancing at the outside. She moves the PDA around more than earlier game sessions *[She has developed her own style of playing]*. She focuses mainly on the screen but looks outside a couple of times to locate the laboratory. A technical error occurs and this part of the game has to be aborted.

4.2.3 Section 3 – The Old Oak Tree

The goal of this section is to pick up the map that Kalle Kula has dropped; the map is located behind the tree. The oak tree is a very common object; it’s situated in an environment with many other trees. The tree has a number of distinct features though; it’s very large and old so it does stick out. The introduction gives the players the following information:

”You are getting close to the old oak tree, here you’ll find some evidence that Kalle Kula has left behind. He has accidentally dropped some important blue prints behind the old oak tree. You have to pick them up and get them back to Kalle Kula so they don’t end up in the wrong hands.”

Alex (1st game session)

The introduction starts, Alex immediately turns the PDA towards the right window *[He knows what to do]*.

- Alex: ”Where is the old oak tree then?”
- Alex: ”There it is!”
- Alex: ”That will be the old oak tree!” *[The tree that he has decided on is the wrong tree. There are a huge number of trees in this area]*.

He aims towards the tree but the tree ends up behind him because the car turns. He follows the cars turn and tries to aim the PDA backwards. He tries to shoot but he does not succeed because the radar has not been turned on yet. He looks both on the screen and outside to get a bearing of where he is. The radar starts and he fires a couple of shots. One of the researchers shows him the real oak tree:

- Researcher: ”That’s the old oak tree”
- Alex: ”Where? Ok, is that the one?”

He turns back and aims the PDA towards the tree at his right hand side and fires. He follows with the PDA in the cars motion. He glances outside to verify his aim. He has to turn fast when the tree is passed and realizes that he has already scored a hit. He turns the PDA and holds it in front of his face.

- Alex: ”I got it!”
- Alex: ”I got the paper, I hit it!”
- Alex: ”It’s hard to know which oak is the right one”
- Alex: ”There are so many trees” *[He obviously has a problem with identifying the correct tree]*

He looks outside and he looks at the screen, it appears that he is waiting for something to happen *[He has not noticed that the section is over]*.

- Alex: ”Soon we will come to that house…” *[He knows what is coming up and is exited about that]*

Linda (1st game session)

- Alex: ”Where are we heading now? Oh right, we are heading for the easiest place. The old oak tree”

The introduction starts and Linda concentrates on the screen. When they are told what to do by the voice in the introduction, they immediately raise their eyes and searches for something *[Most likely the old oak tree]*.

- Alex: ”Wait, I’ll point it out for you. “
- Alex: “It’s the tree over there and you’re supposed to shoot beside it.” *[Points towards the old oak tree]*

Linda is watching the PDA, hold it in her lap and shows it to Fredrika.

- Linda: ”What am I supposed to do?” *[Insecure]*
- Alex: ”That’s the one. Over there! Over there!”
- Fredrika: ”But Linda, you didn’t pick it up”

The radar sound starts, she aims towards the old oak tree and she holds the PDA low, almost in her lap. She fires a couple of shots and hits the map.

- Linda: ”What happened?” *[She looks confused, doesn't understand that she hit the map]*
- Fredrika: ”You hit it, I'll never be able to do that!” *[Concern that she won't be able to succeed in the game]*
- Linda: ”How did I hit it?”
- Alex: ”Linda, show me how much energy you got?” *[Important to Alex]*

Linda shows Alex the PDA.

- Fredrika: ”Maybe she doesn't have any energy?”
- Alex: ”Then it should be game over”

Fredrika (1st game session)

The introduction starts and she looks outside. She prepares herself and raises the game towards the window. She looks at the screen and appears to be focused on the introduction but occasionally raises her eyes to watch the outside. She scans the surroundings and moves the game from side to side when the radar sound starts. She begins to shoot at random. Alex points out the oak tree for her *[As he did for Linda when she played this section for the first time]*. She is still focused on the screen but she aims it towards the tree that has been pointed out to her. She fires and keeps firing when the car passes the oak tree. When the car has passed the tree she lowers the PDA and puts it in her lap, still firing. She misses.

- Fredrika: ”No, I missed. What was I supposed to do with that?” *[Confused]*

She sighs and looks rather confused. A technical error occurs and she misses the introduction to the next section (the cottage).

- Fredrika: ”No that sucks. I was doing so well!” *[Frustrated with technical errors]*

The error is fixed and the PDA is returned to her just as the cottage is passed. She fires a couple of times in the general direction of the cottage and misses. *[Hopes for the best]*

Alex (2nd game session)

There is a technical error with the audio. Alex has to hold the PDA against his ear to hear anything at all when the introduction is playing. He watches the screen and raises the PDA towards the car window. He locates the oak tree and aim towards it. He has some problem to see out the window due to his length. He starts to shoot and he keeps the fire button pressed down. He corrects his aim when the car is turning and combines this with moving the PDA in a clockwise and counterclockwise motion. He looks very concentrated and intense *[Seems to really be involved in the game]*. He looks both on the screen and on the outside (mostly).

- Alex: ”I MUST hit it!”
- Alex: “Yes, I got it!”

He shows the game to the other children in the car with a big smile on his face. *[Proud]*

- Fredrika: ”I’ve noticed a problem. It could be boring for the other kids if there are more than one in the car” *[Seems to say this as a reaction to how much Alex seems to enjoy the game and she wants to play more]*
- Alex: ”No, I don’t think that it would be a problem at all.”
- Linda: ”The cottage is coming up now.”

Linda/Fredrika (2nd game session)

The introduction starts, she holds the PDA in her lap and searches for the old oak tree. She does not appear to find it. She keeps watching the intro and eventually locates the oak tree. The radar starts and she aims the PDA towards it but she does not fire. She corrects her aim when the car is turning and fires two shots. She has to turn hard when the tree is passed and she scores a hit with her third shot *[She does not use the constant firing technique]*. She puts the PDA in her lap and waits for the next section. She occasionally looks outside.

4.2.4 Section 4 – The Old Cottage

The goal of this section is to shoot a single ghost that appears in the direct vicinity of the cottage. The cottage appears by the side of the road, about 10 to 15 meters from it. The cottage can be seen from a distance when traveling on the road leading up to it. The introduction gives the players the following information:

”There is a old red cottage further down this road and it is the home of the unholy swamp lady. She guards her swamp day and night and she does not like that anyone passes her land. She is fast and cunning, but you should be able to catch her if you aim towards her cottage.”

Alex (1st game session)

The introduction starts. He raises the PDA and aims it in front of him and watches the introduction. He occasionally raises his eyes and searches for the cottage. The radar starts and Alex aims the PDA towards the cottage that is in front of him and to the left. He begins to fire *[Keeps the button pressed down]* and occasionally looks towards to the cottage *[To correct his aim]*. He does not succeed in hitting the ghost.

- Alex: ”I didn’t get it?” *[Disappointed, could be a lack of feedback, he does not know if he has succeeded or not]*
- Alex: ”Did I kill it?”

Linda (1st game session)

The intro starts and she raises the PDA and listens carefully. The introduction is interrupted due to a technical error. Suddenly the radar starts.

- Alex: ”There it is!”

Linda raises the PDA. Look over it and then looks at the screen. She keeps it still in the same direction.

- Alex: ”Fire!”
- Linda: “But, There are no ghosts!”

She fires once and succeeds in hitting the ghost.

- Alex: ”Did she hit it?”
- Linda: ”Hit!”
- Alex: ”I told you to shoot”

She smiles *[Seems happy]*, but look confused *[Probably not sure how she did it]*.

Fredrika (1st game session)

This moment had to be aborted due to a technical error.

Alex (2nd game session)

The audio bug appears and Alex has to put the PDA next to his ear to hear anything. He searches for the cottage through the car window and raises the PDA and aims it towards the cottage. He fires.

- Alex: ”Wow, did I hit already!”

He smiles and looks outside. He turns to the girls.

- Alex: ”That was a great shot! I just fired at the cottage and I scored a hit! Am I not the greatest?”

Looks rather confused *[He did not seem to know how he was able to catch the ghost]*.

Linda/Fredrika (2nd game session)

The introduction starts, she raises the PDA in front of her face and watches it. She starts looking out, searching for the cottage after a while. Just before the introduction ends she concentrates and prepares herself. She fires once, she look towards the cottage to adjust her aim and hits it with the next shot *[She appears methodical]*. She lowers the PDA and puts it in her lap.

- Fredrika: ”Linda hit it, before the cottage”
- Alex: ”She hit it a bit later, a bit earlier than me.”
- Linda: ”I just felt, have I hit it already”
- Alex: ”I think I hit it a bit earlier”
- Linda: ”I think we hit it at the same time”
- Alex: ”I really don’t think that you won!” *[He seems jealous]*

4.2.5 Section 5 – The Allotment (The Hattenfnatt village)

The goal of this section is to shoot the ghosts that appear in the allotment. There is a number of ghosts and they will appear anywhere in the area. This means that they can be seen on either side of the car. The introduction gives the players the following information:

”Look out! You’re getting close to the Hattenfnatt village. They are small and numerous and they live in small house. They will attack in groups and from every direction so you will have to watch your back, they can appear anywhere.”

Alex (1st game session)

The introduction starts and Alex watches it, looks interested. The introduction ends and he looks up and around him.

- Alex: ”Something happened now, we should be at the Hattenfnatt village”
- Alex: ”Oh right, there it is!”

He sees the village on his right hand side and the radar sound starts. He raises the PDA, aims it towards the village and fires *[Not firing rapidly]*. He is concentrated on the screen but glances at the outside occasionally *[Has a set point in the village that he is aiming towards]*. He keeps the PDA still; he does not move it to search for ghosts. The car enters the village and he turns to the right and aims the PDA.

- Alex: ”They are getting closer, die, die, die!”
- Alex: ”I have it in my sights”
- Alex: ”Ha, I killed it”

He looks outside and it almost appears like he is watching for ghosts in the real world.
One of the researchers points out to him that the ghosts can appear on all sides; Alex turns around and aims the PDA through the left window of the car. He fires a couple of shots at random *[There is no ghost on the screen]*. He does not encounter any ghosts on the left side so he turns back to right side of the car and searches for ghosts.

- Alex: ”No ghosts!”

The radar sound stops and Alex says:

- Alex: ”I caught 3 of 3. Yes, yes!”
- Alex: ”Yes, I did it!”

Linda (1st game session)

When the introduction starts, she immediately looks out the window and searches for the village.

- Linda: ”Is it the small houses over there?” *[Not the first time she asks for help, seems insecure]*
- Fredrika: ”Yes”

Raises the PDA and aims towards the village through the left car window. She begins to fire and keeps the fire button pressed down, hits a couple of ghosts and keeps her eyes fixed on the screen. She does not move the PDA; she keeps it fixed towards the window. She does not appear to aim at any particular ghost *[Fires and hope for the best]*. She keeps firing and turns to the right window when the car is passing through the allotment. She still keeps the fire button pressed down. She stops firing before the radar sound has stopped and puts the PDA in her lap *[Not consistent with her earlier behavior, earlier she stopped playing when the sound stopped]*.

Fredrika (1st game session)

- Fredrika: ”Now we are arriving at the Hattenfnatt village”

She aims the PDA through the right window.

- Fredrika: ”What am I supposed to do here then?”
- Fredrika: ”Ha! Aiming to the right. On the left side I can see the village. ”
- Alex: ”No, you have to hold it in this way” *[Pushes her arm]*

She looks rather confused, aims to the left. The car turn, she has eyes fixed on the screen and fires sparsely. She turns the PDA in a clockwise/counterclockwise motion. One of the researchers reminds her that the ghosts can appear on the other side as well. She quickly turns to the other side but does not find any ghosts.

- Fredrika: ”There’s no one here!”

She changes side and starts firing, she succeeds in hitting several ghosts.

- Fredrika: ”Yippee, I made it and I didn’t get game over!” *[Relief]*

Alex (2nd game session)

He starts searching for the village as soon as the introduction starts. He watches the introduction and at the same time searches the environment outside the car *[Seems to enjoy the intro, has seen it several times and probably knows what do to by now]*. The radar sound starts and he starts firing through the left window. He does not move the PDA much; he only moves it in height. He keeps the fire button pressed down and occasionally takes his eyes from the screen.

- Alex: ”Show yourself ghosts!”
- Alex: ”I’m going to kill you!”

He moves the PDA when the car turns and drives through the allotment; he is firing through the window to the right.

- Alex: ”What, the sound stopped?”
- Researcher: ”Maybe you’re out of ammo”
- Fredrika: ”Can you run out of ammo?”

- Researcher: ”No, I think there’s a technical error”
- Alex: ”That was the last ghost, my energy bar is full!” [*The energy bar is a very important measure of success for him*]

Linda/Fredrika (2nd game session)

The introduction starts, she keeps the PDA in her lap. She starts to watch the introduction and almost immediately begins to look for the village. She raises the PDA in front of her and occasionally looks outside in both directions and on the screen

- Alex: ”I think that it’s really hard to hit anyone in the village”

The radar sound starts, she holds the PDA towards the left window *[The village is on the left side when driving]*. She begins to fire and moves the PDA back and forth in smooth and calm motions *[More systematic than Alex]*. She fires all the time but she does not keep the fire button pressed down. She manages to hit several ghosts.

- Linda: ”My energy bar is full!”
- Alex: ”Is it?” *[There is a hint of jealousy in the tone of his voice]*

She suddenly starts to keep the button pressed down and fires constantly, the car enters the village and she aims the PDA to both sides of the car. She does not seem to pay much attention to the screen *[This can also be seen in her earlier game sessions]*. She begins to move the PDA

- Alex: ”Are your energy bar full now?”
- Fredrika: ”It became more fun when you know how to do it.”

She puts the PDA in her lap when the radar sounds stop.

5 Conclusions

In general, the evaluation of Ghost Catcher worked very well. The players were able to perform all tasks with exception of the technical errors that occurred at some locations. The players were all very excited with playing the game and provided a rich material to be examined.

The tables presented in section 7.2 are a summary and interpretations of the different sections and what happened in regards to the four aspects. The results proved to be very rich in the detail and gave several insights into the four aspects (relationship towards objects, progress, handling and cooperation). The user relationship with objects proved to be very important, there is a difference between objects with its own set of distinct characteristics. The progress and how the children were given feedback and score were also a big issue for the children. They compared their scores all the time and tried to become better than the previous player. The handling of the game resulted in some insights of how the player used the game; they all developed their own ways of using and interacting with it. The cooperation was very important for the children, they seemed to enjoy helping each other and compare their success between them.

This chapter consists of four parts. The first part is a discussion of the results from the evaluation. It contains a description how the result is interpreted with consideration to the four aspects described in the problem statement. The second part contains a list of what to keep in mind when developing a mobile game, this list is derived from lessons learned during the evaluation of Ghost Catcher and when analyzing and compiling the results of this evaluation. The third and fourth part consists of directions for future work and acknowledgements.

5.1 Discussion of Results

5.1.1 Relationship towards objects

This is a discussion of how the players related to the different objects that they interacted with during the course of the game and how the objects different characteristics (interaction, proximity, duration, preparation and uniqueness) affected the player. The objects can be divided into two categories: physical objects (objects located in the real world) and virtual objects (objects located in the game itself).

Interaction

The interaction is the question of what the player will interact with and how and where it will appear. The sections all differed in this question, the power plant, the old oak tree and the cottage all had a predetermined number of ghosts and the players were informed of this during the introduction to each section. The gas container and the allotment however had, to the player, an unknown number of ghosts. The ghosts in the power plant appeared in the direct proximity of it, the ghosts at the gas container appeared both in the direct proximity and in the general vicinity of it and in several directions. The map and the ghosts in the following three sections all appeared in the proximity of the object and the ghosts in the allotment could appear on both sides as well.

The object that worked best interaction wise was the cottage:

- *Researcher: "At what place did it work best?"*
- *Alex: "It was easiest and funniest at the cottage"*
- *Researcher: "When there were only one ghost[6]"*
- *Alex: "Yes"*

The reason for this is probably that the player only had to catch one ghost and that it appeared in the direct proximity of the cottage, as shown by Alex's comments above. The empirical material also supports this claim. The cottage is also quite easy to spot in the surroundings. When the ghosts appeared in other directions than the direction the players were facing there were some problems. At the gas container and at the allotment the ghosts could appear at other directions, the players were informed of this in the introductions but missed this information (probably due to being distracted by the animations in the introduction). They had to be reminded several times that they should scan for ghost at the left side as well, for example during Alex's second session. The excerpt from Alex above also shows that the number of ghosts was important. At the power plant, the gas container and the allotment there was more than one and this proved to be confusing for the players because they did not know when to stop scanning. The players seemed to prefer when there was only one ghost.

Proximity

This is the issue of how close the object (the power plant, the oak tree etc.), that the player interacts with, is to the player when he or she is traveling in the car. The power plant and the oak tree is very close to the road, the range is about 3-5 meters. The gas container and the cottage are situated further away, at a distance of approximately 15-20 meters. The allotment on the other hand is in the direct proximity of the player; the car travels straight through it. During the evaluation it became evident that the players had some problems with the sections that were located fairly close to the road and where the object were quite small, for example the old oak tree. The size, the proximity of the oak and the speed with which the car passed it became a problem because the children had problems with locating and seeing the oak on several occasions and when they eventually saw the oak they had less time to aim and fire at it (for example Alex's and Linda's first games sessions). The power plant is also located close to the road but the problems that were evident in the oak tree section were not present there. This is probably because its greater size and that more time is spent there. With the sections were objects were located farther from the road there were no problems like the ones at the oak tree, they probably were located at a comfortable distance from the player, not to close and not to far away.

Duration

This is the issue of how long the game section will take and it is naturally very dependent on the speed of the car and how close the object is to the car. The oak tree and the cottage is passed fairly quickly, approximately 20-30 seconds. The other three is passed in about 30-60

[6] The children seemed shy and insecure in the testing environment and sometimes there was need to help them a little bit to get a concrete answer. This is the reason some of the question could be perceived as leading. The conclusions made in this thesis are also based on the gathered video material, which is unbiased. In other words, the conclusions are not only supported by the interviews.

seconds. The oak tree and the cottage are the sections where the players spend the least time. They are small; close to the road and the car usually drives pass them in about 30 km/h:

- *Researcher: "Is it difficult to keep up when you're passing the oak tree, it's a small tree and you pass it quite quickly?"*
- *Linda: "I didn't know when to shoot"*
- *Alex: "You don't know where the paper is"*
- *Researcher: "Can't you imagine where it is because the introduction shows you where it is?"*
- *Linda: "In the introduction it looks like it is besides the oak"*
- *Researcher: "But, you managed to pick up the paper"*
- *Alex: "Yes, but that's because I fired a lot around the tree!"*

The players had problems, especially at the oak tree, with keeping up. The combination of the small size of the object, the speed of the car and that the oak tree was difficult to locate proved to be problematic (see Alex's first session). The other section where the player spent more time (e.g. the power plant, the gas container and the allotment) had other problems with the duration:

- *Fredrika: "Isn't it supposed to stop now?"*

This comments by Fredrika shows that she thinks that the section takes to long, she seems to want to move on to the next. This can depend on that she did not hit any ghosts during the section and really wants to move on to next so she can try again.

Preparation

This is the issue of how long the player has to prepare for each section. This is dependent on how far in advance the player can locate the object, if the object is obscured etc. The power plant and the allotment has a short time for preparation because the power plant start directly after the main game introduction has finished and because the allotment is very close to the cottage. The remaining three objects have a longer preparation time because they are further apart and because they can in most cases be located at a distance. The preparation time between the cottage and the allotment is quite short because they are situated close together. This did not prove to be a problem; the children seemed to have sufficient time to prepare themselves. The only section where the preparation time seemed insufficient were at the power plant, this is clearly evident during Linda's first session:

- *Linda: "How? Where should I shoot? Does the thing show where the ghosts will appear?"*

This is probably due to the fact that it is the first time she plays the game and she is insecure of what to do. This problem does not appear when the children play their 2nd session.

Uniqueness

This is the issue of how unique the object that the player interacts with is. The oak tree, the cottage and the allotment all have a common feel to them. There is nothing in particular that makes them stand out in the environment. The power plant and the gas container however has

a futuristic feel to them, the gas container for example is not a very common object in the urban landscape and has a unique feel to it. The section that had the less unique feel to it was the oak tree; a tree is a very common object. This proved to be problematic for the players at first (the following two excerpts is from Alex's first session):

- *Alex: "Where is the old oak tree then?"*
- *Alex: "There it is!"*
- *Alex: "That'll be the old oak tree!"*

He decides on the wrong tree and this results in problems when he eventually finds out which one to interact with, he does not have enough time to pick up the map and this results in him being stressed:

- *Alex: "I got it!"*
- *Alex: "I got the paper, I hit it!"*
- *Alex: "It's hard to know which oak is the right one"*
- *Alex: "There are so many trees"*

He eventually manages to pick up the map. The other children do not have this problem because Alex shows them which tree is the correct one. The power plant and the gas container on the other hand have a futuristic feel to them. The players seemed to really enjoy this and to play with these kinds of objects:

- *Researcher: "Which location was most exciting?"'*
- *Alex: "That's the one were I got full energy"*
- *Researcher: "Which one was that?"*
- *Alex: "The one with Kalle Kula, his laboratory"*

5.1.2 Progress

All the children had problems with the game at first, Ghost Catcher is played different from other games they had played before so that was expected:

- *Researcher: "What did you think, was it fun?"*
- *Linda: "I don't know"*
- *Researcher: "Maybe if you think for a while"*
- *Linda: "Ok"*
- *Linda: "It became more fun when you understood how to play and handle the game"*

The problems that the children had with the basic handling of the game and how they should use it to scan and aim at ghosts were resolved when they had played a couple of sections. Another issues that changed when the children had gotten used to the game was that of firing. During their first section they carefully tried to get their ghosts in their sight and then fire single, controlled shots at them. But, in the later section (particularly in their 2nd game session) both Alex and Linda just kept the fire button pressed down and fired continuously. They did not put much effort in really get the ghosts in the sights and then fire, instead they fired all the time and then moved the PDA in a non-consistent manner to score some hits.

Something that was very important to the children was the energy bar and the score:

- *Alex: ”Your energy bar is full!”*
- *Fredrika: ”Yes! It says 3 of 3! What!”*
- *Fredrika: ”The energy bar has disappeared. That sucks! There is no sign that can congratulate you.”*
- *Fredrika: ”Who’s the best”*
- *Alex: ”When the energy bar is full, it disappears.”*
- *Fredrika: ”That’s good, then you’ll know that you’re the best!”*

[---]

- *Alex: ”I caught 3 of 3. Yes, yes!”*
- *Alex: ”Yes, I did it!”*

These excerpts, from Fredrika’s first session at the gas container and Alex’s first session at the allotment, are only two of several examples of the importance of the energy bar. It shows that feedback in the form of score or a similar measure of success is imperative in a game. The element of competition is very important to the players and will heighten their experience of a game.

The players also gave a couple of thoughts of how to improve the game:

- *Alex: ”I think that the ghost should scream when you hit them, that would make things more exciting”*

- *Alex: ”You should have like: Level 1, Level 2 and Level 3”* (referring to different difficulty settings)

This shows that other kinds of feedback for example audio feedback is also important for the gaming experience and that there should be different levels of difficulty to suit players that are more experienced than others.

5.1.3 Handling

The players exploring of the game proved to be more difficult for some players and this was expected because this game uses a quite different method of playing. The players have problems with the handling of the game and how to exactly use it when playing during the first couple of sections, for example Linda’s first session. Theses problems were mainly resolved when they had played for a while and had gotten uses to the game. There are very few games that a player can be expected to play right away, there is always a learning curve for when playing a new game. In the case of Ghost Catcher the learning curve is a bit steeper because the different method of playing, the learning curve will be less steep if the players are informed and helped by for example an introduction or tutorial to the game.

The process of scanning, in other words the process of using the PDA to search for ghosts in the environment, is also a different way of using a game. This proved to be quite confusing for the players at first, they were not used to it at all and they just aimed it in the general direction of the object (the power plant, the gas container etc.) and kept it there, for example during Fredrika’s first session at the power plant. They did not scan in the other directions where a ghost very possibly could appear.

The aiming also proved to be difficult for the players:

- *Researcher: "When you had the ghost on your screen were they hard to hit?"*
- *Alex: "I had some trouble with getting them into my sights"*
- *Researcher: "So you could shoot them?"*
- *Alex: "Yes, but I made it a couple of times"*
- *Researcher: "Did you think that you could affect that yourself, how you got them into your sights?"*
- *Alex: "Yes, but there were some that I thought were impossible to catch"*

This problem is probably due to the fact that this also is a different way of using a game and that the compass in Ghost Catcher is very sensitive and quite "jumpy" so the players had to be very calm and cautious when moving the PDA. The problems with the compass can be resolved by chancing its sensitiveness in the program code.

The firing proved to be a quite straightforward maneuver for the players and they had no problem with it. They did however develop two different kinds of patterns when firing at the ghosts. Alex and Linda used a rapid-firing technique where they kept the button pressed down and fired continuously. They did not spend so much time with trying to get the ghosts in their sights, instead they tried to score hits with the sheer volume of shots they fired. Fredrika on the other hand used a more methodical way of catching the ghosts, she moves the PDA in a more controlled and calm manner and fires controlled bursts when she has the ghosts in her sights.

One issue that can be important with handling is the look and feel of the device used in a game. Ghost Catcher is an action game and the players use the device to catch ghosts. The device, in its current state, does not "invite" the players to shoot. It does not have the look and feel of a weapon and this could probably explain some of the problems the players had with it when playing for the first time.

They all developed different kinds of patterns when playing to overcome the problems they had with the handling of the game. It is imperative that a game supports different kinds of patterns developed by a player when using the game. If the player cannot play the game according to his specific kind of handling the experience of the game will probably suffer.

5.1.4 Cooperation

There was some cooperation between the children when they played the game. Alex, who played first, always wanted to help the girls. He points out the different objects for them:

- *Alex: "Look! That's Kalle Kulas laboratory!"*

The girls, especially Linda, seemed insecure and confused when they started playing the game so Alex, who was the most experienced player, wanted to help them. He also helped them with the handling of the game and how they should use it according to his beliefs:

- *Alex: "You can hit them if you hold up the thing against the window and move it!"*

The cooperation between the children also lead to Alex almost ordering the girls to play it according to his beliefs:

- *Fredrika: ”But, there are no ghosts here!”*
- *Alex: ”Never mind that, just shoot!”*

This shows that the more experienced player will try to help the other players with the game and the handling of it. The results of this can be that a beginner learns how to play the game more quickly, but it can also contribute to a negative game experience because the beginner do not get a chance to learn and discover thing for himself or herself.

5.1.5 Other Issues

This is a compilation of the comments made by the players during the game and what they said during the post-test discussion. This section raises some other issues than the ones listed above that appeared during the evaluation of the game and that would be of interest in mobile gaming development.

Ergonomics

The filmed material from the evaluation clearly shows that there are some ergonomically important issues to be aware of. This material shows that there are some problems with the height of the children. The children in the Ghost Catcher test sat in the backseat and therefore had a seat in front of them. A researcher with a video camera occupied this seat so this added to their problems of being able to see outside. Keeping the children height in mind could be of interest when developing games, especially games that are to be played in the backseat of car and also uses real-world objects in the game:

- *Researcher: ”Did you have trouble locating the old oak tree, the laboratory and the other things?*
- *Fredrika: ”Yes, the laboratory”*
- *Researcher: ”Because of the fence in front of it?”*
- *Fredrika: ”Yes and that I couldn’t see outside properly, behind the seat”*

Another issue is that of using a real world object that is very close to the road:

- *Researcher: ”Was it annoying to turn around all the time? Did your back hurt?”*
- *Fredrika: ”Yes, a bit”*

This comment by Fredrika reveals that there is a problem if the children have to turn swiftly to correct their aim when the car is passing the object. Another problem that may be specific for Ghost Catcher is the weight of the game. The game consists of a PDA with some gadgets attached to it so it weighs quite a bit:

- *Linda: ”This was really fun but it was a bit hard to keep the game raised in front of my face for so long.”*

Fun?

When analyzing the video material and the players' comments for expressions of enjoyment and fun the results are mainly positive. One thing that the children seemed to enjoy was the animated introduction to each section, these introductions are about 30 seconds in length and together with a narrator shows and tells the players what to do in that particular section:

- *Fredrika: "I thought that the first animated thing was funny"*
- *Researcher: "The introduction before the game began?"*
- *Fredrika: "Yes"*
- *Alex: "Yes, it was also funny to see Kalle Kula walk around and falling down the stairs"*

The introduction was distracting sometimes, the children watched it with such great interest that they missed the information and did not quite know what to do once the section started.

The players reaction to the general game play are very positive, the analysis of the material and watching the video shows that they are enjoying themselves. There are moments when they are very involved in the game and many comments about their positive experience:

- *Fredrika: "I want to play some more, it was so fun!*
- *Fredrika: "When you're finished developing this thing you've got to sell it to me really cheap!"*

The two things that affected the game experience in a negative way were the technical errors and problems with handling the game. The problems with the handling of the game were resolved when the children had played a couple of sections and had learned how to use it.

Differences between Ghost Catcher and other games

The children all had experience with other computer games both on a stationary computer and on a mobile device (Game Boy).

- *Researcher: "You play Game Boy when you're on a car trip, would you rather play this game?"*
- *Fredrika: "This games is better!"*
- *Researcher: "What if kids in other cars has this game and you can play against them, would that be a good idea? "*
- *Fredrika: "I think that would be a great idea, it would be really fun specially for those who like playing Game Boy and other computer games!"*
- *Researcher: "What's the difference between this game and a Game Boy?"*
- *Alex: "When you're playing Game Boy you have buttons to control the game, you can choose witch game to play and that it's more boring"*
- *Fredrika: "This thing is a lot more fun"*
- *Researcher: "Is it because you play with things outside the car"*
- *Fredrika: "That's the fun part, it's sort of cool!"*
- *Linda: "You don't move the Game Boy, you just sit there and press some buttons."*

This conversation shows that the children notice a couple of differences between this game and a Game Boy. The main difference according to the children seems to be that in Ghost

Catcher you are able to play with the objects outside the car and incorporate them into the game. They also seem to enjoy that in this game you use the whole device as a method of interaction and playing the game, the device is not only a passive device where you control the game with a couple of buttons.

Technical errors

Ghost Catcher is a prototype and incorporates new techniques that never been used together in a game before so this led to a number of technical errors. One section that was particularly troubled with errors was the power plant. This power plant probably generates a magnetic field that interferes with the compass and this in turn generates a technical error because if the signal is blocked the ghosts will not appear:

- *Researcher: "Which section was the least fun?"*
- *Alex: "That has to be the power plant"*
- *Researcher: "Why?"*
- *Alex "Because the game didn't work there"*

At first the children do not seem to mind the error but it gets frustrating after a while. Fredrika especially expresses frustration during the old oak tree section:

- *Fredrika: "No that sucks. I was doing so well!"*

If these technical errors occur frequently in a game the players experience and enjoyment will suffer.

Competition

The element of competition proved to be quite important to the children:

- *Alex: "What, I didn't get a score this time!"* [Due to a bug]
- *Fredrika: "Nope, because you missed them all"* [Sarcastic]
- *Alex: "I caught them all. I hit them all. My energy bar is full!"*
- *Alex: "I'm the first one that got full energy at the power plant!"*
- *Fredrika: "But, that's because it's the second time you've played!"*

They constantly compared their score, how many ghosts they caught and how they were succeeding in the game. The excerpt above is only one example of how they competed against each other in the backseat of the car. The children tried to break each other's scores and this competitive element could be used to heighten a games playability and experience.

5.2 List of my Contributions

This thesis has given insights in evaluating and developing context aware mobile games in general and mobile games incorporating new technology in particular. The following list is a number of design implications for a mobile game, that have been discovered during the evaluation of the Ghost Catcher project:

1. The physical objects that the player interacts with should:
   - Be intriguing and evoke fantasy
   - Be at a suitable distance from the player
   - Be at a suitable distance from the previous object
   - Well-defined and marked off from its surroundings

The object should be intriguing and evoke the player's fantasy so the player really wants to play with the object in question. Malone also supports this claim with his heuristics about emotionally appealing fantasies and metaphors. If the player can relate to a common everyday object in some other way by using his or hers imagination it will heighten the game experience. The distance between the object and the player is important and is of course very dependent on the size of the object, where the player is located in relation to the object etc. The object should be located at a suitable distance in order for the player to experience the whole setting of the object with the environment, the different objects that is to be interacted with etc. The player also need time to prepare between different sections of the game so it needs to be a distance between the objects. The object needs to stick out and be easily identified in its surroundings, if the player starts to interact with the wrong object it will most certainly lead to great frustration and will affect the game experience in a negative way.

2. The virtual objects that the player interacts with should:
   - Appear in a sufficient number
   - Move at a suitable speed
   - Have a suitable size

The number of virtual objects that the player interacts with (e.g. ghosts in Ghost Catcher) should appear in a number that does not overwhelm the player, there should be a chance for the player to succeed at the game section in question. Care has to be taken not to make the chance of succeeding to obvious for the player (the element of competition will be lost) and not to have a too small amount of objects so the section becomes too easy. This is of course dependent on the type of game and the skill level required. The size and speed of the virtual object is also a matter of balance between the skill of the player, the type of game and how difficult the game is going to be (keep in mind that both a game that is too easy and a game that is too hard can be frustrating in its own separate ways). This could be compared to Malone's heuristic about uncertain outcome.

3. The game should support interaction between players:
   - In the same car
   - In other cars, if possible

Joint discovery can be important and can be an enjoyable element in playing games. People will almost always try to solve problems and discover how to play the game together if they are able to. If there is more than one player in the car it will almost certainly lead to a more competitive (in a positive sense) game session when they try to break each other's scores and records. If technically possible, interaction between players in other cars will lead to a more fun and compelling game because comparing scores, chatting with other players, swapping levels and game characters etc. will expand the game world, social interaction and the playability of the game. Because this thesis has shown that interaction with other players in

the direct vicinity is promising and can contribute to a more fun game, it could be of interest to expand a game to include players in other cars.

4. The device that the player use to play the game should:
   - Be ergonomically correct
   - Provide the user with the affordance for its proper use
   - Support different patterns for moving, exploring and firing

The issue of ergonomics is of importance when developing a game and the device that it is played on, especially for smaller children, because they can have problems with a device that is too big, heavy and bulky. There is also important to keep the height of the children in mind, some shorter children can have problems with seeing outside the car when they are sitting in the backseat. The affordance of the device should be clear, the device should provide the user with clues of its proper use and function. For example, the Ghost Catcher PDA where to be used as a gun/radar (the device do not look like a gun) and this was not that obvious for the children at first and it resulted in some confusion when they played. Players will develop different styles and patterns when they have become comfortable with using the game. For example, some players will fire continuously while other will fire controlled bursts. These personal styles of playing the game can be very difficult to predict when developing the game and the game should therefore support this.

5. The game should provide the user with:
   - Introduction
   - Feedback

Introduction to the game and different in-game sections is a very effective way to give the player instruction of how to play the game and to entertain the player between game sections. These instructions are particularly important when the game concept is very new and different. Feedback should consist of audio, visual and some form of score or other measure of success. Malone has also proved that feedback is an important feature in a game. The audio and visual feedback gives the player confirmation of his progress in the game, if he fires at a moving object (for example a ghost) and manages to hit it, the game should provide the player with the appropriate feedback and confirm to the player that he scored a hit.

5.3 Direction for Future Work

The evaluated version of Ghost Catcher is a prototype and naturally there were a number of technical errors that on some occasions affected the experience in a negative way. There would be interesting to evaluate a complete version of the game, with more children playing with more objects and on a bigger stretch of road. This version only supported single player mode, there would be of great interest to evaluate a version that supported multiple players. In a multiplayer version the issue of cooperation and interaction between different players and in the different cars is very important, this would be interesting and of great interest to examine.

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7 Appendix

7.1 Compilation of Segment Characteristics

- Interaction: What will the player interact with and how and where will it appear.
- Proximity: How close is the object to the player.
- Duration: How long will the game section take. Very dependent on the speed of the car.
- Preparation: How much time does the player has to prepare for the section. Will the player see the object from a distance and therefore have more time to prepare.
- Uniqueness: How unique is the object that the player is supposed to interact with.

	Power Plant	Gas Container	Oak Tree	Cottage	Allotment
Interaction	Predetermined number of ghosts (three) will appear within the metal fence (a clearly defined area) surrounding the power plant	A to the player unknown number of ghosts will appear in the direct proximity of the container and in the vicinity of it	One item has to be picked up by the player, and it appears in the proximity of the tree	One ghost has to be caught and it will appear in the direct proximity of the cottage	A number of ghosts will appear on both sides of the car. They will appear anywhere within the allotment, which has a well defined boundary
Proximity	The route is situated beside the fence at a distance of approximately 3-4 meters	The container is situated approximately 20 meters from the road	The tree is situated in the direct proximity of the road at a distance of 2 meter.	The cottage is situated approximately 15 meters from the road	Direct, the road goes right through the area
Duration	Longer than the following sections, the route follows the plant on two sides. Approx. 50-60 sec.	The car passes the container at about 30 km/h so the container can be seen for quite a while when passing it. Approx. 30-40 sec.	Short (approx. 20-30 sec.), the car passes the tree quickly.	Short, the car passes the cottage quickly. Approx. 10-20 sec.	Long, approx. 40-50 sec.
Preparation	Short, starts directly after the main game intro, the view of the power plant is blocked by other structures until the plant is reached	Long, the pause between this section and the previous one is the longest in the game. But, the container is partly obstructed by a fence.	Long, the tree can be seen from a distance	Long, the cottage can be observed on the players right hand side from a distance	Short, this section and the previous section are very close in distance to each other
Uniqueness	Common, but the power plant has a futuristic feel to it	The gas container looks unusual and is not a common element in the urban landscape	Common, the tree is one of many trees in the environment. But the tree has	Common, a cottage is not a unique feature in the urban landscape	Common, an allotment is not a unique feature in the urban landscape

			a unique feel because of its age and size		

7.2 Summary of Results

The Power Plant:

	Alex 1st session	Linda 1st session	Fredrika 1st session	Alex 2nd session	Linda/Fredrika 2nd session
Relationship towards objects	He is actively looking for the power plant and he locates it.	She seems quite confused at the beginning of the section and does not know where to look for ghosts.	She just aims the PDA through the car window; she does not appear to be actively focusing on the power plant.	Because this is his second session, he knows where the power plant is located and how he should relate to it.	This is the second time she plays this section so she probably knows what to do. She starts firing in the direction of the power plant before it is in her line of sight, before she has identified it.
Progress	He does not mention the energy bar. Appears that he has not noticed it.	She does not mention the energy bar. Appears that she has not noticed it.	She is the first one who mentions the score and she is not very happy with it. She did not catch any ghosts so she does not want to be reminded about that.	He mentions the energy bar and is delighted that it is full. He also mentions that he is the first one to get a full energy bar at this section.	She gets annoyed when she does not get a score sign. (Probably due to a technical error)
Handling	He explores his surroundings by looking up from the screen from time to time. He has quickly learned to use the PDA and scan for ghosts. He aims the PDA towards a specific point in the power plant until he sees a ghost. He aims at the ghost and fires a couple of controlled shots.	She keeps her eyes on the screen and she does not use the PDA to scan for ghosts. She keeps it in her lap. She starts to shoot and she keeps the firing button pressed down. She does not seem to know what she is shooting at.	She plays around with the game before the section starts and seems to try to get a feel of the weight etc. She scans for ghost in a methodical way. When she starts firing at ghosts she stops scanning for the ghosts and keeps her eyes on the screen. She fires multiple shots but does not catch any ghosts.	He is very active when scanning for ghosts and he fires continuously. He does not appear to wait for the ghost to get in his sights before shooting it. He has his eyes fixed on the screen while firing.	She has her eyes fixed on the screen and scans the surroundings actively. She aims at the ghost and fires more controlled shots. She waits until she has the ghost in her sights before she fires at them.
Cooperation	He does not interact with the	Alex tries to help her and tells he	Alex tries to help out, but it	He and Fredrika	She does not interact much with

	other players in the car.	what he thinks she should do.	only seems to confuse her.	discuss his score.	the other players in this section. She is insecure about a couple of things but she does not direct her questions to any particular person.

The Gas Container:

	Alex 1st session	Linda 1st session	Fredrika 1st session	Alex 2nd session	Linda/Fredrika 2nd session
Relationship towards objects	When the introduction mentions the container he looks up and start to search for it. When he talks about the container he refers to it as Kalle Kulas laboratory.	They have started to relate to the container as "Kalle Kulas laboratory", not just a gas container.	She has no problem finding the container. She seems to have understood that the ghost can appear both at it and around it.	He knows where the container is located. He focuses his eyes towards the container and it almost looks like he is looking for ghosts in the "real world".	
Progress	He seems to be quite confident of what do to. He has probably begun to learn the basic handling of the game and how it works.	She seems insecure of what to do. She has not understood the basic handling of the game.	Alex points out that her energy bar is full (very important to him) and she is delighted (she has expressed some concerns about not be able to complete the game).	He has learned that the ghost appears after the introduction, he start shooting directly after it. He has also learned what section is coming next.	
Handling	He is cautious when scanning for ghosts and moves the PDA very little. He aims it directly at the container. He only finds one ghost and tries to get it in his sights. He does not use his usual rapid firing technique in this section.	She focuses on the PDA when she hears the introduction, When Alex has pointed out the container she look at it and on the screen. She scans for ghost and aims the PDA in all direction. She fires single shots to begin with but later resorts to fire continuously.	She looks at both the screen and outside at the container. She fires multiple shots and turns the PDA in many different directions. She eventually manages to catch the ghosts.	He moves the game around and fires continuously, when he aims the PDA he only aims it towards the container. He does not scan for ghost in any other directions.	She has developed a more systematic way of scanning for ghosts. She moves the PDA in calm and steady motions. A technical error occurs and this section is aborted.
Cooperation	He has a couple of concerns but it seems that he is only talking to himself (he does	Alex points out the container and raises the PDA towards it for her.	She does not talk with any other players during the sessions; she is	He does not cooperate with the other players during this section	

	not direct his question to any particular person in the car).		very focused on playing.	except for when he is "scanning" Fredrika.	

The Old Oak Tree:

	Alex 1st session	Linda 1st session	Fredrika 1st session	Alex 2nd session	Linda/Fredrika 2nd session
Relationship towards objects	He has trouble with identifying which tree to aim at because there is a number of different tress in this section. Because the close proximity to the road, Alex has to turn quite swiftly to keep the tree in the sights when the car is passing	She looks for the object when the introduction mentions it. She does not have any problem with identifying it because Alex shows her.	She has some problems with identifying the correct tree. She also seems to have problem with keeping up and keep the PDA aimed towards the tree when the car is passing.	He has no trouble with identifying the tree this time and is well prepared when the car is closing in on the tree.	She too, has to adjust her aim when the car is passing the tree. This could be due to the short preparation time for this moment and that she still seems to have trouble with aiming towards the correct tree.
Progress	He is excited about being able to pick up the map.	She has probably learned witch tree to aim towards. She also seems confused about how she was able to pick up the map.	She is very disappointed about not being able to pick up the map.	He has no problem with identifying the tree this time. He has learned which tree to interact with.	She has no problems with finding the correct tree.
Handling	He immediately turns the PDA towards the window and searches for the tree. Because he starts to aim at the wrong tree, he has little time to adjust his aim to the correct tree. He fires couple of shots and manages to pick up the map.	She aims the PDA towards the tree. She keeps it in her lap and fires a couple of shots. She manages to pick up the map but seems confused, she does not know how she did it.	She looks outside and scans the surroundings in a methodical way. She begins to shoot at random until Alex points out the tree for her. She then aims towards the tree and fires but misses.	He locates the tree and aims towards it; he fires continuously and corrects his aim when the car is passing the tree.	She searches for the tree with her eyes and eventually finds it. She aims the PDA towards it and corrects her aim. She fires two shots; she turns hard to keep up with the turning of the car and scores a hit with her third shot.
Cooperation	He does not cooperate with any other players in this section. He gets some help from a researcher to find the correct tree.	Alex helps her with identifying the correct tree. The players also discuss the energy bar and how they think it works.	Alex points out the correct tree for her.	He has a big smile on his face when he manages to pick up the map; he shows the screen to the other children in the car.	She does not talk to any other players during this section.

The Cottage:

	Alex 1st session	Linda 1st session	Fredrika 1st session	Alex 2nd session	Linda/Fredrika 2nd session
Relationship towards objects	Appears that he has some problems with finding the cottage, it is partly obstructed by trees.	She has problems with locating the cottage, Alex shows her. Due to the technical problems she do not have the time to prepare herself. The car passes the cottage quite fast and this also contributes to her problems with preparing.	Aborted due to a technical error.	He has learned where the cottage is appearing and that it is passed rather fast by the car and he corrects his aiming accordingly.	She has no problems with identifying the cottage because this is her second session. The earlier problems with finding the cottage among the trees are now gone.
Progress	He is confused, he does not know if he has succeeded in catching the ghost at first. When he realizes that he failed to catch it he is disappointed.	There is probably a lack of feedback because she does not know if she has caught the ghost or not. She still has some problems with the handling of the PDA.	Aborted due to a technical error.	He succeeds in catching the ghost this time. He seems unsure of how he did it. He knows in which the direction the cottage will appear.	She does not listen to the whole introduction; she has probably learned what to do. She does not have any problems with locating the cottage. There is a discussion among the players of who have caught the ghost first.
Handling	He aims the PDA in front of him when he is watching the introduction. He eventually locates the cottage and aims towards it. He does not appear to scan for the ghost, it appears on the screen and he fires at it. He fires continuously and corrects his aim when the car is passing the cottage.	There is a technical error and the introduction I cut short. The section start suddenly and she is not prepared. She keeps the PDA still and in the same direction. She has not located the ghost and she probably fires because she is told to do so by Alex. She succeeds in catching the ghost.	Aborted due to a technical error.	He raises the PDA towards the general direction of the cottage. He searches for it and adjust his aim when he finds it. He fires and hits the ghost. He do not try to get the ghost in his sights, it appears that he fires and hopes for the best.	She aims towards the cottage and adjust her aim wile the car is moving. She is very concentrated and fires two shots. She manages to catch the ghost.
Cooperation	He does not cooperate or interact with any other persons during this section.	Alex tells her what to do on several occasions, she do not really get a chance to shape her own understanding of	Aborted due to a technical error.	He is very proud of catching g the ghost, he brags to the girls.	There is a discussion after the section has ended about who succeeded to catch the ghost first.

		the game and the sections (Linda appears quite shy and insecure).			

The Allotment:

	Alex 1st session	**Linda 1st session**	**Fredrika 1st session**	**Alex 2nd session**	**Linda/Fredrika 2nd session**
Relationship towards objects	He has no problem with locating the village; he does not search for ghost in all direction at first.	She has some problems with locating the village (she asks for help, she probably wants to make sure she is aiming towards the right place). When passing through the village she does not scan for ghosts in other directions, she only scans through the right window).	She has no problems with locating the village.	He knows by now where the village is and that the car is turning towards and the road goes right through it. He adjusts his movements and aiming accordingly.	She has no problem with scanning for ghosts in all direction when entering the village.
Progress	He is very happy about catching three ghosts of three possible.	Her firing technique is not consistent with earlier behavior. She fires controlled bursts.	She knows what is coming up. She is delighted that she made it and did not get game over.	The energy bar is an important measure of success for him and he is delighted when it is filled.	It seems that all the children thinks of the energy bar as an important measure of success.
Handling	He raises the PDA in front of his face and aims towards a set point in the village. At first he does not scan for ghosts, he keeps the PDA still. He does not concentrate on the screen; he looks outside at most time (it almost appears that he is watching for ghosts in the "real world"). He fires at the ghosts and manages to catch tree of them.	She searches for the village when the introduction starts (she has heard it before, she probably knows what to do and look for). She aims the PDA through the left car window and starts shooting at the ghosts. She does not move the PDA and scan for ghosts. She turns to the right when the car is passing through. She keeps the fire button pressed down and fires continuously.	She aims towards the right side of the car. She gets confused when Alex shows her to aim in a different direction. She scans for ghost in a more consistent manner than the other players (she seems more systematic).	He starts to search for the village when the introduction begins. He has learned that the game begins and ghosts can appear when the radar sound starts. He begins to fire at once; he keeps the fire button pressed down. He does not move or scan with the PDA.	She is more systematic than the others, she moves the PDA in calm motion when scanning for ghosts. She fires rapidly but not continuously. She manages to catch several ghosts.
Cooperation	One of the	She seems	Alex shows her	There is a	Alex shares some

	researchers reminds him that the ghost can appear in every direction of this section.	insecure and asks for help from another player.	how to hold the PDA and pushes it in the right direction. A researcher reminds her, that the ghosts can appear in other direction as well.	discussion about ammunition, if you are able to run out of it.	of his thoughts of the game. There is also a discussion about the energy bar.