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Motion and Spatiality in a Gaming Situation – Enhancing Mobile Computer Games with the Highway Experience

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Abstract: The *Backseat Gaming* prototype is a context dependent mobile game. It uses the changing scenery and sense of motion created during car travel to generate a compelling game experience. We discuss what road-side objects could be of use to create an understandable and fun mobile game, with reference to emerging game research as well as theories in highway design. We also present initial user feedback on the gaming experience.

Keywords: mobile games, entertainment applications, context awareness, augmented reality, interactive design

1 Introduction

Future mobile technology will provide more services that exploit the benefits of mobile life (Chincholle et al, 2002). Current mobile games are often portable versions of classic computer games (Kuivakari, 2001). There is also the possibility of incorporating different aspects of mobility to create immersive experiences. We suggest that a mobile game could become especially compelling, if it is aware of the vivid and dynamic mobile context. Car travel is a good example of how the changing scenes and the sense of motion provide for a special experience.

We have developed a context dependent game on a handheld computer. The purpose is to acquire early feedback about how mobile games could benefit from the travel experience. Given the new game concept we wanted both to understand the possibility of building a light-version of augmented reality technologies, as well as develop a preliminary theoretical framework for this type of game. The game device is aware of its direction and tilt by means of a digital compass, and its geographical position by means of a GPS-receiver. The player has to attend to stories provided at certain locations, and point the device toward things passing by along the road to make virtual objects appear on the screen.

A central design challenge is to understand the characteristics of the linkage between roadside objects and the game, in order to create a satisfactory user experience. It is essential that users are able to interpret the objects correctly, enjoy the exploration of the game space, and manipulate the relationship in an engaging manner. Initial user feedback shows positive reactions both towards the idea of using road objects and car travel as gaming resources as well as the idea of the roadside as a fascinating game world to explore.

The target group is children who travel in the back seats of cars. They can enjoy the journey and look out of the windows. Often they also amuse themselves by reading, talking or playing traditional context related games where the participants compete by spotting and counting specific objects along the road. Portable computer games have been available as an alternative since the 1980s. A report on mobile multimedia, by Andersen Consulting (2002), shows that mobile games are mostly played during transit, and especially in cars. Now, we can add a new gaming concept to make their situation more enjoyable.

2 Backseat Gaming

The initial game consists of a framing story and five physical game locations where local stories are told and game manipulation is pursued. The game locations are situated along a four kilometer stretch of road in the periphery of downtown Stockholm, separated by a distance of approximately 800 meters. The children have to find virtual objects at these locations, which are only visible when using the screen of a PDA as a small and virtual window.

2.1 Framing story

A story is told when the game starts to provide the player with an understanding of the goals of the game. It is about a scientist who works in a laboratory at the edge of the town. He has succeeded in inventing a special kind of energy. Unfortunately he gets locked out of his lab and finds himself in a parallel world inhabited by other life forms. The player's mission is to carry a virtual key and give it to him as soon as he is found. When the scientist is provided with the key, he can get back into the lab and get rid of the ghosts from the parallel world. The player can see the parallel world through a special device. It works both as a virtual window, that reveals objects in the parallel world, and as a collector of these objects. Many of the virtual objects are malicious creatures, which attack the player in order to grab the key. It is safe as long as the player has enough energy left in the virtual window. If their attacks on the player are successful they get hold of the key and then the lab. Then they would be able to invade our real world.

Fighting ghosts requires energy. Therefore, it is essential that the player have some success, not only at avoiding being killed, but also at sucking energy from the attacking creatures and maintain the energy level. Feedback on the energy level is presented in an energy indicator on the virtual window (fig. 2).

Figure 1: Screenshot from local story.

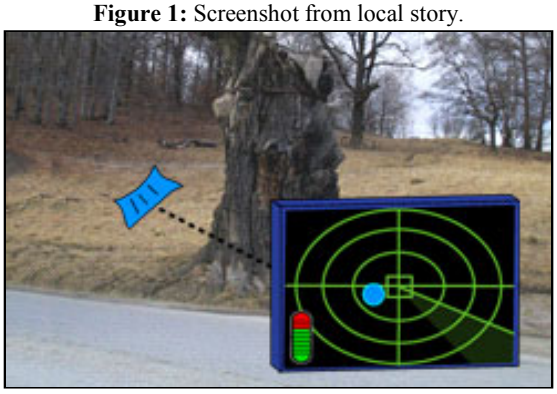

Figure 2: Description of manipulative event.

2.2 Local stories

The game is designed to make it possible to reach the different game locations in any sequence without affecting the possibility to interpret and engage in a series of manipulative activities. When the car approaches a location it will first trigger a local story (fig. 1). The story is presented by means of pictures of the particular roadside object, overlaid with animations and a narrator voice. It starts well before the roadside object arrives, in order for the story to be completed before the manipulation begins. The story provides instructions about the upcoming manipulative event, which is important since the player is only located near the game location for a very short time. The stories are also intended to make the exploration of the road environment more enjoyable, by interpreting it with reference to a fascinating local story. Figure 1 present a screenshot from a local story that is connected to an old oak tree. It shows an animation of the game character dropping a document by the tree.

2.3 Manipulative events

A manipulative event is triggered when the player comes even closer to the location. First, the device automatically changes to window-mode (fig. 2). The player can aim at objects in the physical environment, which have been described in the local story, to find virtual objects. The player must point the device in the correct direction to get the objects to appear in the virtual window. This only occurs if the device is aimed towards their virtual positions in the landscape. Then they must fine-tune the device so that the object, in the form of a big dot, moves to the centre square of the screen. Now, it is possible to attack it and suck up its energy by pressing a button on the device. In figure 2 the device is aimed almost directly towards the virtual object— in this case the document dropped by the game character. Thus the dot is positioned just outside the square.

3 Combining Highway Experience and Mobile Computer Gaming

The linking of roadside objects to a computer game is the most distinctive feature in the current prototype. In this section, we describe how the linkage is informed by recent game research as well as architectural theories on highway experience.

The game has a traditional relationship between player and computer, similar to a simple combat game (Crawford, 1997). The player manipulates the device to get an object (a big dot, fig. 2) to a specific position on the screen (a rectangle) and then fires at

it by pushing a button. However, the game is innovative in the specific ways in which it crosses the normal default separation of the virtual from the real world (Eskelinen, 2001). It becomes a first person action/adventure game only when all the elements are considered in conjunction. As in this type of game, the player enjoys the exploration of the game world as he moves within it and engages in various forms of manipulative events. But in this case, it is a real, and not fictitious, world.

The architects Kevin Lynch and Donald Appleyard have carefully described the special characteristics, which make up the highway experience (Appleyard et al, 1964). It is seen as being a sequential experience, resembling a dramatic play of space and motion. In the beginning of the 1960s, they believed that road construction could be further developed if it was informed by their detailed studies of road user experiences. Based on their findings, road design should be seen as a work of art like architecture, cinema and dance. Forty years later it is also possible to design the highway experience by means of pervasive computing. In our case, we have set out to investigate how the sensation of space and motion during road travel could be used to develop an engaging mobile computer game. The drama of highway experience could be of use. But as the game researcher Markuu Eskelinen argues, to be a game it must also provide compelling manipulative situations where the player's actions are of fundamental importance (Eskelinen, 2001). Thus, the sequential highway experience is used to provide both drama and manipulative challenges to the game.

Backseat Gaming violates the traditional separation between game and world since spatial relations in the game are caused by geographical positions in the outside world. According to Eskelinen, spatial relations are *interpreted, explored* and *manipulated* during a game play. In the following, we will discuss these aspects when selecting roadside objects.

3.1 Roadside objects: distinction, location and meaning

We are concerned with objects' size, the possibility to discern them from the background, their distance from the road, and the meanings they convey. How do these characteristics affect interpretation, exploration and manipulation?

First, objects are selected from an interpretative perspective. It should be easy to recognise and single out the object from the surroundings, when passing by in a car. The chosen objects are either single items, such as a tree or a house, or an area e.g. an allotment or a gas works. Areas are easier to distinguish than smaller items. But the choice of objects must also be considered in terms of adequacy for manipulation. The player has to know where to look when aiming. A virtual object can be more difficult to find if the player is uncertain where to look within the physical object. The player has to find exactly the right spot in the area to look to find the virtual object. We believed that it would not add to the gaming experience to search the whole area just for one virtual object. We have therefore chosen to add multiple virtual objects on large physical objects. This is hereafter referred to as a *patch event* since the virtual objects can be seen as a number of patches on a large roadside body. Examples include an allotment area inhabited by several virtual creatures or a gas works area containing virtual tools. *Wrap events* consist of a singular virtual object tied to a specific physical object, e.g. a virtual document dropped at an old oak tree, or a ghost inhabiting a cottage. They provide for different manipulative challenges when finding the virtual objects at a specific area and aiming at them.

Figure 3: A gasometer.

Figure 4: An oak tree.

Figure 5: A little cottage.

Figure 6: An allotment.

Second, the objects chosen were located close to the road, at about ten to fifty meters distance. The proximity adds to the sense of motion, which is central to the highway experience (Appleyard et al, 1964). However, the time for identification and manipulation is decreased making game manipulation harder. Further, most of the real objects chosen were placed on one side of the road, rather than on both sides. The allotment was an exception, where the player travels through the object and gets surrounded by virtual objects. According to Lynch, the latter type of object creates a specific sense of drama, which affects the road experience. Again, the

positive experience of exploration can make the gaming manipulation trickier.

Third, the objects were chosen to convey a specific meaning. It had to be easy to refer to them in a local story, and for the player to locate them by the roadside. We assumed that players would easily understood the meanings of concepts like "old oak tree", "red cottage" and "power plant." Further, the game would benefit if the objects were interesting elements even within the traditional highway experience.

There is an element of prying in looking out of car windows: "[t]he sight of activity, or a sense of the meaning and use of areas, is an important pleasure of the road." (Appleyard et al, 1964). Therefore, we chose objects like a power plant, a cottage, and a gasometer, which evoke questions concerning their everyday use. Finally, the objects have a meaning in the game stories.

We have chosen to use the everyday meanings of objects, and make the game story fit with them, in order to balance requirements regarding interpretation, exploration and manipulation. The magic of the objects is created in the way the objects' traditional meanings are used as elements in the game stories. An alternative would have been to ascribe new meanings onto specific objects (Björk et al, 2001). The cottage could be referred to as a space rocket etc. However, we have only invented new meanings for objects if the players almost certainly lack a clear understanding of what the object is, e.g. when making a gasometer into the lab of the main character.

4 Implementation

A prototype has been built to gather initial user feedback. The game is implemented on a Pocket PC equipped with a GPS receiver and a digital compass module (fig. 7). The compass provides heading, as well as roll and pitch output. Data needed to run the game is locally stored in a database. This makes it very easy to provide content into the game.

Figure 7: Hardware

Figure 8: Gaming device

4.1 Software architecture

The game engine continuously receives the players positioning data and speed from the GPS receiver. This information is sent to the mapping thread (fig. 9), which compares it with information stored in a database and decides when the game engine should trigger each event. The database contains the following data:

- Type of event, real object's latitude-longitude co-ordinates, radius of manipulative area, Rm (fig. 10)
- Latitude-longitude co-ordinates, number and type of virtual objects located at a real object.
- Information about which local story belongs to which real object and its duration in seconds.

Each story is a self-contained animation sequence.

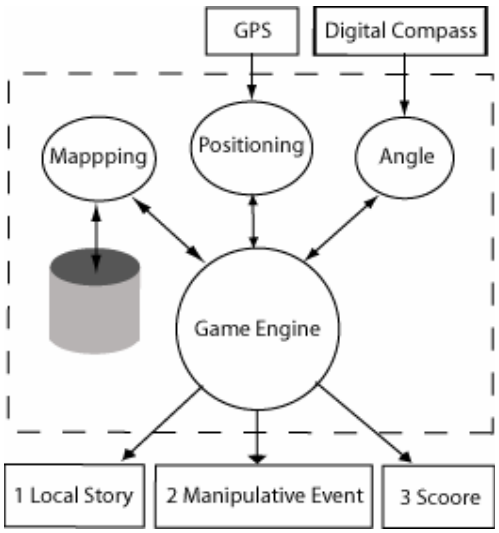

Figure 9: System architecture

The game typically proceeds through a series of three different modes when the player passes a game location (fig. 10): a local story mode (1), a manipulative event mode (2) and a score feedback mode (3).

1. A local story is activated if the player is at distance, Ds + Rm, from a real object. The distance is calculated by the mapping thread, which accounts for the speed and time needed to present the story. The local stories are created in Macromedia Flash and saved as Flash Player files.

2. A manipulative event is initiated when the player reaches the pre-set distance, Rm, from a real object. Manipulative events can be either *wrapped* or *patched*. The virtual object's co-ordinates are found in the database at a *wrap event*. The co-ordinates are randomly generated within the distance of Rm at a *patch event*.

When a manipulative event is activated the game engine starts reading the heading and tilt angles of the device from the digital compass. The desired

aiming direction towards virtual objects is achieved by continually calculating the bearing between the co-ordinates of the player and the real object. The bearing is defined as the angle measured horizontally from north to the direction of the object co-ordinate. Where on the screen the game engine should visualise the object depends on the difference between bearing angle and heading angle of the device and its tilt. The virtual object will be visible on the screen if the heading difference is less than 45° and if tilt is within ±25°. This is the field of view of the virtual window.

3. The manipulative event ends when the player is outside of the pre-set distance Rm from the game location or as soon as all the virtual objects are caught. The player is then provided with feedback on gaming status and score.

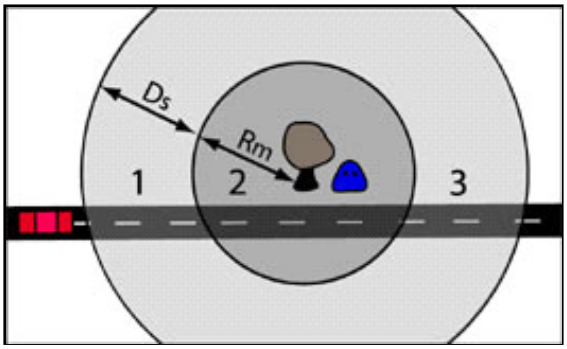

Figure 10: Events at a game-location

5 Initial User Feedback

5.1 Method and Setting

Evaluation of games must focus both on ease of use and fun of use (Wiberg, 2001). It is not appropriate to evaluate game concepts with regard to the time it takes for a specific playing task. In contrast to work oriented service, an enjoyable game should be easy to understand but difficult to master (Malone, 1981). Therefore, we must find other ways to acquire feedback on how users enjoy, understand and handle the game.

The test took place in a realistic setting. Initially all the participants received an explanation of the game. Two girls and two boys, between the ages of five and ten, each played the game twice. Their activities were video recorded. The recordings have been coded and analysed. We studied facial expressions, general appearance, movement of device and gaze, aiming, firing behaviour and spontaneous comments at each event in the game. Careful analysis of visible behaviour increases the possibility of understanding their appreciation and skills. Asking the children questions about the game experience tends to be unreliable, as they often want to please the researcher (Hanna, 1997).

5.2 Understanding the game

General understanding and manipulability

Initially, all the children hesitated before accepting roadside objects as part of the game. This was visible in how they constantly focussed their gaze on the screen. One of the boys, who was only five years old, never understood the idea of connecting the game-play with real world objects. The older three children changed their behaviour after a while. Two of the players understood the game concept rather quickly i.e. they made a connection between the game-content and the physical surrounding outside the car. It took a bit longer for the third player.

Their understanding that the game included the road setting was visible in the ways in which they looked for objects outside as soon as they were referred to in a local story. The oldest boy got the most immersed in the game. He even avoided aiming the sight towards the supposed object if any other physical object, e.g. the car seats in front of him, were in the way. This indicates that he thought of the virtual creatures as really being on the roadside. Thus the fictitious connection was successful.

The three oldest children managed to find and hit virtual objects at least a couple of times during the game. Two players were very successful during their second round and managed to hit almost every virtual object they passed. The third player was less successful but managed to score a hit once in a while. We concluded that it was possible for the older children both to understand the game concept as well as manipulate the device successfully.

Interpretation of Roadside Objects

In general, the players managed to find and interpret roadside objects correctly. But some mistakes were made, e.g. when one boy tried to interpret the meaning of “old oak”. He found it difficult to decide which of all the trees was the oldest one.

Interpretation of Virtual Objects

The possibility of locating an object is an indication of ease of interpretation. They managed to find virtual objects at *wrap events* with minimal effort, but it was harder during *patch events*. We expected them to scan both sides of the area with their virtual window when the local story declared the virtual objects to be all around. But instead they sighted in a fixed direction out of the right side window of the car and used the movement of the car to sweep through the area. Possibly they missed information

presented in the local story telling the number and location of virtual creatures. The players could more easily find the virtual objects if they were located close to a rather small and concrete roadside object, than if they were patched over a big roadside object.

Manipulation at Patch and Wrap Events

Two of the players soon developed gaming strategies that differed between *patch* and *wrap events*. There was a noticeable difference between the ways they moved the device, and how they fixed their gaze, during the two types of manipulative events. During *wrap events*, such as the old oak and the cottage, they identified the physical object and then aimed straight at it. The angle of the device was continuously adjusted to the position of the car to fine-tune the direction. Their gaze moved back and forth between the screen and the physical object to make sure that they aimed in the right direction. At *patch events*, they adopted a different strategy. They either aimed the virtual window at a fixed point inside the car, making it sweep through the large roadside object, or at a specific point outside of the car. Further, they fixed their gaze either on the device or out through the window. We suggest that this behaviour could be explained by the larger virtual space to explore in order to find the virtual object. They had to explore the roadside continuously during the whole event. The exploration of the large virtual space was cumbersome. Therefore, they focused either on the screen waiting for objects to show up or out through the window, peppering the environment, without checking whether there were any virtual objects on the screen.

Two players understood the distinction between *wrap* and *patch events* and adapted their playing strategies. We conclude that it's possible to build on different relations between real and virtual, where the real objects provide clues as to what virtual objects there could be, and where they are located.

5.3 The Enjoyment of Backseat Gaming

General Indications of Enjoyment

The players' facial expressions differed between the first and the second round. Two of the children looked concentrated and serious during the first tour but relaxed during the next round. The older boy became active and involved, which was visible in his expressive facial expressions and body movements. The other child was generally calmer in appearance during both rounds. But there was a noticeable difference as soon as she had understood the game. She said that it was hard in the beginning when she tried to hold the device like a normal portable game, but became fun as soon as she understood what to do. The second girl looked tense all the time, even though she made very positive comments afterwards.

The Fun of Individual Events

The children's level of engagement varied between different events. Their emotional experience will be discussed in relation to the manipulative events and to the local stories. First, the older boy got excited during several manipulative events, and seemed to favour the old oak tree the most. He also said that he enjoyed the two *wrap events* most. It was easy to figure out where the virtual object was at the old oak tree. At the same time, it provides a strong sense of motion (Appleyard et al, 1964), since it stands at a corner close to the road. The successful girl displayed a more relaxed attitude, as she smiled gently, during many of the manipulative events. The less successful girl looked stressed and didn't seem to enjoy the game very much. Second, the children also showed varieties of emotions in relation to the exploration of the journey as different local stories played out along the way. In general, they displayed amusement with many of the stories, including the framing story. The allotment event, which is a *patch event* where the car passes right through the gamespace, caught most of the girls' attention. This is supported by the research on the highway experience, which suggests that objects surrounding the road generate a special sense of drama (Appleyard, 1964). Here, we also received positive reactions regarding the girls´ manipulation.

To sum up: *Backseat Gaming* is an amusing and functional game. But it is complex and the players differ in the way they appreciate exploration and manipulation. Basically the fun of use differs depending on whether the players prefer exploration or manipulation. If the players focus on manipulation, they favour *wrap events*. They prefer *patch events* if they enjoy exploration most.

Summary of initial user feedback

Our user study provides accurate knowledge about individual gaming situations although the number of test situations is limited. The feedback provides an indication of user experience of mobile context-dependent gaming in a road setting. In general:

- The players succeeded with interpretation and manipulation well enough for us to conclude that the game concept is a plausible design approach.
- They enjoyed the stories in the game. Eskelinen's argumentation for a focus on manipulation in game research should be understood as a

part of the game experience and not the whole experience. The balance and variation of exploration and manipulation should be further studied. It would be interesting to design a prototype, which would have a stronger focus on the narration as opposed to the manipulation.
- The roadside objects must be highly distinctive. The choice of ambiguous objects, such as a specific oak tree from among several, has negative effects. This could be a problem on monotonous sections of roads.
- It was hard to convince them that the virtual objects could be located all around the vehicle. They had a preference for the closest roadside. This has consequences for the possibility to play the game going in the opposite direction.
- Using the everyday meanings of roadside objects in the story worked. But it is not possible to tell if it is better or worse than strong integration since that was never evaluated.
- Players developed consistent strategies to cope with *wrap* and *patch events*.
- Manipulation is most fun at *wrap events*.
- Exploration is fun at *patch events*.
- Manipulation is more fun if it provides a strong sense of motion.
- Storytelling is most fun at roadside objects that in themselves evoke interest, such as places that display activity or dramatic places.
- The game could be hard to understand for very young players even if they are accustomed to traditional computer games. More research should be done into how the game could be more intuitive.

6 Related work

A number of mobile game concepts cross the boundary between computers and the world. But no game uses movement and direction of the player relative to the surrounding as a resource. Further, no scientific study evaluates the manipulative qualities of context dependent game play itself.

The development of mobile games is being led by industry. And there are a few examples of commercial context-aware games. Cybico's mobile device with wireless peer-to-peer technology supports a number of multiplayer games for people in the proximity of each other (cybiko.com, 030123). Nokia Game (nokiagame.com, 030123) use a variety of channels in the player's immediate setting e.g. the Internet, , email, phone etc. But this setting is very different from the backseat of a car. Botfighters and Supafly from It's Alive use the location of the player as a resource in the game (it-salive.com, 030123). The location is determined with GSM mobile phone positioning, which is too inaccurate to tie game events to roadside objects. Some academic research projects mix virtual game content with the physical space including ARQuake (Thomas et al, 2000) and Pirates! (Björk, 2001). Pirates! is a wireless multi-player game that uses proximity to locations or other players to activate events. It relies on a pre-set infrastructure of beacons to detect proximity. This is not feasible outside of office environments. It should be possible to play *Backseat Gaming* in a vast environment, where the availability of extensive infrastructure is unrealistic. ARQuake is a technical project seeking to map a traditional game like Quake onto a physical arena. This is achieved by superimposing graphics directly upon the real world using a see-through head-mounted display. These displays are too cumbersome to use. Instead we make use of handheld devices that are less intrusive for the user. Additionally they are becoming more and more available to potential users.

Technically, *Backseat Gaming* is similar to Websigns from HP (Pradhan et al 2001). This is implemented on handheld devices equipped with a digital compass and GPS-receiver. It links information from the web with physical places by aiming the device toward specific objects in the landscape. *Backseat Gaming* employs a similar platform but explores its usefulness in the area of entertainment rather than information retrieval.

7 Conclusion

It is possible to exploit the changing road context during car travel to create a compelling and fun mobile game experience. Research on the unique characteristics of the highway experience can contribute when choosing the most interesting objects to explore. It is important to distinguish between the fun of game exploration, and the fun of game manipulation, since the traditional experience of travel in itself is already so much about exploration. A good manipulative object must instead provide a challenge that requires some physical dexterity. The designers must therefore balance the requirements against each other. A primary focus on either context-aware exploration, or context-aware manipulation, affects which roadside objects to be included in the game as well as how the objects are linked.

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