The Road Rager - Making Use of Traffic Encounters in a Mobile Multiplayer Game

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ABSTRACT
We present Road Rager, a prototype built in order to explore our hypothesis that proximity and a possibility to identify other players during temporary encounters could spur social interaction and enhance a mobile gaming experience. In this case, it is a multiplayer game designed to enable passengers in different cars to play against each other during a meeting in traffic. Using such meetings as resource opens new interesting possibilities for novel and engaging mobile experiences. In this paper we present the game concept, the implementation and the possibilities to interact - designed to successfully benefit from the dynamic and vivid mobile context created during a traffic encounter. We also present a technical test and some initial user feedback on the gaming experience.

Categories and Subject Descriptors
H.5.1 [Information Interfaces and Presentation]: Multimedia Information Systems - Artificial, augmented, and virtual realities; H.5.2 [Information Interfaces and Presentation]: User interfaces - *Prototyping*; K.8 [Personal Computing]: Games.

General Terms
Design, Experimentation, Human Factors

Keywords
Proximity-based mobile games, interaction design, traffic encounters, social interaction

1. INTRODUCTION
Future mobile technology will provide more services that exploit the benefits of mobile life [5]. Current mobile games are often portable versions of classic computer games [12]. There is also the possibility of incorporating different aspects of mobility to create immersive experiences. We suggest that a mobile game could become compelling in a new way, if it is aware of the vivid and dynamic mobile context. Travelling along a road means a continuous flow of impressions and new situations where changing scenes, sense of motion and contingent encounters provide for a very special experience. It can be seen as a sequential experience, resembling a dramatic play of space and motion, also called the highway experience. Contingent traffic encounters such as rapid meetings, protracted overtaking or gatherings i.e. traffic jams or red light accumulations constitute an essential part of the experience of travelling along a road [1]. We explore how these meetings, the motion of the accompanying traffic, can be used to create a fun and compelling mobile game and how it can add to the gaming experience. Our hypothesis is that proximity and a possibility to identify other players could spur social interaction and enhance the experience. The target group is children who travel in the back seats of cars.

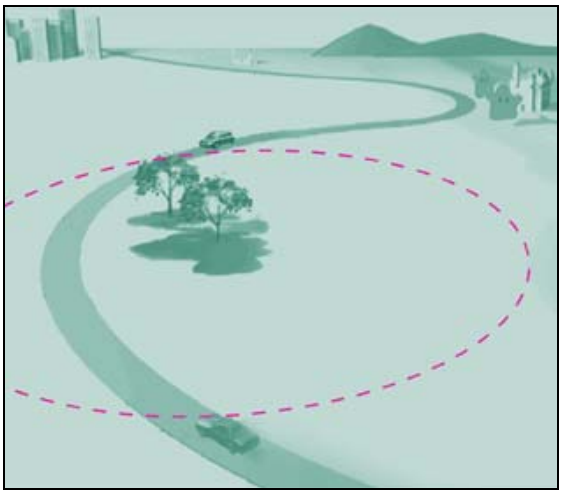

Figure 1. We explore how contingent traffic encounters can add to the gaming experience.

A game prototype, i.e. *Road Rager,* was created. *Road Rager* uses wireless ad hoc networking technology to enable game-play between car passengers as they convene within a limited range. Due to high relative speed an encounter can be extremely momentary, sometimes not longer than a couple of seconds. Consequently, a central design challenge concerns the possibility to enable and balance the player's engagement between virtual and real when the time for identification and interaction with the opponent player is very brief. However, drawing on a screen based interface risks having the player focusing on the screen rather than looking out through the window. This inspired us to explore the interaction in terms of a tangible interface. The fictitious connection between the game world and occurring encounters was achieved by means of direction and distance to the

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opponent player. Additionally, it was important to recognize that traffic encounters occur in a variety of ways, this imply that different kinds of encounters call for different possibilities to interact. When designing the game we chose to focus on three different encounters, i.e. meeting in opposite lanes, overtaking and traffic-light accumulations. Furthermore, the game is designed in such way that it often is rewarding for the player to identify the kind of encounter taking place, in this way we further stimulate the player to engage with the surrounding physical world.

The paper is outlined as follows; we start by presenting a brief overview of traffic encounters and the idea of using them as resource in a game. We then move on to present the concept and the possibilities to interact within the game. Section four gives a discussion on how the game is designed in order to map to different traffic encounters. Further, we present the implementation and a small technical test in order to gain insight into its feasibility. Section seven gives a summary of initial user feedback from a field trial. Finally, we give a brief account for related research.

2. COMBINING MOBILE GAMING WITH TRAFFIC ENCOUNTERS

Any road user's journey often coincides with several other journeys. Traffic encounters arise when two or more people on the roads are co-located and are within visible sight of each other e.g. in intersections, passing in opposite lanes or when overtaking [11]. Encounters with other road-user can occur in many different ways. Due to high relative speed an encounter can be extremely momentary, others more persistent.

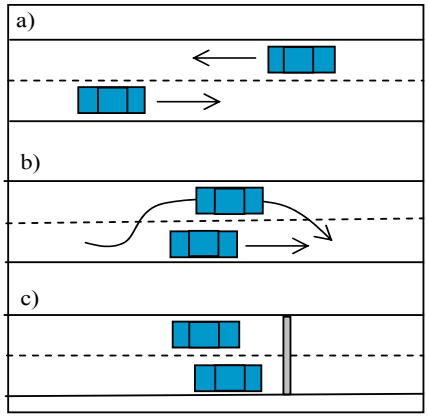

Figure 2. a) Meeting in opposite lanes, b) overtaking, c) traffic-light accumulations

When designing the game we have focused on three different types of encounters, i.e. meeting of two vehicles travelling in opposite lanes, overtaking and traffic-light accumulations (fig. 2). These encounters were chosen because we believe that they constitute short gaming events but bring about different challenges regarding interpretation, exploration and manipulation for the game-play [8]. Encounters where two vehicles travel in opposite direction generally last for a very short period of time, often not longer than a couple of seconds. Overtaking often mean a more protracted co-location than a meeting but contribute to the disadvantage of having another player behind the back during parts of the encounter. Traffic-light accumulation characterise a situation where the players are standing still for a short period of time in close proximity of each other.

3. ROAD RAGER

Using temporal and unpredictable encounters as resource requires a game-design that takes into account sudden and unpredictable appearance and interruptions between players. A hypothesis is that the possibility to identify other players can enhance the gaming experience and spur social interaction. This motivated several design criteria:

- The game should be designed to support the fictitious connection between the game world and the physical world.
- It should support identification, awareness and social interaction between players.
- It should take different situations into account, i.e. it should recognize that different kinds of encounters call for different possibilities to interact.
- It should cultivate the player's fantasy and imagination.

With these design criteria in mind we will in this section present the *game* concept and the ability to interact within the game.

3.1. Game Concept

The game *Road Rager* consists of a framing story, a set of game level stories and of manipulative events automatically taking place when players are in the proximity of each other. The framing story is told when the game starts to provide the player with the story as well as an understanding of the rules and goals of the game. Game level stories are told in between manipulative events with the purpose of cultivating the fantasy of the game-play. When the game begins the player takes on the role as a character with magic powers. The player's goal is to gain as high power as possible before getting to the big yearly meeting for witches and warlocks. High power can be gained both by achieving knowledge, such as new spells or by gathering powerful objects by being the most powerful in battles. The implementation of the game is currently restricted to game-play between only two persons during a manipulative event. When two players are within wireless reach the game initiates a duel with the purpose of enchanting the opponent. The manipulative event ends if one player gets enchanted or if they get out of each other's wireless reach. If the opponent gets enchanted the player can trade objects and knowledge in possession for more powerful ones. If the connection is broken before any of the players gets enchanted they will receive objects and knowledge dependent on the result of the game-play.

3.2. The Interaction within the Game

In order to preserve the connection with the physical world during brief meetings it is essential that the player during these events can focus outside the window of the car rather than on a screen. We have partly used a tangible interface to directly link the digital and the physical world and provide a seamless method of allowing natural physical and social interaction between people [10]. In swift meetings, when the period of time for interaction with other players is limited, the player can concentrate on spotting the other player and act instantly without looking at a screen.

Figure 3. The Clutcher, a PDA and a Bluetooth GPS

The tangible interface is realized as a magic gadget, i.e. the Clutcher, equipped with fourteen LED's and a button. The LED's communicate certain information relevant for the game-play. Four of these, so-called locator LED's, inform the player about the direction to the opponent player (fig. 4). Ten smaller LED's, so-called power bars, are placed in two rows and are sequentially turned on and off to indicate the amount of magic power the players possess. One of the rows indicates the player's own power and the other the opponent's. The button is for changing tool (see section 3.3).

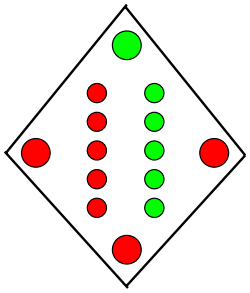

Figure 4. Feedback LEDs located on top of the Clutcher

To further encourage the player to interact directly with the physical world we use sounds as feedback on the interaction. We also use it as a two-sided feedback, meaning that both players will hear audio feedback as a result of an action. The purpose is to increase the awareness and feeling of presence of the other player and to encourage social interaction.

At the same time as the real world can provide for a rich space where the game can take place it is also important to cultivate the fantasy and imagination of the game and to provide the player with proper feedback and interpretation of the game-play. Therefore we have chosen to use the screen of a PDA as interface in between different manipulative events. The player can then view animated stories related to the game play, the identity of an encountered character, as well as results and status.

3.3. Virtual Tools

The interaction during manipulative events relates to the traffic encounters in terms of direction and distance to opponent player. These design parameters are varied to enable the Clutcher to be turned into any of three different virtual tools, i.e. an *Electro squeezer*, a *Sludge thrower* and a *Magic wand*, and are designed to be more or less suitable for the traffic encounters previously discussed (fig. 2).

Figure 5. Sending out electronic pulses with the Electro squeezer

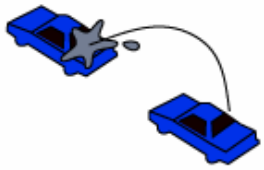

Figure 6. Throwing sludge with the Sludge thrower

Figure 7. Cast a spell with the Magic wand

The tool that demands least understanding of the opponent's physical location is the Electro squeezer, based on neither aiming direction nor distance. This tool can be used in a battle without knowing anything about the location or direction to the opponent player, as long as being within wireless reach. It sends out electric pulses and is fired by squeezing the Clutcher (fig. 5). The Sludge thrower is based on aiming direction which makes it more dependent on an understanding of the opponent's physical location than the Electro squeezer. When using the Sludge thrower the locator LED's are active and indicates, if lightened, the direction to the opponent. With this tool the player can throw magic sludge and is used in the same fashion as if throwing something, i.e. the player has to move the Clutcher forward/ downwards at the same time as aiming it towards the opponent (fig. 6). The player will hear a sound indicating that something is flying through the air for two seconds and then a sound indicating

hit or miss. The Magic wand is the tool that demands most understanding of the opponent's physical location, being based on both aiming direction and distance. The Magic wand can be used to cast spells (fig. 7). To do this the wand should be swung to follow a circular pattern, but it can only be used once during an encounter. Similar to the Sludge thrower it shows the direction to the opponent player with the help of the locator LED's. It makes use of distance in the way that the closer the player is to the opponent player the more powerful is the tool.

- *The Electro squeezer*: No demand of aiming or identification
- *The Sludge thrower*: Aiming but not identification needed
- *The Magic wand*: Aiming and identification needed

4. MAPPING GAME MANIPULATION TO TRAFFIC ENCOUNTERS

The tools and the scoring are mapped to the type of traffic encounter accordingly. The Electro squeezer is quicker and easier to use than the other two tools and require no understanding of direction or identification of opponent. Consequently, the Electro squeezer is suitable for encounters that last for a very short period of time when the interaction time is very limited, such as in sudden meetings in opposite lanes. Additionally, it can be handy to use when it is hard to aim, such as during parts of an overtaking when the opponent is located behind the back. The Sludge thrower is a tool suitable to use at encounters that persist for a while longer such as during an overtaking or at traffic lights. This is due to the procedure of using the tool, which is a bit more time consuming than the Electro squeezer. Similar to the Electro squeezer the Magic wand can be favourable to use in a swift meeting. At a good hit in close proximity of the opponent player it is very powerful. Still, using the Magic wand is also related to a bigger risk of failing. It can for example be difficult to identify the location of the opponent player in time because of intense traffic or dense road networks, such as in a city-centre.

Table 1. Suitability of tools during different traffic encounters

	Meeting	**Overtaking**	**Traffic light**
Electro squeezer	Quick and easy to use	Quick and easy to use	Quick and easy to use
Sludge thrower	To slow-bad to use	Easy to use if opponent is in front. Difficult to use if opponent is behind	Easy to use if opponent is in front. Difficult to use if opponent is behind
Magic wand	Difficult to use	Difficult to use, especially if opponent approach from behind	Difficult to use

The reward system is designed so that the player need to choose tool depending on the encounter in order to be successful in the game. The more connection to the opponent player the tool conveys the more powerful it is. But choosing the most powerful tool is not always the best solution as it also can be difficult to master during certain encounters. Firing the Electro squeezer is very quick and easy but has a low effect on the opponent character. The Sludge thrower is trickier and more time consuming to use than the Electro squeezer but is more powerful. The effect of the Magic wand is dependent on the distance to the opponent player, the closer the more powerful, and is much more powerful than any of the other tools if fired close enough.

5. IMPLEMENTATION

The game is developed on a PDA equipped with WLAN capability to enable network connection between the players. It is aware of the player's aiming direction by means of a digital compass and its geographical position by means of a GPS-receiver. A Basic stamp II microcontroller controls the LED's and the external button. An additional button is also mounted inside the Clutcher in order to accomplish the squeezable feature. A serial cable connects the Clutcher with the PDA (fig. 3).

5.1. Software Architecture

Gaming activity between players during multiplayer events is accomplished through peer-to-peer wireless ad hoc networking, allowing connection between the players without any further infrastructure. *Road Rager* uses the MongerLib library in order to handle this connection [14]. Mongerlib is based on a rapid mutual peer discovery protocol to quickly detect and connect the players when they meet. It takes care of transmitting and receiving information between the connected devices as well as makes sure the devices disconnect properly when coming out of reach from each other. Furthermore MongerLib also obtain the player's latitude and longitude coordinates from the GPS receiver and handles positioning arithmetics such as calculating distance and bearing to the other player.

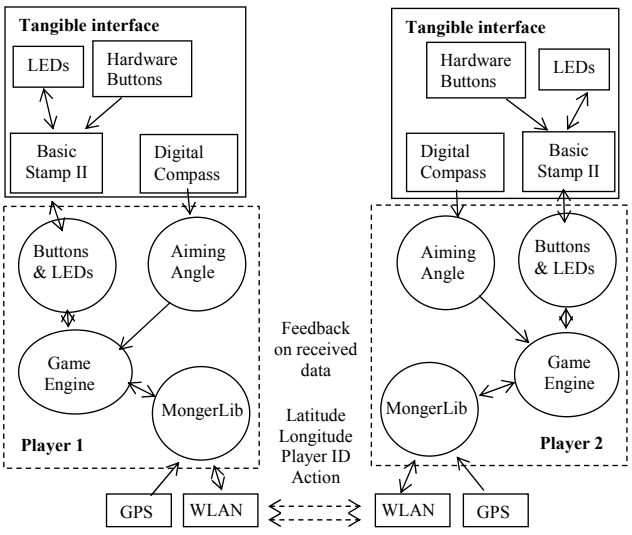

Figure 8. System architecture (during a manipulative event)

A multiplayer event typically proceeds in the following manner:

1. MongerLib detect when two devices are within each other's wireless reach. When MongerLib have established a connection a message is sent to the game engine that will set the game in connected mode. Data can now be sent between the devices.
2. As soon as the game is set in connected mode the game engine starts to continuously trigger its present longitude and latitude to be sent to the other device. When the location data is received from the other device the distance and desired aiming direction to it can be obtained. The desired aiming direction is achieved by calculating the bearing between the co-ordinates of the players. The bearing is defined as the angle measured horizontally from north to the direction of the other player's co-ordinate. By comparing this information with the current angle of the compass the game engine sends messages to the Basic Stamp microcontroller to switch on that locator LED which position corresponds to the desired aiming direction, i.e. towards the direction where the opponent player is physically located. The locator LED's are set to turn on within a range of 45º from the intended aiming direction. Except from the positioning data also information about character identity and of the player performed actions are sent between the connected devices. With performed action we mean if the player fire and with what tool. Rewards for the performed action are not achieved until a feedback on the sent data is received back from the other device. Upon reception of the feedback the magic power is counted up/down and a message is sent to the microcontroller to update the power bar LED's according to the new result.
3. MongerLib detects when two devices come out of each other's wireless reach, it then closes down the connection and sends a message to the game engine, which in its turn sets the game to disconnected mode.
4. The player is then provided with feedback on gaming achievements on the screen of the PDA.

6. TECHNICAL TEST

A technical test was conducted in order to investigate if the prototype would perform as expected. The networking capability had already been tested in prototypes such as Soundpryer [14] and Hocman [6, 7] and proven to work within this setting. A performance criterion critical for the game and important to investigate was rather the accuracy of the aiming direction during a critical situation, such as when the players are standing still in close proximity of each other or during the passing moment of a meeting. The test was carried out in its intended setting and involved a situation where one car passed by a stationary car (fig. 9). The test was monitored from within the moving car. During the test the Clutcher was continuously aimed toward that side of the car where the meeting with the other car eventually would take place, i.e. 90 degrees from driving direction. A camera was mounted to film both the Clutcher and the outside of the side-window at the same time. Afterwards, when looking at the recorded video, a measure of the aiming precision (α) during the moment of meeting could be made. This was accomplished by calculating the distance (x) in meters between the exact moment of the meeting (z) and the turning on/off of the frontal locator LED. The distance was calculated with the help of the speed of the car and the time-encoding of the video. The test was carried out in 50 km/h as well as 70 km/h and the distance (y) between the cars in the moment of the meeting was 10 meters. The LED was set to turn on/off within an aiming range of 22º from the intended aiming direction (fig. 10).

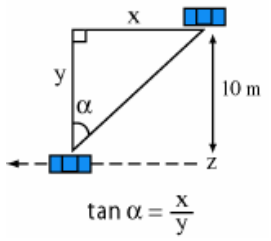

Figure 9. Test situation

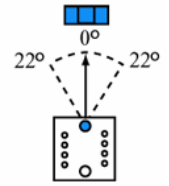

Figure 10. Aiming rage

6.1. The Result

The table below show the results from the test (table 2). A positive number indicates that the locator LED turned on before the point of the meeting and a negative indicates after. The test showed a satisfying result regarding the aiming precision in five out of seven test cases when the car drove 50 km/h. With a satisfying result we mean that the locator LED turned on before or right at the point of the meeting, i.e. it had at most 22 degrees inaccuracy. When the speed was changed to 70 km/h the aiming precision deteriorated considerably. At this speed the locator LED was in all test cases turned on after the exact point of the meeting with an average inaccuracy of 62 degrees. However, as a car at this speed travel 19,4 m/s, this means a lag of 0,43 seconds during the exact moment of the encounter. The aiming range in the game was then change to a value of 45 degrees. A smaller lag was also presumed when the game was designed. With these results we concluded that it would be feasible to carry out a field trial off the prototype, following section will present a summary of user feedbacks from this trial.

Table 2. Test results

	Driving 50 km/h			Driving 70 km/h		
	x (m)	α	inaccuracy	x (m)	α	inaccuracy
1	1,11	6,3º	15,7º	-10,11	-45.3º	67,3º
2	0,00	0,0º	22,0º	-8,56	-40.6º	62,6º
3	3,89	21,3º	00,8º	-9,33	-43,0º	65,0º
4	5,56	29,1º	7,1º	-5,44	-28,6º	50,6º
5	-17,22	-59,9º	81,9º	-7,78	-37,9º	59,9º
6	-1,11	-6,3º	28,3º	-9,33	-43,0º	65,0º
7	-10,56	-46,6º	68,6º			

7. INITIAL USER FEEDBACK

A field trial was conducted in order to discover design flaws and to observe the feasibility of using encounters as resource for the game-play. Furthermore, to get an indication if physical presence and a possibility to identify other players during temporary encounters would spur social interaction and enhance the gaming experience. The test was set up to involve a total of fourteen children, seven children in the age of eight and seven children in the age of ten. The two age groups played the game separately for approximately thirty minutes. Three cars drove simultaneously along a preset route with two to three children in each car. This ensured encounters with other players as well as made it possible to observe the game-play. Initially all participants got an explanation of the game. The activities were video recorded and an interview was carried out after the game-play. Unfortunately, because of certain technical problems, the test cases turn out to be fewer and the game-play sometimes uneven, but they are nevertheless valuable results that indicate possibilities and flaws for the coming evaluation.

Figure 11. Kids playing Road Rager

It was clear both from the interviews and from observations of the players' behaviors and expressions during the game-play that these temporary encounters created a very thrilling gaming situation. This was not just the case for the player in charge of the Clutcher, but also for the rest of the children in the car. As these gaming events occurred suddenly and often during short periods of time it was usual that all children in the car were involved trying to spot the opponent and to suggest what tool to use. It was also usual that the children divided tasks in between each other so that one was in charge of the PDA and one of the Clutcher or that one was in charge of the game manipulation and one of the searching for the opponent. Situation also occurred when several children held the Clutcher at the same time trying to help each other. Many children mentioned in the interviews that it was the feeling when someone was in the proximity and the searching for the opponent that was the most fun and thrilling part of the game. Equally, they also mentioned that one of the worst things was if they didn't manage to visually spot the opponent. Another thing that they mentioned as fun was the way they could move and manipulate the Clutcher in order to play the game.

After some experimenting, the majority of the children quickly got the idea of how to manipulate the Clutcher during the encounters and how to interpret the feedback from the LEDs. The tools that were most used during the game-play was the Electro squeezer and the Sludge thrower. Even though several children from the beginning had decided that the Magic wand was the most useful one they soon changed there minds. None of them got the concept of waiting until they where close up before using it, which resulted in disapproval. The tool that was generally considered as the most fun to use was the Sludge thrower, but it was often exchanged by the Electro squeezer because of the difficulty to aim during certain meetings.

8. RELATED WORK

Exploring the possibilities of using traffic encounters as resource in a game is one aspect of a bigger adventure game intended to combine game-play with the highway experience. One prototype has already been developed, called Backseat Gaming, which investigate how to integrate roadside objects as part of the gaming experience [3].

The possibility of using the physical world as game-board has been explored for several year by the industry. Commercially available Botfighters from It's Alive [itsalive.com – verified 1st July 2004] use mobility, location and proximity of players as a resource in the game. Road Rager is related to the ideas of Botfighters but explores the impact of proximity during temporary moments for the gaming experience. In Botfighters location is determined with GSM mobile phone positioning, which gives relatively high positioning inaccuracy making it highly unlikely that the players would ever meet while playing the game.

A number of research projects explore the idea of integrating tangible, social and human to physical world interaction into digital and ubiquitous games [2, 4]. These projects are designed for use in a pre-set room and exploring the possibilities of using true mobility as a resource in a gaming constitutes a different design challenge. Examples of games that draw on the other players' physical proximity without any preset infrastructure include PacMan Must Die and Earth Defenders [13] but these games are designed for use during longer periods of co-location of the players and not for short occasional encounters. An example of a game exploiting issues of incorporating different aspects of mobility and the physicality within the experience in an outdoor setting is Can you see me now? [9] This game explores collaboration between online participants and mobile participants on the street.

9. CONCLUSION

We have presented a game prototype, designed to make use of contingent traffic encounters as a resource, in order to explore our hypothesis that proximity and a possibility to identify other players during temporary encounters could spur social interaction and enhance a mobile gaming experience. We have also presented a technical test and some initial user feedback on the gaming

experience. Important design criteria include how to support the fictitious connection between the game and the real world and simultaneously cultivate the player's fantasy and imagination, how different kinds of encounters call for different gaming situations and how identification, social interaction and awareness could be supported between players. The initial user feedback gives a strong indication that encounters and the motion of the accompanying traffic, occurring during car traveling, can be used to create a compelling and fun game. The user feedback also indicates that the possibility to identify other players can spur social interaction and enhance the gaming experience. This result motivates us to proceed with our research and future work includes an extensive user evaluation of the prototype.

10. ACKNOWLEDGMENTS

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