Arch'n'Smile: A Jump'n'Run Game Using Facial Expression Recognition Control For Entertaining Children During Car Journeys

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ABSTRACT
Children can be a distraction to the driver during a car ride. With our work, we try to combine the possibility of facial expression recognition in the car with a game for children. The goal is that the parents can focus on the driving task while the child is busy and entertained. We conducted a study with children and parents in a real driving situation. It turned out that children can handle and enjoy games with facial recognition controls, which leads us to the conclusion that face recognition in the car as a entertaining system for children should be developed further to exploit its full potential.

CCS Concepts
•**Human-centered computing** → **Interaction techniques;**

Author Keywords
Face Recognition; Game; Children; Entertainment; Facial Expression; Distraction; Driving

INTRODUCTION
Families often use the car for long trips to visit family or to go on holidays. During these long rides, children tend to become bored since they are not used to sit still for a long period of time. As a result, children often claim their parents' attention. Previous studies revealed that children are a significant source of distraction while driving [3, 8]. Parents are twelve times more distracted by their children than by talking on a mobile phone during the car ride [3].

To keep themselves occupied, children often play games, listen to audio books, or read. However, playing video games or reading books on car journeys can lead to motion sickness. Motion sickness occurs because the passenger's inner ear encounters a disagreement between the expectation of no movement (e.g., eyes are fixed on book and see the car's interior) and the actual movement of lateral and longitudinal acceleration [1]. Hain and Oman [1] recommend to stop reading and look outside instead to decrease motion sickness.

To entertain children properly, we developed the game *Arch'n'Smile*. *Arch'n'Smile* is based on a traditional Jump'n'Run game but uses facial expression recognition to control the avatar. In order to run, the player has to smile; arching an eye brow results in jumping. Previous research could show that technology which naturally encourages smiling positively affects users' mental state [10, 9]. The background of the game uses a live camera view of the current window view so that the player has the impression of running on a guardrail of the street (Figure 1). This background allows children to play a game while seeing that they are moving, preventing the aforementioned discrepancy between spatial awareness and perceptual vision.

Due to improved machine learning and computer vision algorithms as well as large databases, face recognition and automatic detection of facial expressions have gained increasing attention [5]. Applications of face recognition include biometrics, law enforcement access controls, information security, surveillance systems, smart cards, and entertainment applications [5, 12]. However, only few games have used facial expressions as input control. In Yang et al.'s adaption [11] of the popular game *Angry Birds*, the player has to smile to dispose of obstacles. In contrast, detecting body movements as input for games has already been used successfully in commercial games like *Nintendo Wii*. Face recognition has also been integrated in automotive user interfaces, for example for detecting drowsiness [2, 6] or authenticating the driver to adapt the car's settings to the driver's preferences [7].

To our knowledge, facial expression recognition for controlling a game during car journeys has not been examined yet. We expect that children enjoy this new kind of controlling. We (a) present *Arch'n'Smile*, a game for children based on facial expression recognition control, and (b) explore whether facial expression recognition games have the potential to be used for children on car journeys. Therefore, we asked three families to use the game on a car journey. Afterwards the families reported on their experience regarding the children's entertainment, motion sickness, and parents' distraction.

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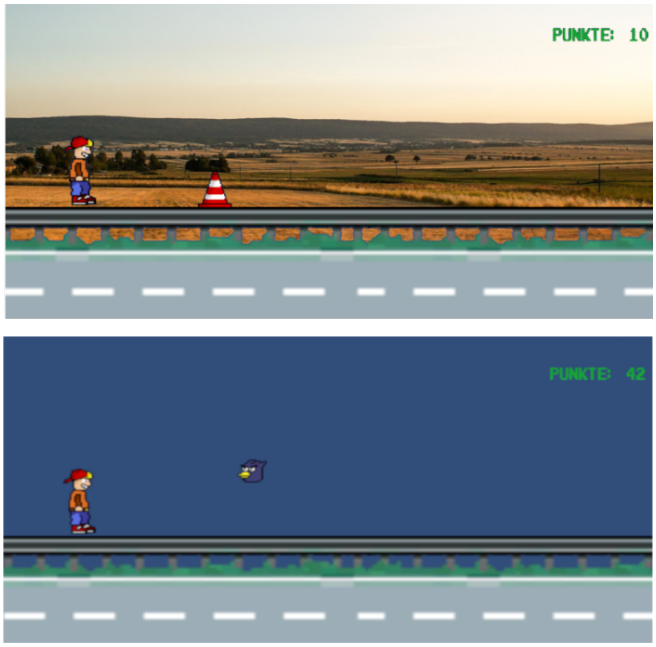

Figure 1. *Arch'n'Rune*: Facial expression recognition is used to control the avatar. The game is set on a guardrail either using a live camera of the current view (above) or a neutral blue background (below).

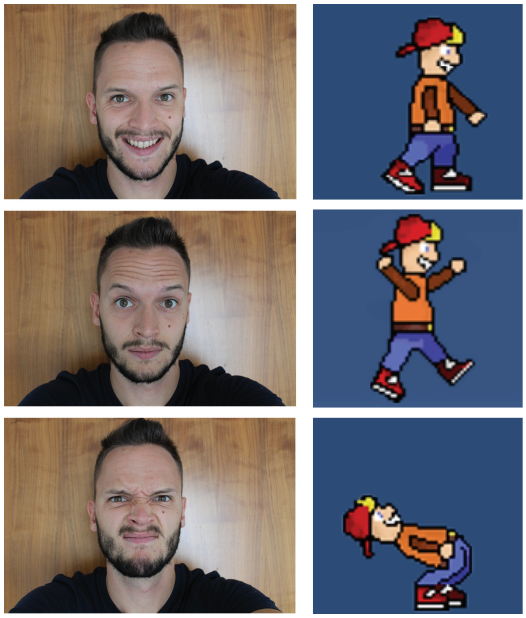

Figure 2. The avatar can perform three different movements controlled by facial expressions: smiling for running, arching an eyebrow for jumping, and wrinkling the nose for crouching (from top to bottom).

In the following, we first describe a pilot study, which we conducted to learn more about children's behavior on long car journeys. Afterwards, we present our Jump'n'Run game and report our insights from exploring the game with children. Finally, we discuss our findings and give implications for future facial recognition games in cars.

PRE STUDY: INTERVIEWING PARENTS

In order to define the requirements for the study and the game we performed a pilot study. In this study we asked two sets of parents, each with two children, about their opinion on distraction in the car, the activities of their children on long car rides and their attitudes towards a game using facial expression recognition. Both couples had experience with long car rides together with their children.

Participants' perceived very different reasons for feeling distracted by their children. They mentioned that it depends on the driving situation and the child itself. All of our four participants indicated that a main reason for distraction was that children became restless and noisy on longer car rides. The children of the interviewed parents usually busy themselves with reading, playing games or listening to audio books. However, they told us that children can get sick due to these actions. They had different opinions about a face-controlled game for their children. Some of them were skeptical whether such a game would even deteriorate distraction or make their children feel more sick. The others were open towards the idea of new input controllers and expressed an interest to try it themselves. Based on these insights we derived the following requirements for a children's game for long car journeys using facial expressions as input:

- The game has to be entertaining for children.
- Children can handle the game on their own to prevent further distraction.
- The game avoids much gesturing minimize parents' distraction but uses other – more unobtrusive – body movements
- The game prevents motion sickness.

GAME

We developed a game based on traditional retro Jump'n'Run games, situated in a highway with an avatar walking on guardrails. The used game engine was *Unity 3D*. The goal of the game is to receive as many points as possible. Points are collected by running on the guardrail and covering distance. The avatar is prevented from running by two enemies in the form of traffic cones and birds. The traffic cones are placed on the ground, forcing the player to jump over them. The birds are placed in the sky, so that the player has to crouch to pass them. If the player touches an enemy the game is lost and they have to restart from the beginning. If they pass an enemy, they are rewarded an additional ten points.

The avatar can perform three different movements: (1) running, (2) jumping, (3) crouching. These movements are controlled by the player's facial expressions (Figure 2). We used the *Affectiva*[1] Software Development Kit for the automatic detection of facial expressions. Smiling causes the avatar to run, arching an eyebrow to jump and a wrinkling nose to crouch. Furthermore, the different expressions can be combined. For example, when the player smiles and arches her eyebrows simultaneously, the avatar jumps upward and forward.

[1] https://developer.affectiva.com

Figure 3. Study Setting.

We developed two different versions for the background of the game (cf. Figure 1). The first version uses a live video of the car's surroundings for the background. The video is created by an external web cam outside of the car, connected to the device displaying the game. We expect that this background prevents children from suffering from motion sickness since it has the same effect as looking outside the car's window. The second version uses a simple blue background. Finally, the game includes a tutorial, which explains the basic movements and allows the player to practice the movement.

REAL DRIVING STUDY

In order to collect high-quality feedback, we let four children and four parents experience our game in a real driving scenario. Therefore, one parent drove together with one of their children and one of the authors through Munich in their own car.

Study Set-Up

The children in our study could experience the *Arch'n'Smile* game on a 12.3 inch *Microsoft Surface Pro* tablet. The tablet was mounted on the back of a front seat as shown in Figure 3. Before beginning the car ride, the tablet was adapted to the child's eye height. Participants used their own car, driven by one of the child's parents to foster a realistic driving scenario.

Procedure

First, we explained the game to the child using the tutorial. Afterwards, the child practiced the game with the blue background for five minutes to get used to the facial expressions. When the child felt confident, the actual study started.

The child's parent drove their own car through the city for fifteen minutes. During that time the child first played one version of the game for seven minutes and afterwards the other one for another seven minutes. One author was present in the car to take notes. To prevent safety risks, the researcher did not interact further with the driver and parents were instructed to drive on familiar roads close to their home.

In the last part of the study we interviewed the child first to avoid that the children were influenced by their parents' opinion. We asked children whether they liked playing the game and were satisfied with their final score. In addition, we wanted to know whether they would like to play the game more often and would like their parents to buy the game for them. Finally, we asked them whether they felt sick during the game and whether the avatar behaved the way they expected. Since qualitative research with children as participants needs special preparation, we designed our study and the post interview to be suitable for children [4]. We therefore complied to the advice to keep the interview short in order to avoid a loss of concentration. Since children tend to prefer to answer positive-sounding questions, we emphasized that there are no right or wrong answers. Finally, we tried to build a trusting relationship with the children and made it clear to the children that they can abort the study at any time.

Afterwards, we also asked the parents for their opinion about the game. This interview included questions regarding their general opinion about the game and their impression whether their child liked the game. Furthermore, we wanted to know whether the parents felt distracted while driving and whether they thought that their child became motion sick.

Participants

We had a total of eight participants (four adults and four children), who participated in the study in pairs of one parent and one child. The adults were 48, 53, 42 and 48 years old. Two of them were female and two male. The children were 6, 7, 8 and 9 years old and all male.

Results

In the following, we present our findings from the interviews with the participating children and parents. One author transcribed the interviews during their conduction. For the content analysis, three of the authors coded and categorized the interviews using affinity diagrams.

Children's perspective:

All four children explained in the interview that they enjoyed playing the game and were satisfied with their performance. They happily shared their score with the interviewer. All of them expressed consistently positive feelings while playing the game. The children would also like to play the game more often and would be happy if their parents bought the game. They mentioned that they did not feel bad or dizzy during the car journey.

On the other hand, the children indicated that the avatar did not always behave the way they expected and probably did not recognize all of their facial expressions. Nonetheless, the children did not express any frustration during the game, even when they lost once. Instead, the children seemed to be very ambitious while playing the game. When asked which version of the game the children liked better, very different answers were given. One kid liked both versions equally. Two children preferred to play the game with the static blue background and one child liked the game better with the embedded live video.

Parents' perspective:
The parents had the impression that their children had fun while playing the game and were favorable about a game controlled by facial expressions. They found it easy to use and funny to look at when they saw their children smiling and nose wrinkling in the car's back mirror.

Moreover, the parents reported that their children were quiet and busy all the time. Therefore, the parents did not feel distracted while driving. However, they expected to feel disturbed in case the children encountered an error, for example with the facial recognition.

Nonetheless, the parents were skeptical whether the game would actually keep their children sufficiently busy on longer car journeys. Thus, parents were still hesitant to buy such a game. Parents did not have the impression that children felt motion sick during the car journey for neither version.

DISCUSSION

All children enjoyed playing *Arch'n'Smile* and remained quiet while being preoccupied with the game. As a result, the parents also reported that they did not feel distracted while driving. However, the parents were skeptical whether the game is sufficient to keep their children busy on longer car journeys. It is possible that the children enjoyed playing the game only due to novelty effects. Therefore, future long term studies have to evaluate children's level of enjoyment and parents' level of distraction on (a) naturalistic long-distance car journeys, (b) several successive car rides, and (c) in comparison with traditional game controllers.

Although we expected that the embedded live video could prevent children from becoming motion sick, we could not determine any difference between the two versions and their effect on the children's well-being. None of the children showed any signals of motion sickness. Due to the small sample, we cannot draw any conclusion whether the game actually prevented motion sickness. Again, future studies have to investigate the influence of the game on longer car rides, comparing and contrasting traditional occupation strategies like video games and books with our game.

Finally, the children were very enthusiastic to use facial expressions as input control. However, we also encountered problems with the control of the game since the camera sometimes did not recognize the children's facial expressions. We assume that different lighting conditions were responsible for not accurately identifying the child's face. Another factor could be how much the child's face is pronounced. We suspect that difficulties occurred when long hair covered parts of the face or light eyebrows were not registered by the camera. Hence, we conclude that facial expression is a promising input control for a children's game. Nonetheless, to employ these games in cars, future work has to improve face recognition to make it robust against demanding conditions of a car.

FUTURE WORK

Our vision is a driving assistant for children that keeps them busy while driving. On the one hand, this driving assistant offers an entertainment collection of several games (Jump'n'Run, racing games, quizzes, music games, etc.), audio books, and movies for children. Due to children's positive reaction, we suggest that future game designers consider facial expressions as input control. This input control offers the advantage of small muscle movements, children do not usually use for playing games, while these movements remain unobtrusive to reduce parents' distraction. However, further studies are necessary to evaluate these effects on long-distance journeys.

On the other hand, face recognition can inform parents about critical states of their children. For example, face recognition could be used to detect whether children are becoming motion sick and send a warning to the parents on time. Of course, such as system has to be developed carefully, considering privacy and distraction aspects.

REFERENCES

1. Timothy C. Hain and Charles M. Oman. 2003. Why does reading in a moving car cause motion sickness? *Scientific American* (2003).
2. Qiang Ji and Xiaojie Yang. 2002. Real-time eye, gaze, and face pose tracking for monitoring driver vigilance. *Real-time Imaging* 8, 5 (2002), 357–377. DOI: http://dx.doi.org/10.1006/rtim.2002.0279
3. Sjaan Koppel, Judith Charlton, Chelvi Kopinathan, and David Taranto. 2011. Are child occupants a significant source of driving distraction? *Accident Analysis & Prevention* 43, 3 (2011), 1236–1244. DOI: http://dx.doi.org/10.1016/j.aap.2011.01.005
4. Riitta-Liisa Kortesluoma, Maija Hentinen, and Merja Nikkonen. 2003. Conducting a qualitative child interview: methodological considerations. *Journal of Advanced nursing* 42, 5 (2003), 434–441. DOI: http://dx.doi.org/10.1046/j.1365-2648.2003.02643.x
5. Ashu Kumar, Amandeep Kaur, and Munish Kumar. 2018. Face detection techniques: a review. *Artificial Intelligence Review* (2018), 1–22. DOI: http://dx.doi.org/10.1007/s10462-018-9650-2
6. Thomas Kundinger, Andreas Riener, and Nikoletta Sofra. 2018. A Robust Drowsiness Detection Method based on Vehicle and Driver Vital Data. In *Mensch und Computer 2017-Workshopband: Spielend einfach interagieren*, M. Burghardt, R. Wimmer, C. Wolff, and C. Womser-Hacker (Eds.). BoD–Books on Demand, 433. DOI:http://dx.doi.org/10.18420/muc2017-ws09-0307
7. Jeff Plungis. 2018. Car Companies Show Off Face Recognition and High-Tech Cockpit Features. https://goo.gl/nC9kkV. (2018). Accessed: 2018-07-28.
8. Jane Stutts, John Feaganes, Donald Reinfurt, Eric Rodgman, Charles Hamlett, Kenneth Gish, and Loren Staplin. 2005. Driver's exposure to distractions in their natural driving environment. *Accident Analysis & Prevention* 37, 6 (2005), 1093–1101. DOI: http://dx.doi.org/10.1016/j.aap.2005.06.007
9. Hitomi Tsujita and Jun Rekimoto. 2011a. HappinessCounter: Smile-encouraging Appliance to

Increase Positive Mood. In *CHI '11 Extended Abstracts on Human Factors in Computing Systems (CHI EA '11)*. ACM, New York, NY, USA, 117–126. DOI: http://dx.doi.org/10.1145/1979742.1979608

10. Hitomi Tsujita and Jun Rekimoto. 2011b. Smiling Makes Us Happier: Enhancing Positive Mood and Communication with Smile-encouraging Digital Appliances. In *Proceedings of the 13th International Conference on Ubiquitous Computing (UbiComp '11)*. ACM, New York, NY, USA, 1–10. DOI: http://dx.doi.org/10.1145/2030112.2030114
11. Changeun Yang, Yuxuan Jiang, Pujana Paliyawan, Tomohiro Harada, and Ruck Thawonmas. 2018. Smile with Angry Birds: Two Smile-Interface Implementations. In *Nicograph International (NicoInt)*. IEEE, 80–80. DOI: http://dx.doi.org/10.1109/NICOINT.2018.00026
12. Wenyi Zhao, Rama Chellappa, P Jonathon Phillips, and Azriel Rosenfeld. 2003. Face recognition: A literature survey. *ACM Computing Surveys (CSUR)* 35, 4 (2003), 399–458. DOI:http://dx.doi.org/10.1145/954339.954342