The Bronco: A Proof-of-Concept Adaptive Fairground Ride

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ABSTRACT

This paper presents a proof-of-concept for a novel design of fairground ride, which has been developed as part of an ongoing exploration into the use of wearable bio-sensing to enhance the experience of amusement parks and fairgrounds. The ride is controlled by a human operator, whom is solely reliant upon information transmitted from a personal telemetry system worn by the rider, which collects and transmits auditory, visual and physiological information. The design and implementation of this ride experience is presented, and its first deployment at a major public exhibition is described. Initial reflections on this event draw on observations and interviews, with the aim of helping to shape the agenda for research in this area.

Categories and Subject Descriptors

H.5 INFORMATION INTERFACES AND PRESENTATION

General Terms

Experimentation, Human Factors

Keywords

Fairground, Ride, Bucking Bronco, Wearable, Sensors, Bio-Sensing, Heart-rate, Adaptation, Telemetry

1. INTRODUCTION

Theme parks and fairground rides are an important form of entertainment that have a long and well documented history of development [1]. The earliest rides were small-scale and tended to be driven mechanically by an operator. In comparison, modern rides are often powered electrically and may have substantial elements of automated operation. Large, high-throughput rides (for example, those at busy theme parks) tend to be almost completely automated, with each ride experience being an instance of a standard ride program controlled by a computer. In contrast, smaller rides at fairgrounds often still allow an element of manual control, which a skilled ride operator may use to provide an optimum level of entertainment. Emerging ride technologies (e.g. [6]) are beginning to provide for a significant level of robotic control over small groups of seats, or even individual seats. This may enable the personalized, fine-grained tuning of ride experiences, but raises the research question of how this adaptation might best be achieved. The authors have been investigating the use of physiological monitoring to aid adaptation; the proof-of-concept ride presented in this paper is an initial step towards the development of a new form of ride.

The development of this concept began with previous work by the authors [2], in which a telemetry system, capable of capturing live video, audio and physiological reactions of riders, was deployed on a series of large-scale fairground rides. This system was used to transmit data to a live audience, for educational and entertainment purposes, and was also used to generate souvenirs of the experience, which were distributed to riders. After the event, professional ride operators were interviewed regarding their thoughts on the potential of the system to inform ride operation. Operators professed to a high degree of enthusiasm and professional pride in being able to reward riders with the best possible experience, but revealed a certain dissatisfaction in the disconnection with their customers that had been created by larger, more automated rides. Operators confirmed that telemetric transmission from rides would be a welcome addition, and one that had the potential to connect operators with riders in a more direct way than was previously possible, especially if transmission contained an element of physiological response, reflecting internal state. An intriguing possibility raised by these discussions was the potential for operators to learn how to interpret internal state; this raises the potential of creating an adaptive experience, which is analogous to computer games which employ biofeedback (e.g. [4,5]).

Informed by these responses, a prototype system was constructed to enable an investigation into the use of additional data streams in a ride operation task. Based around a Bucking Bronco (a small, mobile ride designed for use by just one participant) the prototype was first deployed at *Pioneers 2*009, a large public exhibition organized by a UK research council. This paper describes the construction of a system for this event, the performance that it was embedded within, and the response of operators and other participants. In the study presented here, the riders were 'trained professionals' employed to take part in the experience whilst the operators were volunteers, drawn from an audience. As such, this first deployment reversed the usual roles, with the public controlling the ride, and the professionals riding. Through this mechanism, a variety of individuals were engaged in attempting to control the ride, and we provide a flavor of their experience, through the use of semi-structured interviews and observations. Our primary contribution, however, is in expressing the *concept* of developing an adaptive ride; we hope, in the future, to perform a more rigorous investigation into this topic, intended to provide objective evidence to inform a future design process.

2. DESIGN AND STAGING

The configuration used at the Pioneers event is shown in Figure 1. To the left of the picture, partially occluded by a screen, is the Bucking Bronco, which consists of a large, red, oblate spheroidal seat, on which a rider sits. This seat is attached to a base, which contains a variety of mechanical and electrical components that allow for the seat to be "spun" (a lateral 360 degree spin in either direction), and "bucked" (a combined sinusoidal rolling and pitching motion). The control console for the ride is shown in the lower center-right of Figure 1, where it is currently in use by an operator. The Bronco is surrounded by a large inflatable white and black mat, and this protects the rider during a fall.

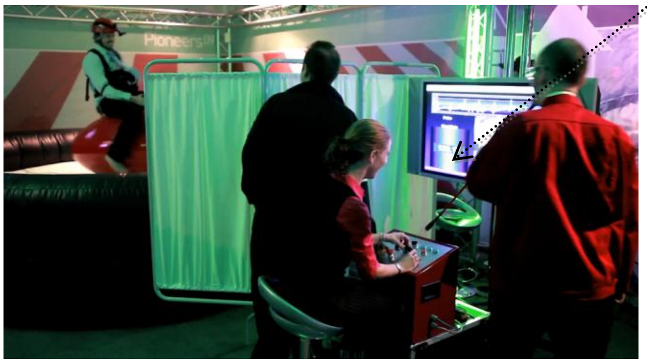

Figure 1: Setup at Pioneers

The screen to the right is used to present the operator with a live visualization of the data channels transmitted from the rider. Figure 2 shows a detailed view of this screen, which displays heart rate, electro-cardiogram (ECG) and facial video. These data channels provide the operator with the majority of information from which they must make their ride control decisions. Heart information is captured using electrodes mounted on the chest, and is transmitted using a Bluetooth data aggregator. Video is captured from a helmet-mounted video camera and transmitted through a wireless video sender. The equipment is carefully designed to avoid any danger in the case of falling from the Bronco; cables are easily detached, the video sender and data aggregator are in a padded pouch that is placed to avoid impact trauma, and the mounts for the video camera are designed to bend on impact. As an additional safety precaution, three riders were employed for this event all of whom were given pre-event training in riding the Bronco. All riders were allowed to practice using the device, and were taught methods for falling safely.

The experience was presented as a staged performance called "Bucking Bronco: Adaptive Ride Experiment No.1" (known here as "The Bronco"). The ride was designed to provide an entertaining experience in its own right, and also to study how novice operators used telemetry data to inform their operation of the ride. Key characters in this performance were a showman, who controlled proceedings, the three riders, a technician who fitted and operated the sensing devices, and an expert operator who oversaw participant operator training and the safe operation of the ride at all times. The showman recruited a volunteer at a time from the audience to operate the ride. This volunteer was then given instructions by members of the crew as to how each experience would work.

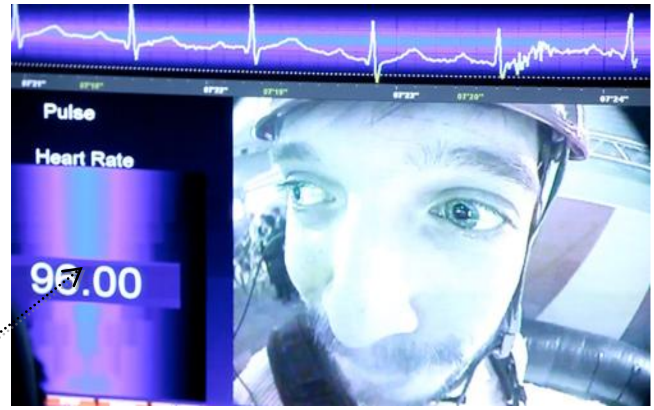

Figure 2: Operator Display Screen: Live Streaming Feeds

In the first stage of each experience one of three potential riders was selected by the volunteer. The panel of riders was chosen to have a range of thrill-seeking tendencies, using an informal evaluation based on the Zuckerman Thrill and Adventure Seeking scale [7]. Each was labeled with a chalk-board as being a low, medium or high thrill seeker. The volunteer was invited to choose a rider to take part in the experience, and was then encouraged to tailor the ride controls to match the thrill-seeking tendency of their selection. Before controlling the ride for real, each volunteer was given a chance to practice the operation of the Bronco without a rider and under the tuition of an expert operator. After each volunteer confirmed they understood the controls, a screen was drawn to obscure the Bronco, and the volunteer asked to control the ride guided by telemetry data alone. In order to provide some guidance for the volunteers as to how they should control the ride, they were asked to sequentially perform three different tasks, and the time taken for each was recorded publicly, to create a feeling of competition between volunteers. In the first task, the volunteer was asked to "please" the rider, by providing them with gentle motions, and by aiming to prompt facial expressions of pleasure. In the second task, the volunteer was asked to "scare" the rider, through motions that generate a higher heart-rate and facial expressions of displeasure. Finally, the volunteer was asked to "excite" the rider, by aiming for as high a heart-rate as possible, while still providing expressions of pleasure. In this task, the volunteer was guided towards generating increasingly challenging movements of the ride, whilst not pushing the rider so far that they fell off. However, almost all operators pushed the rider too hard in this task, causing the rider to fall off, and ending the experience of the operator.

During the day of the performance, it became clear that members of the public were most likely to choose a high-thrill rider whom rapidly became fatigued and less keen to get a thrilling ride (altering the "thrill seeking hierarchy"). This experience highlighted that rides must adapt both to the rider's general attributes such as their level of thrill seeking and fitness, and also to their current physical and mental state, which may be altered by factors such as how tired they are or other rides they have recently been exposed to.

3. EXPERIENCE AND FEEDBACK

These reflections begin by giving a flavour of the experience of a participant through the following commentary (transcribed from a recording taken during the event). In this excerpt, the participant is labeled as P, and the showman, is labeled as S. The participant here is a journalist, and was recording a piece for camera. His experience is, however, broadly typical of the experience of many of our participants on the day.

P: *I can't believe I've got a human being at the end of this joystick. So I'm just going into the bucking motion. I'm going to start with quite a low speed, and as I do that, we can see images of his face. This is very disconcerting as I can't actually see him in real life, as he's been deliberately screened away, so the only information that I'm getting about him is from this screen. Now then, so I'm bucking him around, actually, that's the spin, so I'm spinning him around, he's probably getting very dizzy. He's smiling. <to showman>, is that good, he's smiling?*

S: *Yeah, fantastic, I think we've definitely given him pleasure. Absolutely. So now we're moving on to scaring the rider. We'll be looking for facial expressions of frowning, in these muscle groups around the eyes. So that's your next task.*

P: *So my task now is to scare him. So I can change the speed, I'm going to ramp the buck speed and the spin speed up, so here we go … I'm pushing the lever forward and spinning it as well …*

S: *Oh! Did you see it? You scared him already!*

P: *You'll have to say that again.*

S: *You scared him already, and that was just 3 seconds. So now we're going into the final section where you have to excite him, so you're looking for high levels of heart-rate, you have to raise the heart-rate, whilst also still giving him high levels of pleasure. So that's your final task.*

P: *I think I'm getting high levels of pleasure myself from doing this. So I'm going to push this lever forward, we're getting this thing to buck around, and he's being flung all over the place, his face looks contorted with fear, his eyes appear to be popping out of his eye sockets, and his heart rate's gone up to 123, it was originally 90 by the way, 128 now, 126, he's showing a lot of displeasure and fear on his face, 130 on the heart-rate, I'm going to go for some really serious spinning now and some bucking motion, bringing all these horrible motions together, 130 heart-rate, going down to 128, so I'm going to crank up the speed, he'll probably fall but here we go, I deliberately gave him a few seconds gap to give him a false sense of security, now I'm almost at full speed, and I'm trying to get that heart-rate higher than 130 … I think he's fallen off! His heart-rate goes up to 186 momentarily! Its back down to down to 140. I've actually thrown him off … I can't believe I've done that to a fellow human being.*

In addition, feedback gathered from the Pioneers 2009 event included a post-session interview conducted with participants after immediately after their session had ended. Four specific questions were asked of six participants regarding their options of the experience, with a final general discussion point concerned future rides:

What was your experience of controlling someone on the ride?

All participants agreed that controlling the ride was fun. One indicated that pushing a participant to a limit, as indicated by the expression on her face, was particularly enjoyable. A second, however, said that she was a bit scared of hurting the rider. A third described his experience as "strange".

Were you in control of the rider's experience?

All participants agreed that they were in control to some extent. One participant described the evolution of his feelings of control in more detail. He reflected that while early on, he didn't feel in control at all. However, as he got used to the control panel, and as he learnt to interpret the rider's facial expressions and heart-rate, he felt in more control.

Could you sense a relationship between the data you saw and the rider's experience?

This question provoked a wide variety of responses. Most participants managed to extract some information from the telemetry data, although one participant struggled to interpret it at all. Some participants focused on the facial expression data stream, and identified an indirect relationship between this and their control of the ride. One participant, however, seemed to learn how to interpret both facial expression and heart-rate data streams together, and to make use of these in his control of the ride. He describes how, at one point, where he was moving the ride quickly, he noticed a strong correlation between the rider's heart rate and facial expressions. He then interpreted as meaning that he had caused a particularly strong response.

What would you think of being on the ride if it were being controlled by someone else?

This question also elicited a variety of responses with two participants said they would not like to be on the ride with someone else controlling it, and one said they would. A further individual indicated that they would be willing to be controlled by someone who they trusted and another indicated that they would be happy to be controlled as long as someone who they trusted could step in during an emergency.

General thoughts of future ride experiences?

Finally, participants were asked their thoughts on a future ride that could somehow be tuned to their own responses, through telemetry data. All said that this would be interesting. Several participants wondered whether this could be done by computer. One indicated that she would be less scared of a computer-controlled adaptive ride going wrong, another indicated that fear of the a computer-controlled ride going wrong would add to the "scary, adrenalin-fuelled impact of the ride itself".

4. DISCUSSION

The Bronco was a first investigation into the potential of live telemetry data to augment the task of operating a ride, in order to give a better experience to those who are participating in the ride. This investigation has provided an initial proof of concept and has revealed several interesting issues for future work.

Although some participants reported struggling to extract any information from telemetry data, several managed, at least, to make use of facial expression video in their control of the ride.

This could be expected since humans are expert at the interpretation of others facial expressions since it is something that most individuals do regularly during the process of interacting with others. A smaller number of participants felt that they could make use of heart-rate data in their ride-control; this may reflect a lack of everyday expertise in the interpretation of this data, and that this data stream, on its own, may not be much use for operators without a greater degree of expertise in interpreting heart-rate response.

A potential future investigation therefore may be to allow operators substantially more time to gain experience of heart-rate data, and to investigate whether their use of it in controlling rides can improve over time. Additionally, an interesting challenge may be the development of techniques that can support this process, whether they consists of expert tuition, or of automated processes that apply some degree of processing to telemetry data to convert it to a form which is more amenable to its use in ride control. Such techniques may run continuously whilst a ride is in operation, and they may fuse multiple data channels together in order to allow an operator to rapidly make sense of complex data from multiple channels in real time. Finding good methods to present processed and fused data channels, in real-time, and in a way which makes them amenable for use in ride operation then becomes another challenge for future work.

Moving beyond the issue of supporting ride operation, consideration should be given regarding who is actually being entertained by the installation. Traditionally, fairground rides are thought of as being entertainment for riders. However, in the case of The Bronco at least, it is obvious that substantial amounts of entertainment are also provided for the operators. All operators indicated that they enjoyed their experience, and some substantially so. Partly, this may be due to the interesting challenge of making use of varied data streams to control a ride, and partially it may relate to the unpredictable responses of the human riders. In some ways, The Bronco, as performed at Pioneers 2009, has more similarities to a computer game with a real human as a subject, than to a traditional fairground ride; operators are given tasks to complete, and are scored on their success. Interpreted in this way, the experience may fit more closely with those that integrate real humans into gaming, such as Can You See Me Now [3] by Blast Theory. Ultimately, there may be potential in creating rides in which humans are both (at least partial) operators as well as riders.

Casting real humans as characters in games raises interesting ethical issues as one of our volunteers observed, and an important issue is one of dehumanization. Although one participant was clearly thinking of the rider that she was controlling as a human ("I was a bit scared of hurting him"), for others, the rider seemed to be somewhat dehumanized. As an example, one operator talked about the difficulties of empathizing with another human who is only being seen through limited data channels; other operators however commented on getting enjoyment from pushing riders to their limits, as indicated by facial expressions of displeasure. This highlights that care must be taken to encourage controllers to think of the rider as a real person, to avoid people treating riders badly. In this experiment, the showman felt that controllers possibly had more empathy when they spent more time interacting with the rider at the point the rider was chosen, which suggests that personal contact between controller and rider may be useful to minimize these effects. Future work will rerun the experiment with riders and controllers who are already previously acquainted, to discern whether this existing social bond aids them in interpreting the responses of the rider. Other work will only allow people to operate the ride after they have themselves experienced it in person. This may serve to enhance their understanding of the ride experience and perhaps their empathy with other riders.

A related issue is that of safety – both perceived and actual. As with any ride, great attention was paid to safe construction and operation of the experience, including provision of training, expert monitoring and a manual safety override. Another important aspect to be explored in future work will be the provision of an 'envelope of control' that constrains actions of human operators to be within 'normal' limits. As with many machines, it may be sensible to constrain the range of allowed movements of the ride to be a subset of those that are feasibly possible and that also fall within the comfort zone of riders.

Finally, as well as improving the telemetry enhanced ride operator experience described here, future work also intends to apply lessons learnt from human rider operators to the creation of automated rides, using a computer system to adapt the ride based on the recorded telemetry data. This project will require both creation of real-time analysis tools to interpret the rider's responses, and a system to create rides based on this analysis. The experience reported in this paper, and indeed future trials with The Bronco, will provide valuable data about how humans control such a ride to inform the design of automated approaches.

5. CONCLUSION

This paper has described an experiment in the use of telemetry by ride operators in order to tailor a fairground ride to the individual riders. This experiment has demonstrated the feasibility of using telemetry data to control a ride and has provided an insight into the experience of controlling such a ride. This may be useful both for future experiments creating telemetry for human ride controllers, and also potentially provides useful inspiration for the creation of automated rides which respond to telemetry.

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