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PPR524

Matching speed production in real and simulated driving environments

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Transport Research Laboratory

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Matching speed production in real and simulated driving environments

by C Diels, A M Parkes (TRL)

Prepared for: Project Record: **Speed production in the TRL driving simulator**

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(Neil Paulley)

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Abstract

Despite geometrically correct optic flow displayed on large Field Of View displays, a common observation in driving simulators and other Virtual Reality systems is that visual speed is underestimated leading to speed overproduction. This may compromise the validity of human behaviour in these environments. In a previous study we have demonstrated that manipulation of the Geometric Field Of View (GFOV) potentially provides a subtle technique to improve speed production, and hence, simulator validity. To determine optimum GFOV settings, the aim of this study was to compare speed production performance in simulated and real driving using identical experimental methods and procedures. This is because (i) speed underestimation may also occur in the real world, and (ii) speed perception and production performance varies widely depending on the methods employed. Results showed that the produced speed was 9% and 4% higher in simulated and real driving, respectively, compared to target speed. On average, drivers drove 5% faster in the simulator compared to the test track. Based on the linear function of GFOV and speed production as determined in our previous study, it was concluded that a GFOV/FOV ratio of 1.119 provides optimum speed production in the TRL driving simulator.

1 Introduction

Despite geometrically correct optic flow, a common observation in driving simulators and other Virtual Reality (VR) systems is that visual speed is underestimated leading to speed overproduction [1-2]. This may compromise the validity of human behaviour in these environments. In a previous study we have demonstrated that manipulation of the Geometric Field Of View (GFOV) (see Figure 1) potentially provides a subtle technique to improve speed production, and hence, simulator validity [3]. To determine optimum GFOV settings, the aim of this study was to compare speed production performance in simulated and real driving using identical experimental methods and procedures. This is because (i) speed underestimation also occurs in the real world [4], and (ii) speed perception and production performance varies widely depending on the methods employed [5]. Discrepancies between real and simulated driving performance can then provide input to adjust the GFOV accordingly.

Figure 1: Screenshots of the urban environment in 3 GFOV settings. GFOV/FOV ratio 1:1 = optic flow displayed geometrically correct

2 Method

2.1 TRL driving simulator

Manual 2001 Honda Civic car running SCANeR II (OKTAL) simulation software; 3 forward screens (1280×1024 pixels per channel) giving a 210° horizontal FOV; 3DOF motion and vibration; stereo sound system providing engine, road, and traffic sounds (Figure 2).

2.2 Test track vehicle

2007 Mk5 Golf 1.4 TSI petrol; engine configured to produce 90 bhp in line with the simulator vehicle performance (Figure 2).

Figure 2: TRL driving simulator (left) and test track vehicle (right)

2.3 Procedure

Following a brief training session with the speedometer visible, the speedometer was then covered. In the simulator, 16 experienced drivers produced six target speeds (20,30,40,50,60,70mph); a further 12 participants produced 4 target speeds (20,30,50,60mph) on the test track using the same methodology.

Speeds were tested in pairs of low and high speeds (e.g. 30, 50mph). Participants were asked to accelerate up to one of the target speeds. When indicated to have reached the target speed, they were then asked to accelerate or decelerate to the next target speed after which they were asked to bring the vehicle to a halt. Each target speed pair was tested twice in a balanced order to control for speed adaptation.

3 Results

As shown in

Figure **3**, both in the simulator and on the test track, drivers underestimated their speed resulting in a subsequent overproduction of speed which, on average, was significantly higher in the simulator (9%) compared to the test track (4%) ($F_{(1,104)}=5.220$; $p=.024$). Presentation order did not affect speed production ($p>.05$).

Speed production errors in the simulator tended to be higher towards the lower target speeds. However, differences across target speeds in both the simulator and test track were not significant ($p>.05$).

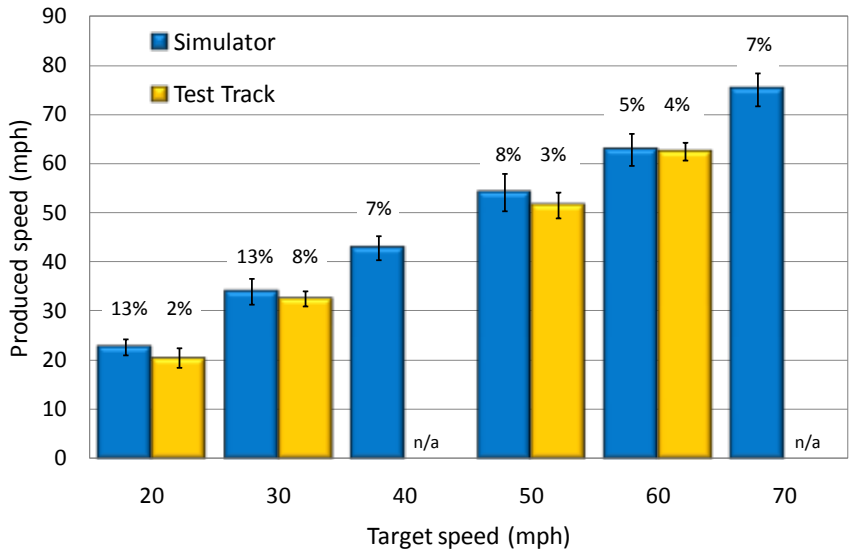

Figure 3: Mean produced speed (mph) and percentage overproduction for each target speed for simulator and test track (±95% CI)

Speed production errors in the simulator tended to be higher towards the lower target speeds. However, differences across target speeds in both the simulator and test track were not significant (p >.05).

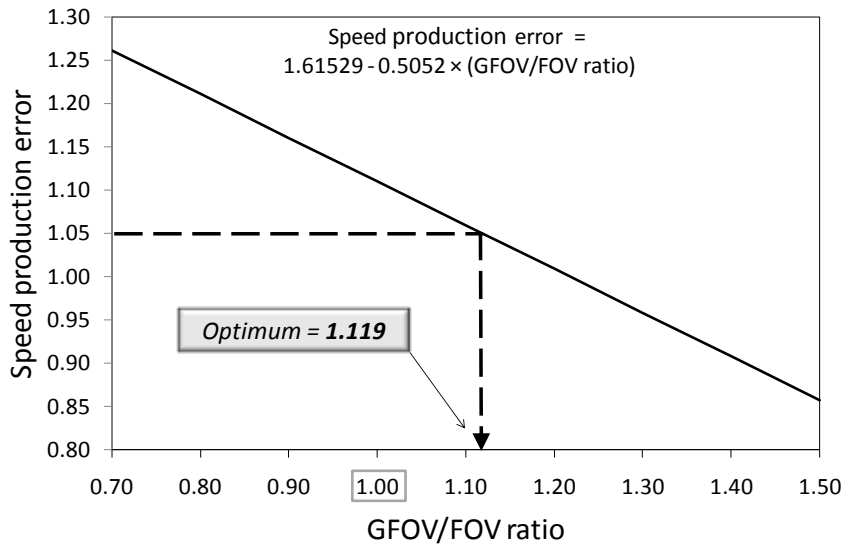

Figure 4: Linear relationship between speed production error and GFOV setting and optimum GFOV/FOV ratio

Based on the average difference in speed production error between the simulator and test track (5%), an optimum GFOV/FOV ratio for the TRL driving simulator was determined at 1.119 (Figure 4).

4 Conclusions

- Speed production did not depend on prior vehicle speed.
- Produced speed was 9% and 4% higher in simulated and real driving, respectively, compared to target speed. On average, drivers drove 5% faster in the simulator compared to the test track.
- Based on the linear function of GFOV and speed production [3], a GFOV/FOV ratio of 1.119 provides optimum speed production in the TRL driving simulator.
- Although non-significant, differences in speed production error across target speeds suggest the possibility of (i) multiple optimum GFOV settings dependent on typical driving speeds in simulated scenarios or (ii) dynamic GFOV settings according to driving speed.

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