Driving simulator: an innovative tool to test new road infrastructures

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Introduction

With the Driving simulators, we can :
- achieve complex tasks at a relatively low cost.
- test and compare different existing or new road configurations or equipment.
- determine how road design solutions are perceived and understood by the drivers, and which driving behaviour are generated.

→ The managers of road networks are particularly interested in the acceptance of these solutions by the users, in their impacts on the speed and the lateral position of vehicles, or in their impact on traffic safety.

## Configuration of Driving Simulators
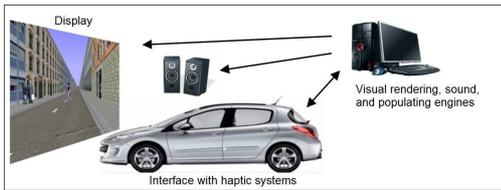
Fig. 1. Simplified representation of a driving simulator

Examples of research aiming at improving simulators for road configurations testing:

- High Dynamic Range (HDR) visual rendering for more realistic luminance and contrast levels [1];
- Stereoscopic display for improved distance perception and feeling of presence;
- Inertial (on the dynamic platforms) and haptic feedback for improved control;
- A Behavioural multi-agent traffic simulation model.

Advantages / Requirements of driving simulation

Advantages	Requirements
Allows to test hazardous situations	Realistic 3D database
Control and reproducibility of the driving situations for all participants	Actors inside the virtual world capable of natural interactions
Easy scripting of non-existing road features	Algorithms for lighting and sound rendering
	Techniques to limit the simulator sickness
Allows to record all traffic data and subjects' actions	Techniques for good distance and speed evaluations

Fig. 2. Advantages and requirements for road evaluation

Simulators and experiments validity

Four levels of simulators' validity: (1) physical, (2) experiential, **(3) ethological (i.e., adopted behaviour)**, (4) psychological.
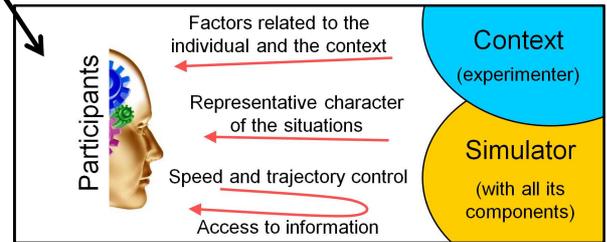

Fig. 3. Factors that influence the behaviour of the participants

Each factor should be taken into account when looking for ethological validity. The importance of the **pre-experiment**, the **familiarisation task**, and the **instructions** given to participants should therefore be emphasized.

Examples of simulator-based studies

**Audio-tactile systems
Real and virtual
(ROADSENSE ANR Project)**
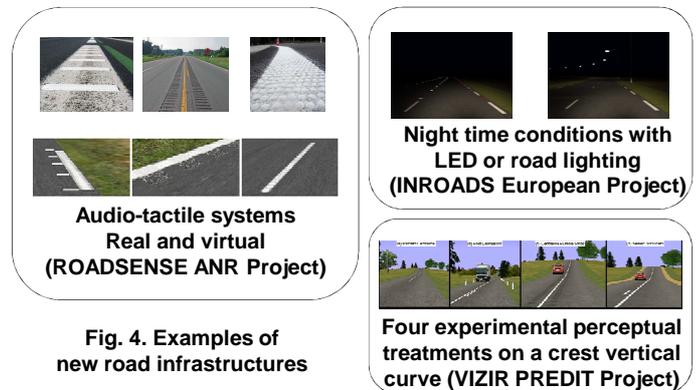
Fig. 4. Examples of new road infrastructures

**Night time conditions with
LED or road lighting
(INROADS European Project)**

Four experimental perceptual treatments on a crest vertical curve (VIZIR PREDIT Project)

Conclusions

- Importance of ethologic validity for having similar behaviours on a simulator and on the road.
- Assume that it will derive from experiential or physical validity.
- Compare behaviours on a simulator with behaviours in situ for a limited number of controlled reference conditions → assume that the validity applies to other conditions.
- The configuration of the driving simulator is important and depends of the experimentation [2].

Recent references

1. Shahar, A., Brémond, R. (2014). "Toward smart active road studs for lane delineation". *Transportation Research Arena*, Paris, April 2014.
2. Rosey, F, & Auberlet, J.M. (2014). "Impact of a driving simulator configuration on drivers' behavior: example with rural intersection studies", *93th TRB Annual Meeting*. Washington D.C., USA, 2014.

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