SIMULATION AND PERCEPTION OF MOVEMENT

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1. DRIVING SIMULATORS

The perception of movement, in particular during automotive driving, is studied since a long time (Gibson, 1938). It is generally considered as a visual task and several variables are proposed for characterisation (tangent point, Land and Lee, 1994; time to contact, Lee, 1976 or splay angle, Beal and Loomis, 1996).

The difficulty nevertheless consists in the study of the simulator architecture, especially when this includes motion rendering and/or Virtual Realities (VR) display systems.

These variables are taken into account more and more frequently (G. Reymond and al, 1999) for simulator evaluation and assessment with simulator and real vehicle data comparison.

Figure 1 : Simulator proyotyping, CARDS project,, Eureka n°1924

2. VIRTUAL REALITY TECHNIQUES :

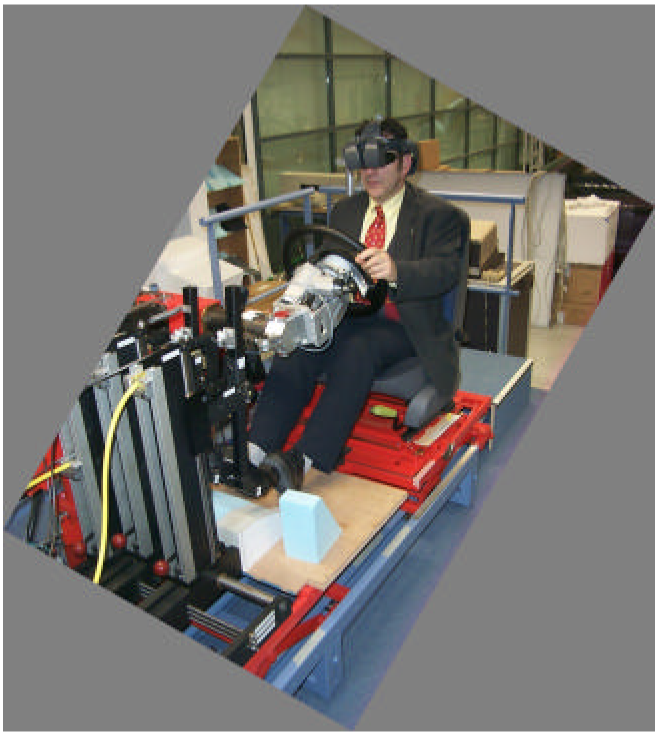
Virtual Reality Techniques (VR) are integrated progressively in driving simulator architectures. One example is Volvo's static simulator, installed in 1993, using head mounted display (Virtual Reality and nVision with FASTRAK sensor) and Cyberglove.

Renault's Driving Simulator and Virtual Reality Research Group has equipped an ergonomics conformator with head mounted display (KAISER Proview 60) in 1999. It is also the leader of the European Eureka n°1924 CARDS project since 1998 which aims the study and the development of a motion based simulator with vibration seat and large field-of-view head mounted display to be provided respectively by Hydraudyne, Pons and SEOS who are project partners. Other partners are Infotron, specialised in VR, as well as FEL/TNO and LPPA/CNRS-Collège de France, for sensor and simulation fidelity characterisation.

The utilisation of this device as a research tool as well as the very notion of *immersion* are crucial, in particular that of the body and movement of the driver in the simulated spatio-temporal reality.

The perception of this reality by a user dealing with virtual objects is function of the rendering quality of visual (depth cues, vection, optic flow) or auditory stimuli, but also of the integration of the actions of the user in the sense of Gibson. The visualisation of the user are to be carried out, namely by rendering haptic and kinesthetic stimuli.

Figure 2 : The ergonomic conformator of Renault equipped with the SCANeR simulator software



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3. VISUAL PERCEPTION OF DEPTH AND MOTION

A key issue is the validity in depth perception (especially absolute) due to erroneous or partial rendering of visual depth cues by VR systems used so far, or to erroneous or inexistant force feedback contributing to visuo-motor perception.

Some visual depth cues produce conflicting stimuli since VR helmets technology use fixed optical collimation distances (virtual observation distance) which are predefined to 3-3.5 meters in general, whereas image generator may vary the binocular convergence depending on the observed object.

This conflict between visual cues may induce an important uneasiness especially when observing near objects such as dashboard, steering wheels, gearshift, and may induce difficulties in binocular fusion or relative distance perception.

Using stereoscopic display requires the use of binocular goggles coupled to a head tracker to avoid a conflict with the motion parallax visual cue. Therefore, a proper depth perception requires the use of individual systems. This fact, besides gains in sizes, unlimited field of view, and level of immersion, makes VR helmets excellent candidates for driving simulators display devices.

Vection, a visually-induced perception of self-motion, relies on visual cues such as the optic flow. Vection also depends on the coherence between visuo-vestibular stimuli and anticipation (the driver expects to be pushed forward when initiating braking), which requires to respect the multi-sensory and cognitive coherence.

Motion perception being also a visuo-vestibular effect, timing discrepancies in the rendering of visual and inertial motion may produce some uneasiness above 10-50 ms depending on the simulator architecture and the driving tasks considered.

Using VR technology with motion platforms makes this integration even more difficult due to the extra transport delay. Indeed, using VR helmets requires to measure the position and orientation of the head and possibly gaze. Physical generation of motion cues by a mobile platform makes use of control techniques which also introduce transport delays (time constants).

It is to be expected, since the validity and acceptance of driving simulator depend on it, that many research studies will be conducted in the future to characterise the visual, vestibular and proprioceptive perception of motion by drivers, on real and simulated vehicles.

<u>Figure 3</u> :VR room at Renault with helmet and stereoscopic screen

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