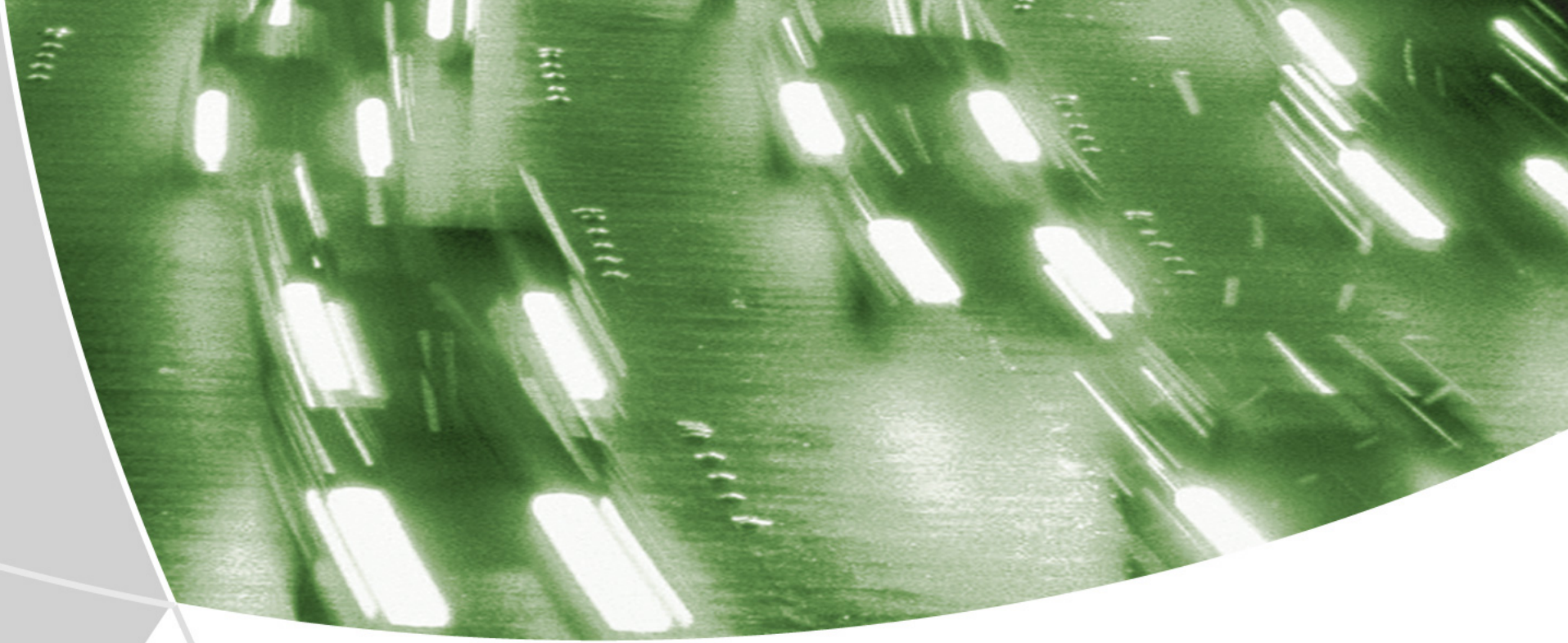


Opposing Aspects in Motion Cueing

Motion Cueing at DLR

Dipl.-Ing. Martin Fischer, 2nd Human Centered Motion Cueing Workshop, 30.03.07

The Simulator

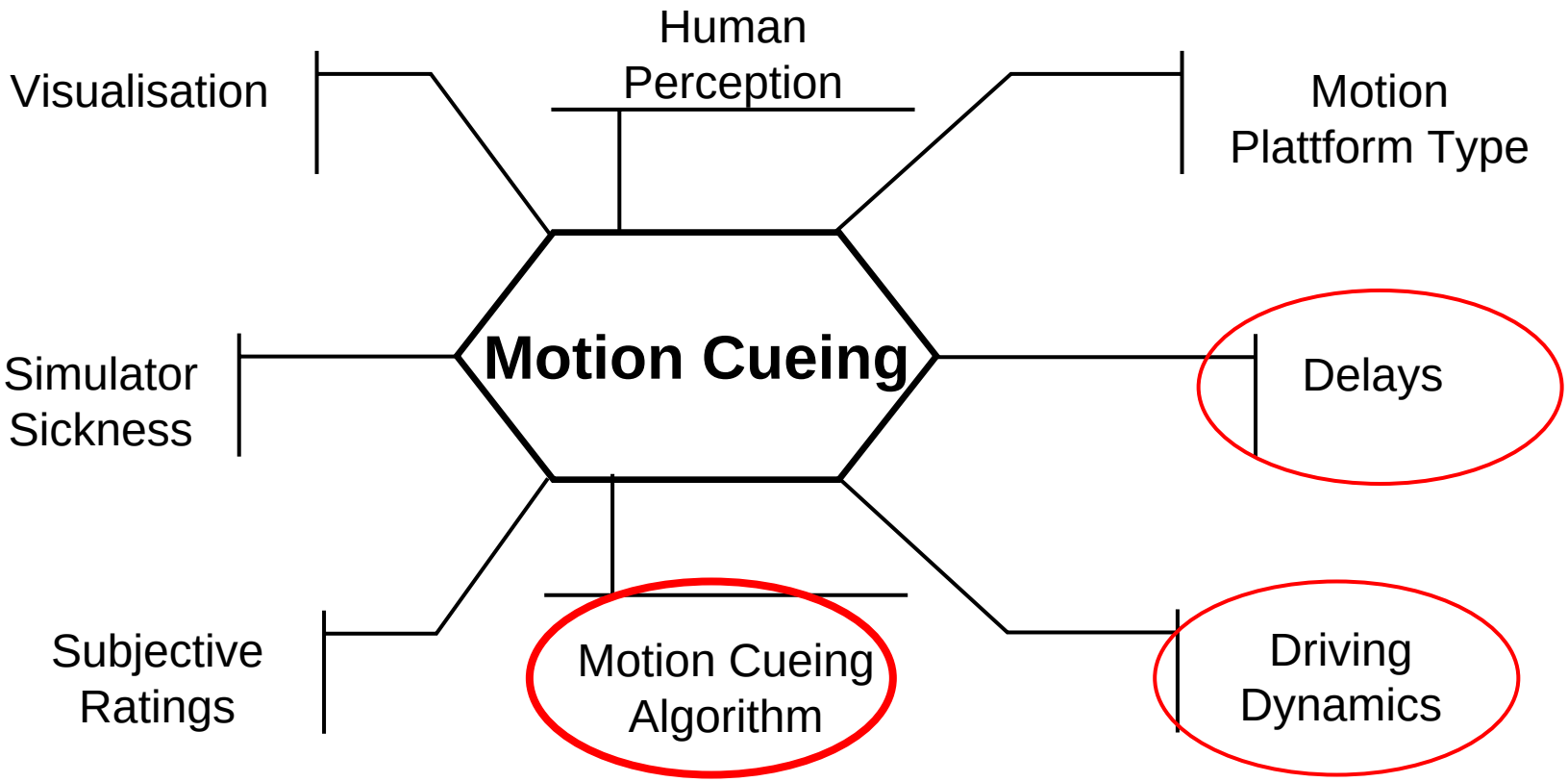
Simulator Facts

- Motion Capabilities

	Position	Acceleration		Position	Acceleration
Surge	±1,5 m	±10 m/s²	**Roll**	±21 °	±250 °/s²
Sway	±1,4 m	±10 m/s²	**Pitch**	±21 °	±250 °/s²
Heave	±1,4 m	±10 m/s²	**Yaw**	±21 °	±250 °/s²

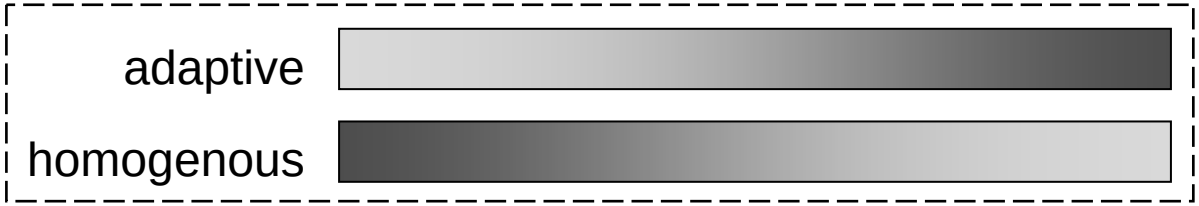
- Full cockpit
  - force feedback steering
  - active brake pedal
- Visual system
  - 270° x 40° field of view
  - TFT-displays in outside mirrors
  - Large LCD-screen on backseat as rear view mirror
- …

Important Motion Cueing Factors

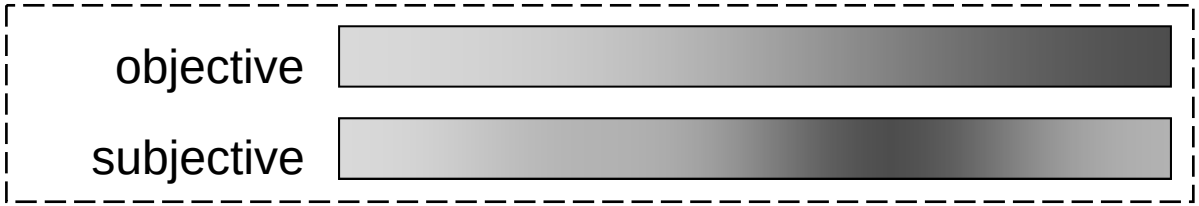


Opposing Aspects I

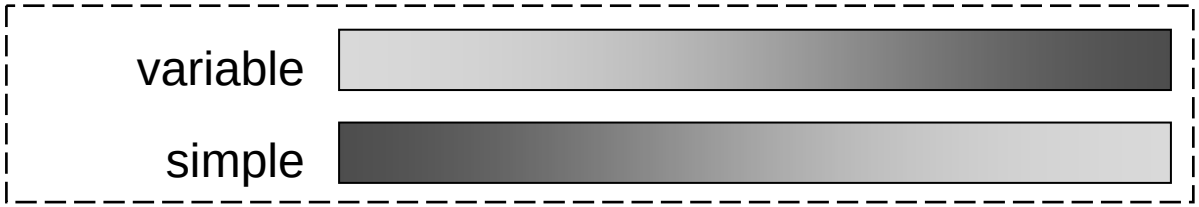
Motion Response



Realism

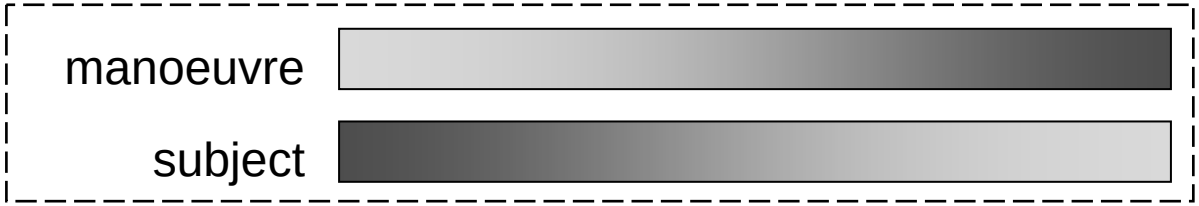


Tuning Options

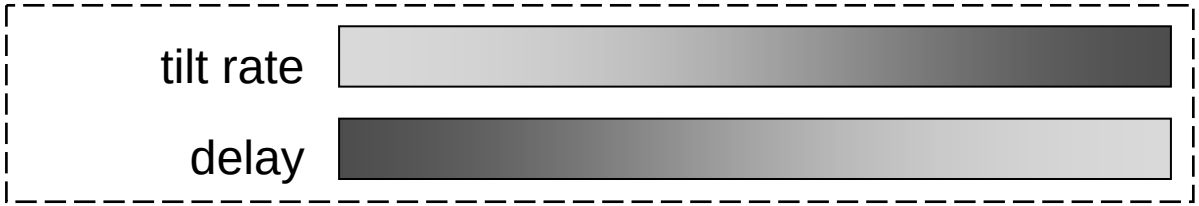


Opposing Aspects II

Tuning Criteria



Sustained Accelerations False Cues

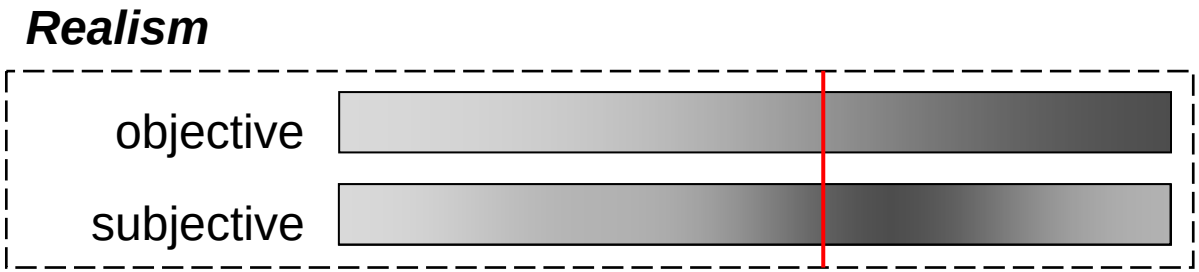


Motion Cueing Studies

Phase II – Objective vs. Subjective Rating

- Phase II
  - 12 drivers
  - Real world vs. simulator driving
  - Different manoeuvre specific MCA parameter sets
  - Subjective ratings vs. objective driving data analysis

- Subjective ratings and objective driving data analysis results correspond
- Driving (braking) behaviour in simulators is repeatable

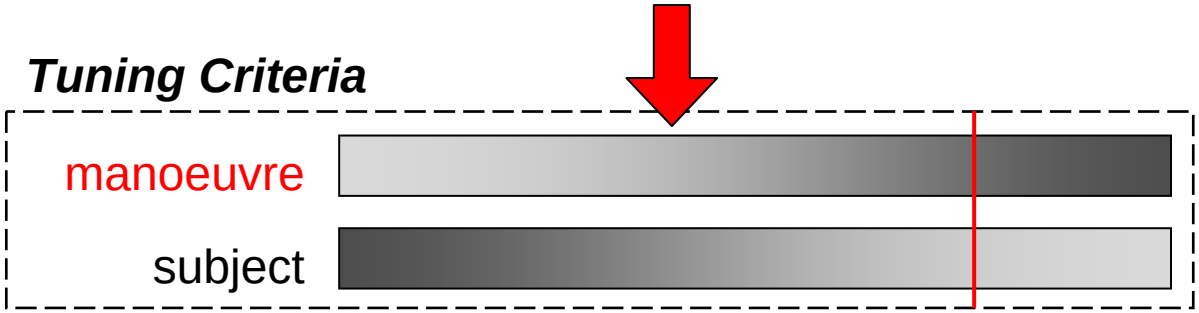


Motion Cueing Studies

Phase III / IV – Manoeuvre vs. Subject based tuning

- Phase III
  - 4 „normal“ drivers
  - Subjective rating of different classical washout parameter sets

- Phase IV
  - 3 expert drivers (expert knowledge in driving dynamics)
  - Self-tuning (manoeuvre specific)
  - Subjective rating of own tuning vs. given parameter set

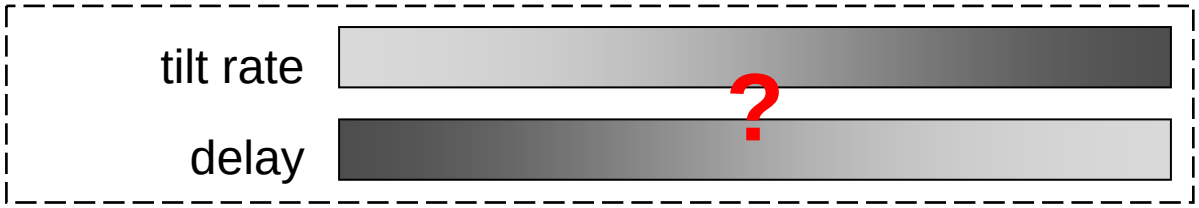


Motion Cueing Studies

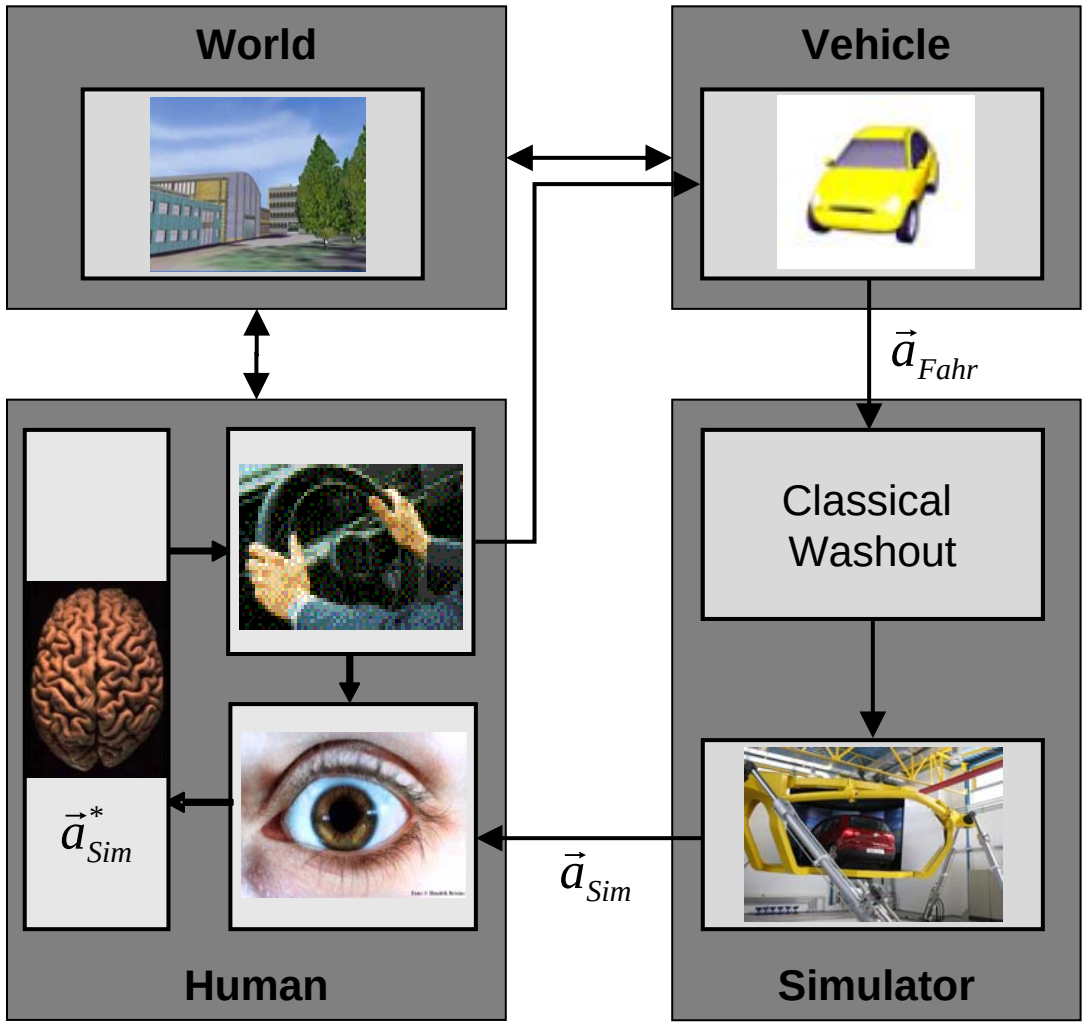
Phase V – Sustained Acceleration false cues

- Phase V (June 2007)
  - 15-20 students
  - perception thresholds
  - influence of tilting point position

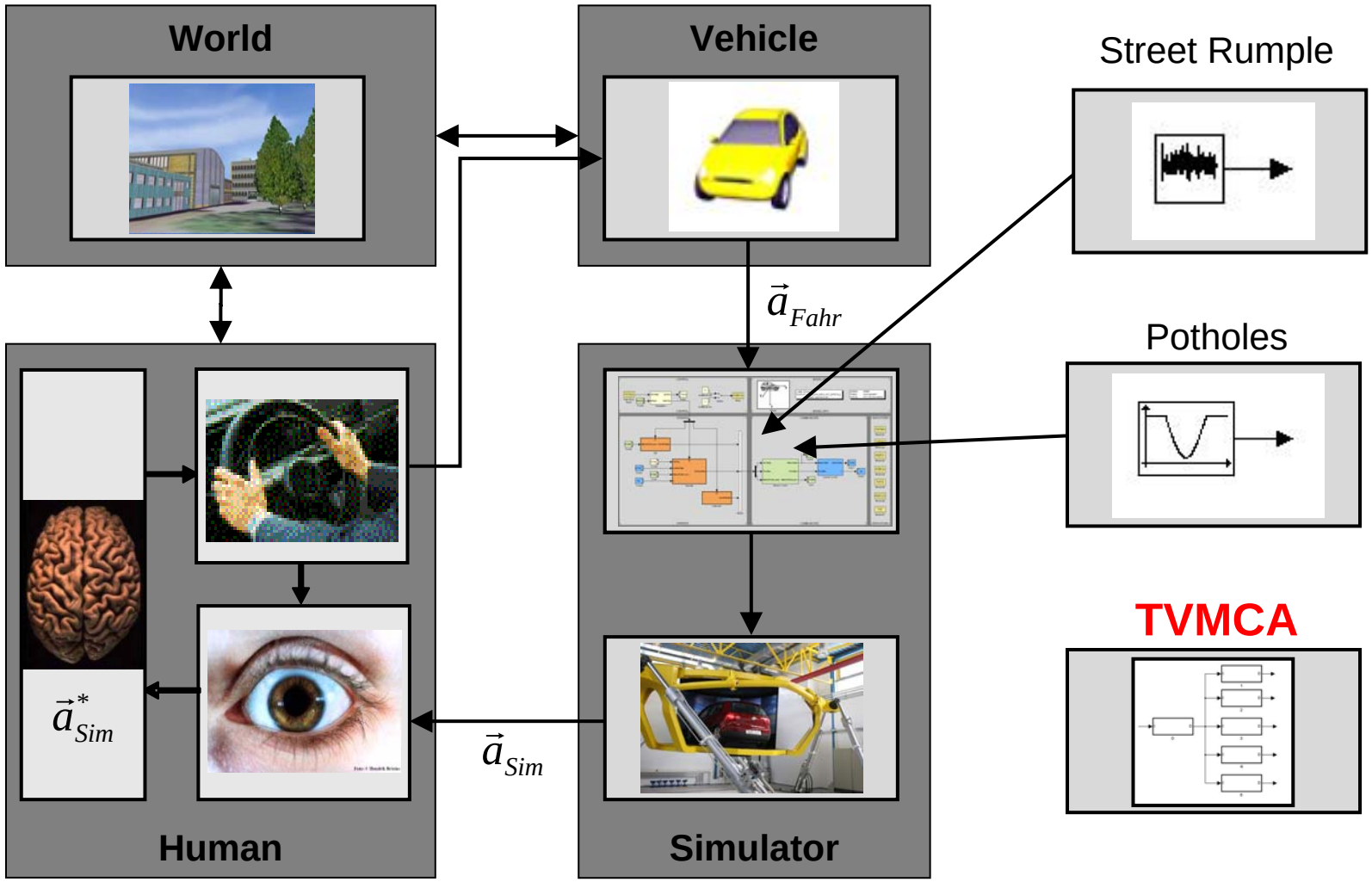
Sustained Accelerations False Cues



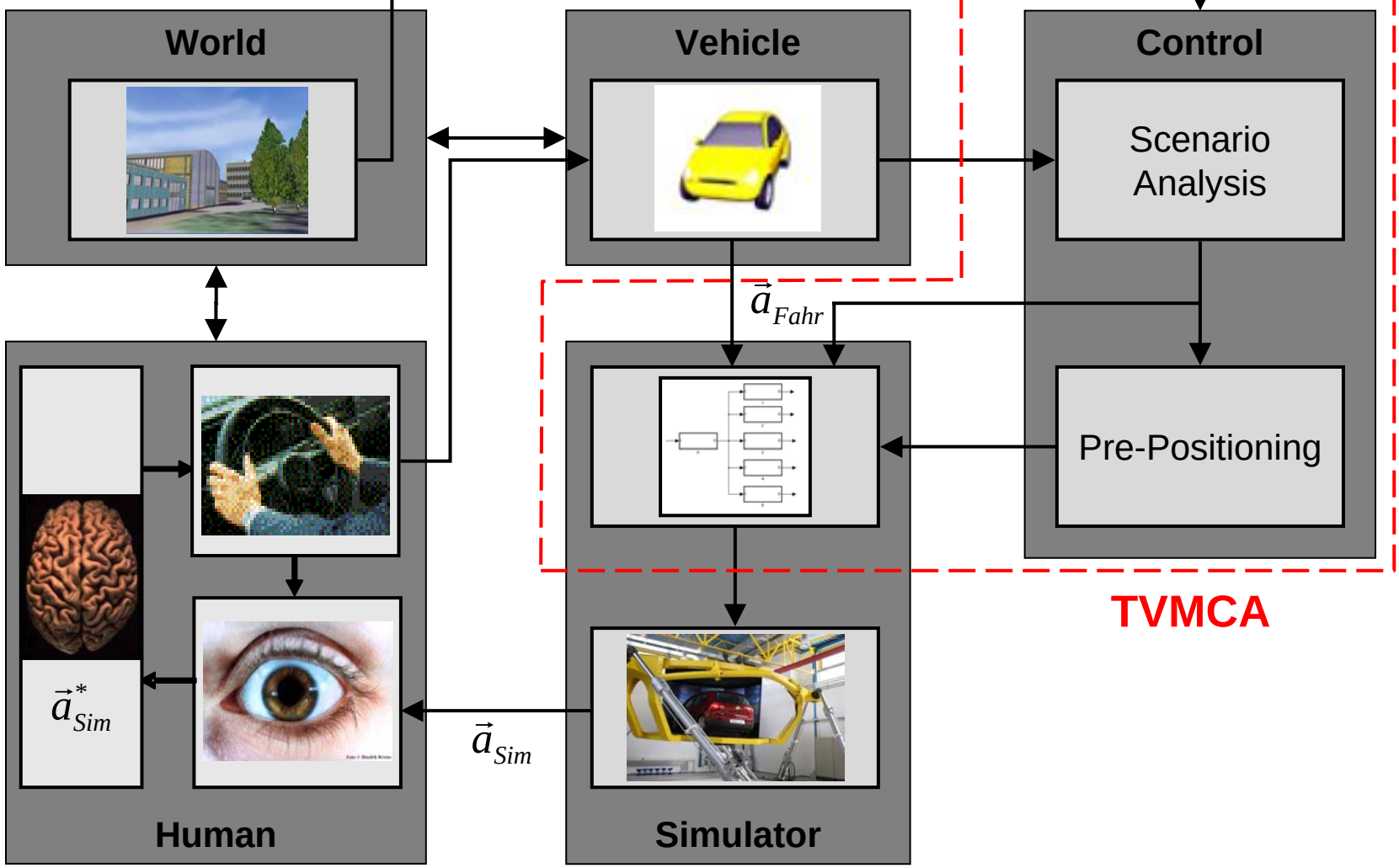
Simulation


World
Vehicle
$\vec{a}_{Fahr}$
Classical
Washout
$\vec{a}^{*}_{Sim}$
$\vec{a}_{Sim}$
Human
Simulator

Simulation

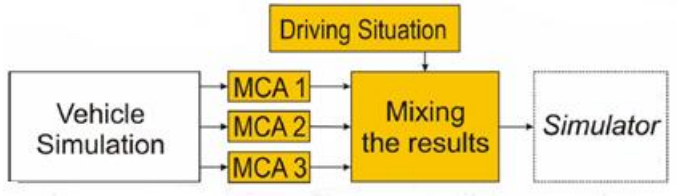

World
Vehicle
Street Rumple
$\vec{a}_{Fahr}$
Potholes
TVMCA
$\vec{a}^{*}_{Sim}$
$\vec{a}_{Sim}$
Human
Simulator

Simulation

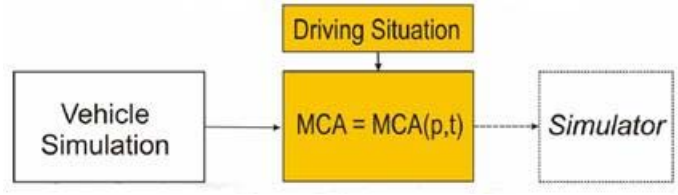

World
Vehicle
Control
Scenario Analysis
$\vec{a}_{Fahr}$
Pre-Positioning
TVMCA
$\vec{a}^{*}_{Sim}$
$\vec{a}_{Sim}$
Human
Simulator

Time Variant Motion Cueing Algorithm

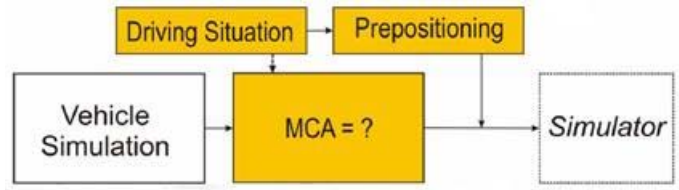
- Structural Changes
  - Soft switching!



- Time Variant Filter Parameter
  - Additional washout!

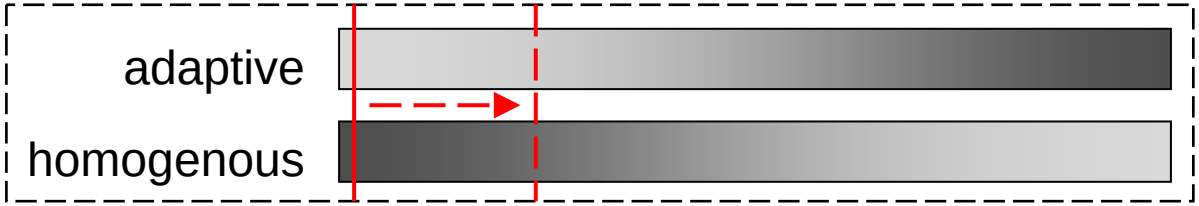


- Prepositioning
  - Unidirectional movement!

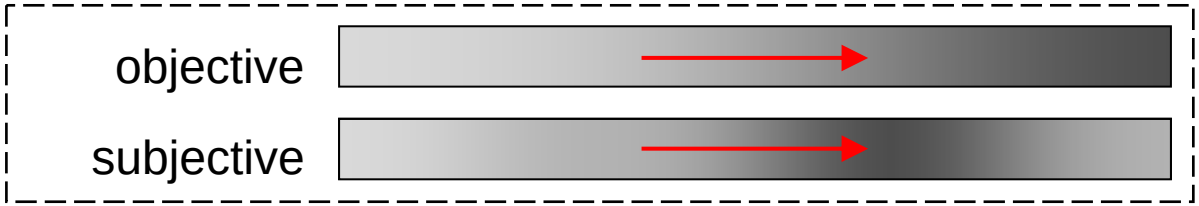


Time Variant Motion Cueing Algorithm

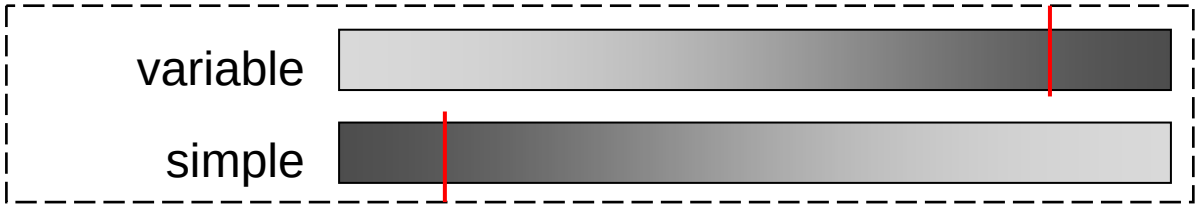
Motion Response



Realism



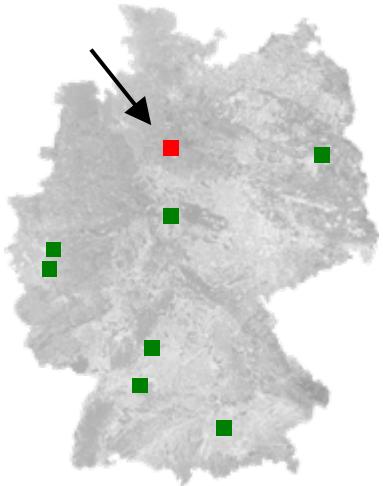
Tuning Options



3rd HCMC Workshop & Motion Simulator Conference

- 3rd Human Centered Motion Cueing Workshop

  - At DLR Institute of Transportation Systems in Braunschweig - www.dlr.de/fs



- 2nd Motion Simulator Conference
  - Invitation will be send in Mai
  - Conference will be at the end of September in Braunschweig
  - More information: www.gzvb.de

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