

Driver observation in car simulators: added value of observation technologies such as eye tracking and driver model identification

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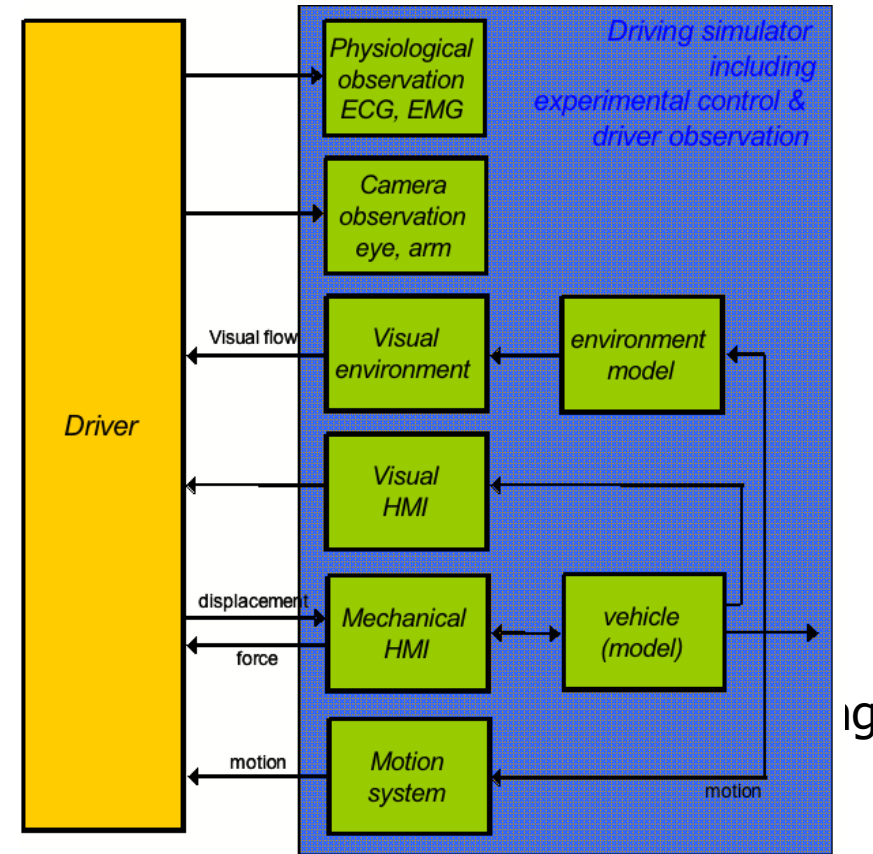
Diving Simulators - Outline

Driver in the loop testing

- Suspension
- Steering system
- Tyres
- Driver information & support systems

Simulator Technology

- Motion
- Visual Systems
- Sound
- Steering feel



Simulator Technology

Motion hard- & software



6-9 DoF

3

Simulator Technology



4

Simulator Technology

- Visual systems
 - LCD / TFT
 - Projection / screen

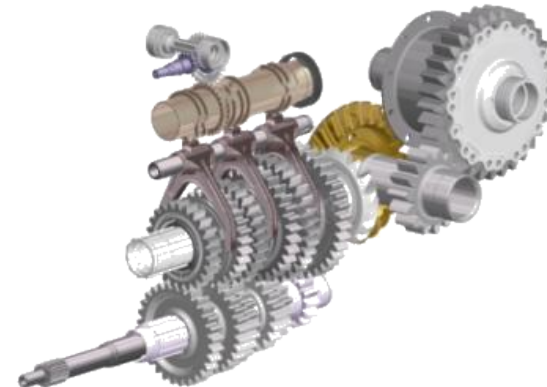
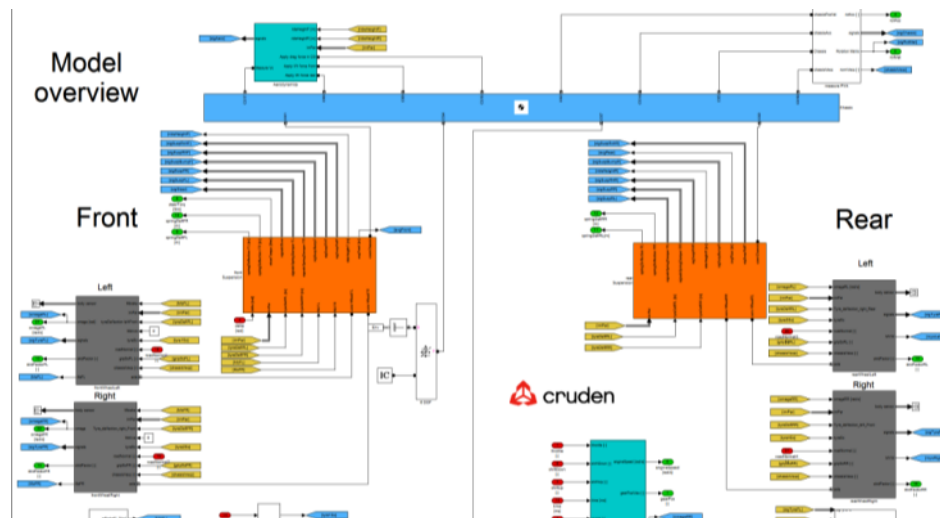
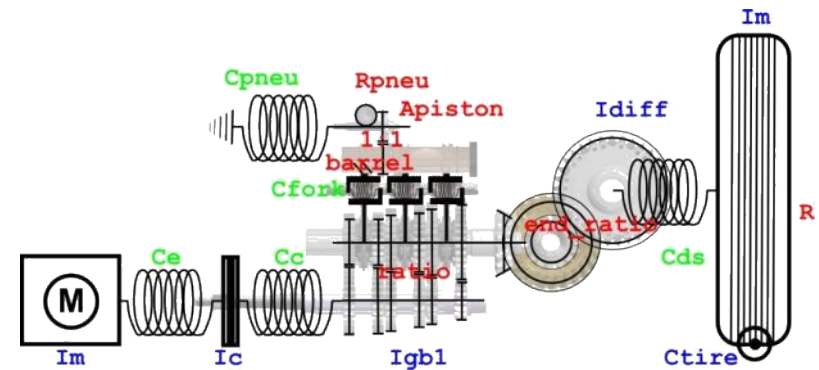
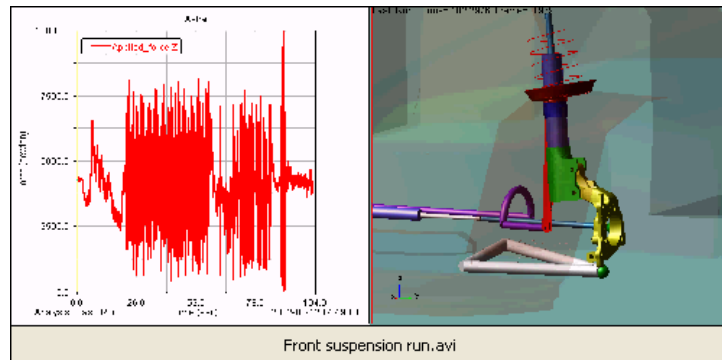


- 3D scenery
 - Cars
 - Environment
 - Tracks



Simulator Technology

Simulation software & vehicle models



Eye Tracking

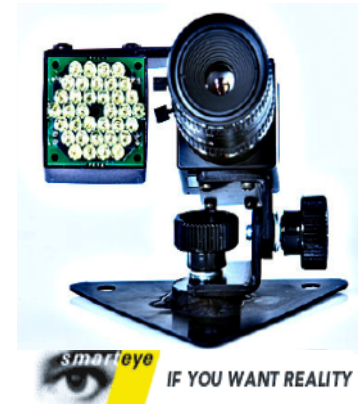
- Measure driver's visual focus & head orientation
 - Accuracy 0.5-1 deg
- Non intrusive
 - Analysis of streaming video, nothing to wear
- Active IR illumination
 - Accommodate varying light: sunlight, night, tunnels, alleys
 - Patented method for removing reflections in glasses
- Multiple cameras (2+)
 - Flexible camera position



Eye Tracking

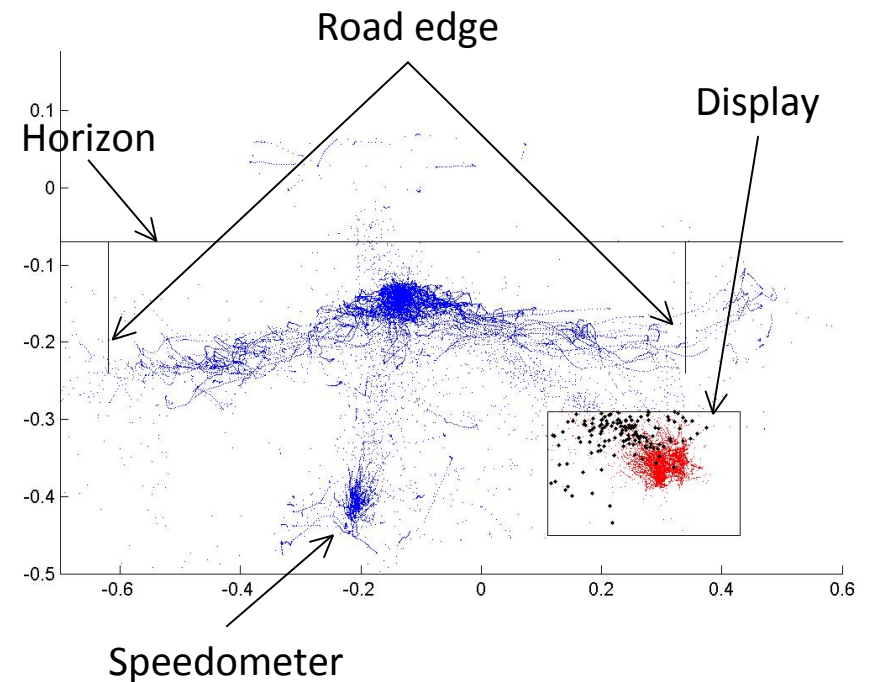
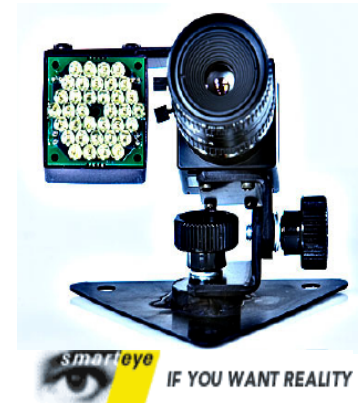
- Head position and rotation (6 DOF)
- Gaze direction*
 - 3D vector, 2D point on plane, pixel on screen
- Eyelid opening*
 - Distance in mm between lower and upper eyelid
- Pupil size*
 - Size of pupil in mm

** Consensus or both eyes individually*

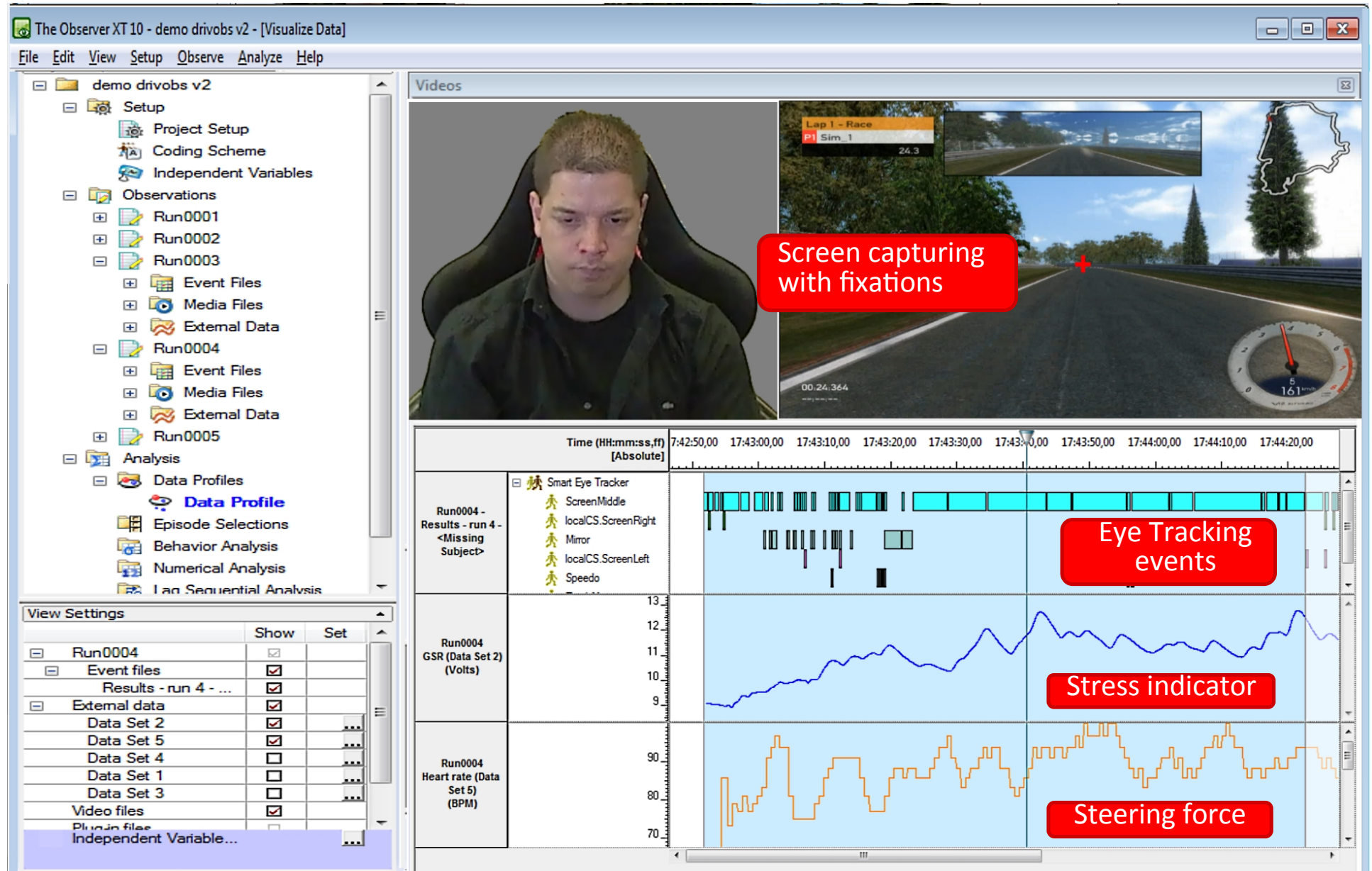


Results Eye Tracking

- Visual scanning of
 - Road
 - Instruments
 - Navigation, radio etc
 - Mirrors
 - Road signs
 - Other road users
- Automated analysis for objects fixed in simulator
- Moving objects still manual



Integrated data analysis



Integrated data analysis

Behaviour

- Body posture
- Eye movements
- Facial expressions
- Gestures
- Verbal comments

Driving Performance

- Driver input
- Vehicle motion
- Motion with respect to road and other road users

Physiology

- Emotional state
- Galvanic skin response

Mental load

- Heart rate variability
- Pupil diameter
- Respiration
- Facial temperature

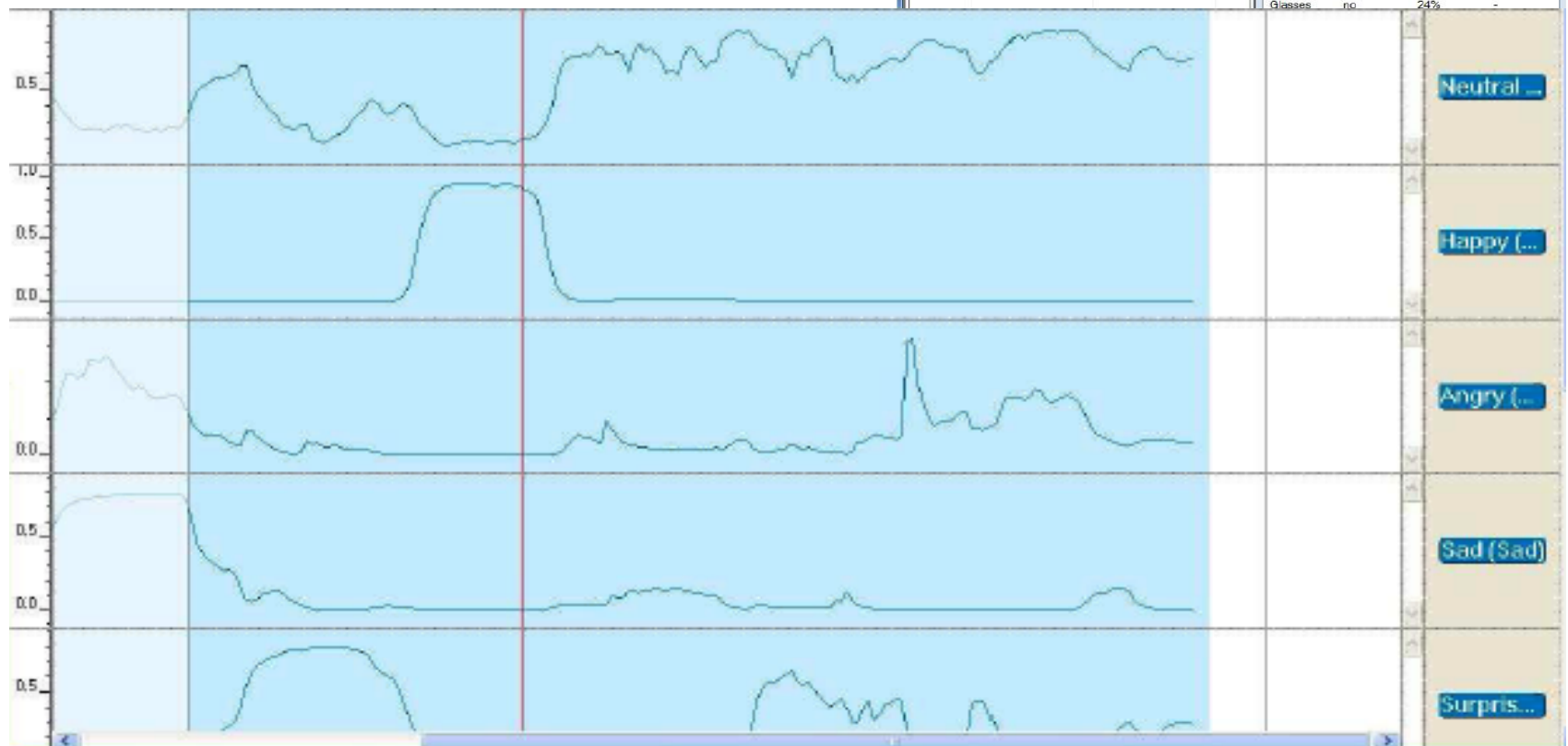
Physical load

- EMG (muscle activity)
- Grip force

Measurement of Facial Expression

Six basic emotions classified automatically

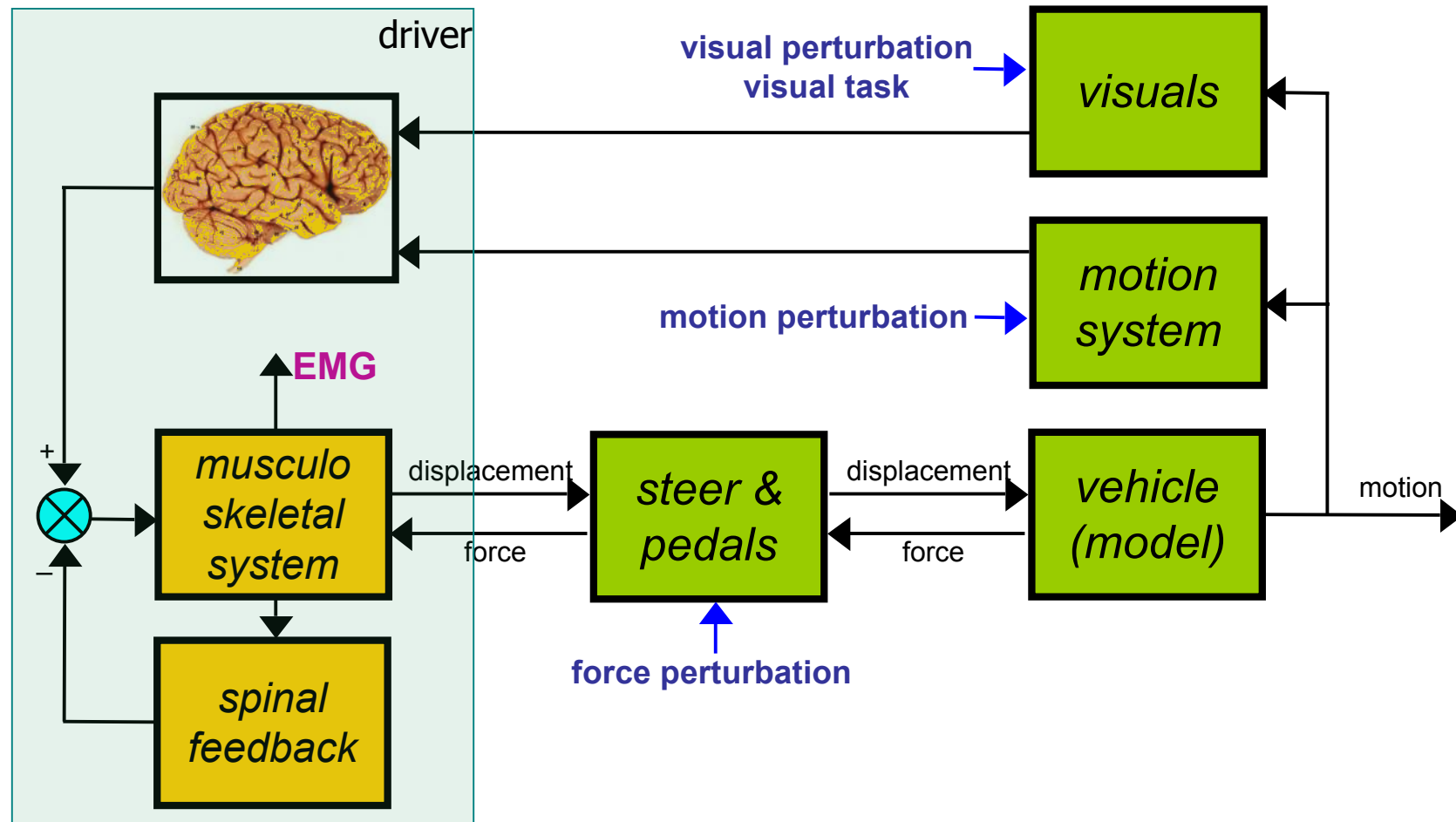
Facereader



Driver model identification

- System identification of driver control actions resulting from visual, motion (vestibular) and force stimuli.
 - Understand driver behavior
 - Quantify driver adaptation to vehicle modification
 - Monitor driver performance/distraction
- Estimate driver parameters using short observation windows (seconds/minutes)

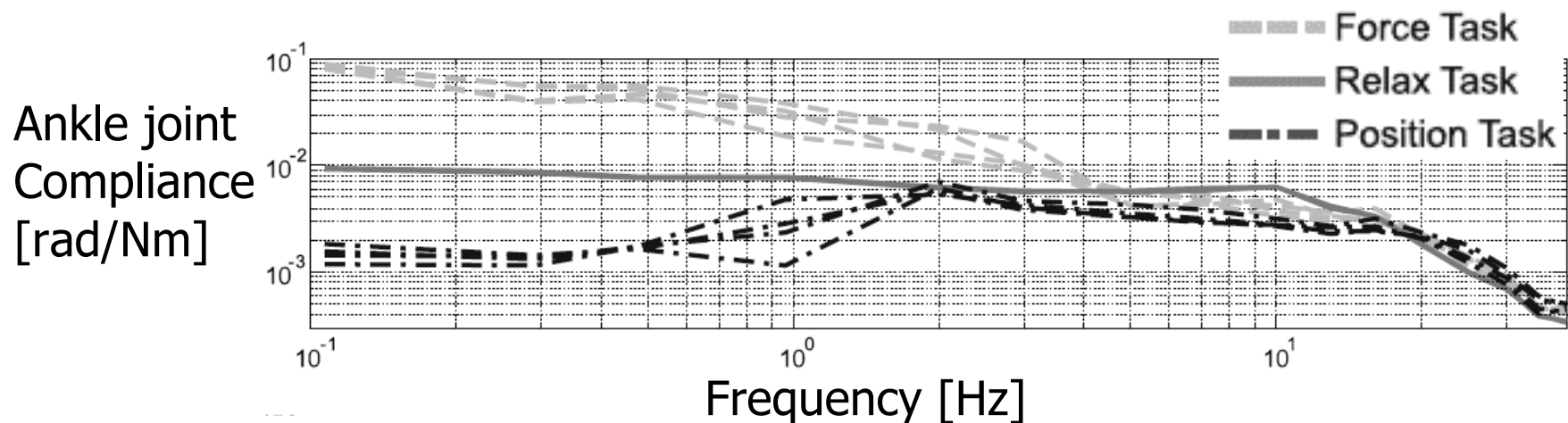
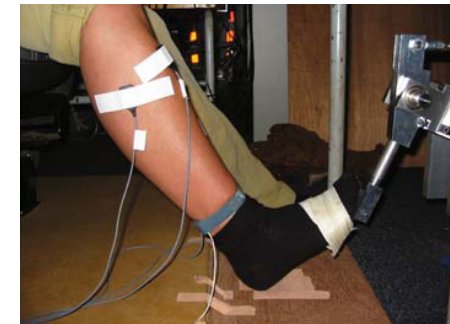
Driver model identification



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Identification human ankle control gas pedal

- Random Force Perturbations
- Frequency Response Functions
- Estimate reflex delays and gains



Mugge, Abbink et al. Exp Brain Research 2010

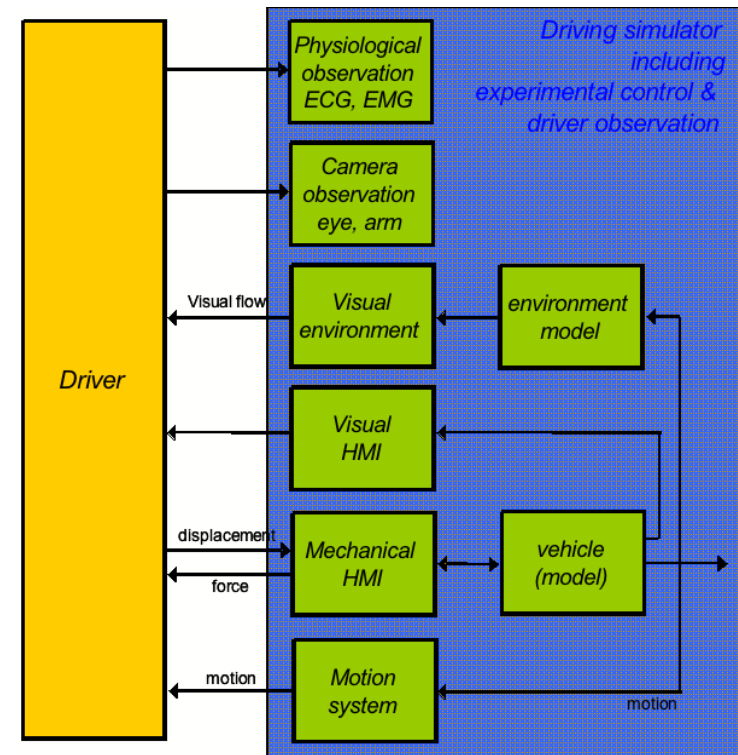
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Driver model identification results

- **Reflexive stabilization** identified with random force perturbations
 - Gas pedal
 - Drivers tune reflexes when using a haptic gas pedal
 - Steering ongoing
- **Visual** loop identified in car following
 - Visual gains reduced when using the haptic pedal
 - Visual gains enlarged with distance & acceleration display
 - Visual loop in steering ongoing
- **Vestibular** loop to be identified

Behaviour Observation in Simulators

- Benefits
 - Better understand human driving
 - Making the simulator a more sensitive measuring system
- Integrating observation of
 - Driving performance
 - Eye tracking, facial expression,...
 - Workload, Distraction, Stress, Fatigue
 - Driver modelling



See us at

5060 – CRUDEN

- Drive our simulator
- Eye tracking

5255 – DrivObs

- Real time display
- Discuss project's findings
- Demonstrate driver reactions
- Eye tracking analysis
- Observer

