ČESKÉ VYSOKÉ UČENÍ TECHNICKÉ V PRAZE

D C I S

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Visual Investigation of Driver Behavior for Fatigue Detection. Driving Simulator Experiments

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Problem of driver drowsiness and fatigue

Reasons:

- Monotonous road (highways), long commutes to/from work
- Driving tired, after sleep deprivation (shift work, overtimes)
- Travelling at night…

Consequences:

- Decrease of attention (to road signs, other traffic participants)
- Driving without awareness (DWA)
- Partial or total loss of vehicle control
- Accidents

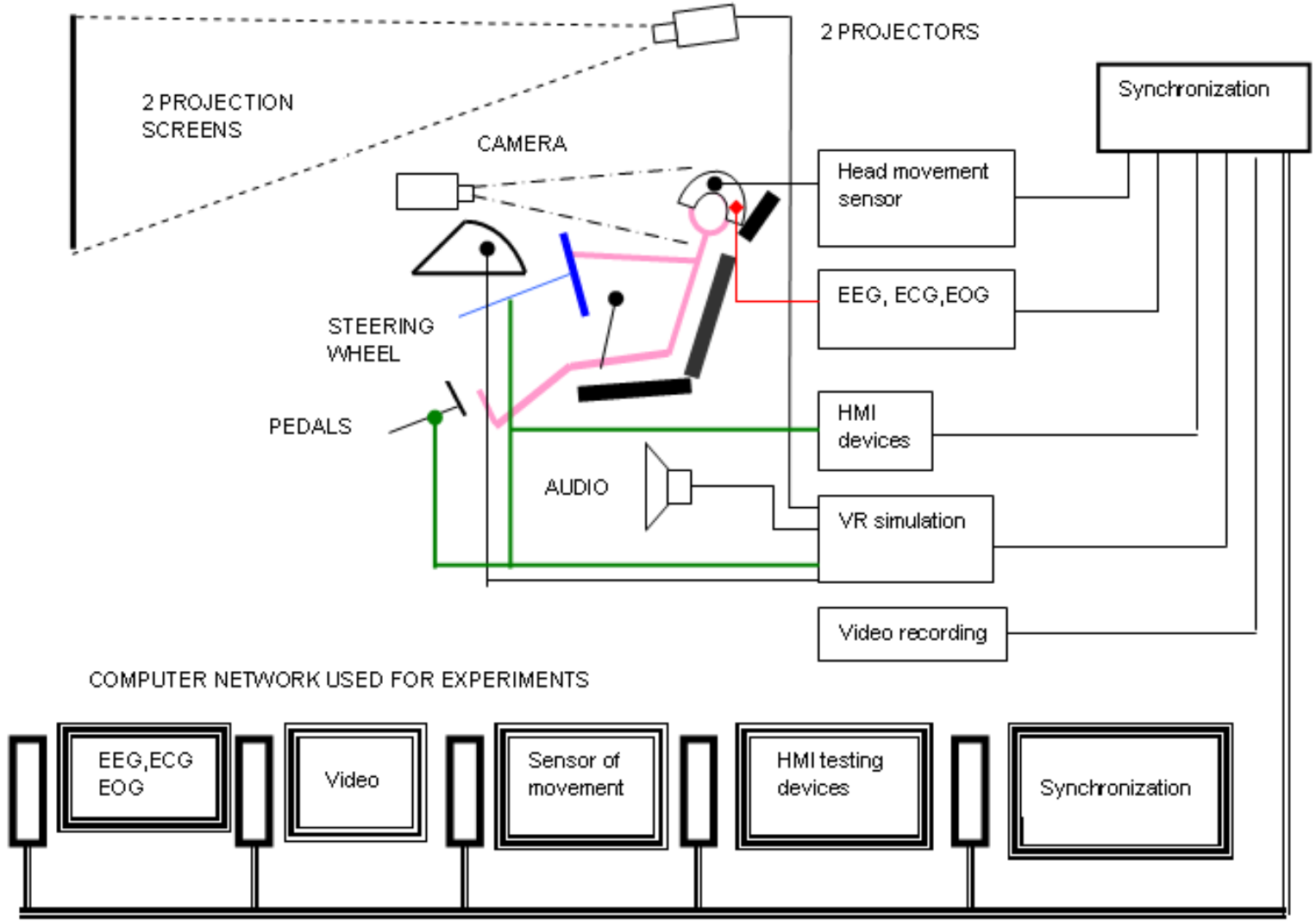
Research of driver fatigue

- Experimental research on simulator (or sometimes in field)
- Measurement of driver behavior:
  - Physiological parameters (EEG, EOG, EKG)
  - Eye-tracking (direction of sight, eye closures)
  - Visual behavior (employment of in-vehicle control elements, body movements, gestures, mimics etc.)
- Simulator data for evaluation of vehicle behavior
  - Speed, steering/weaving, acceleration/breaking etc.

Full simulator - Superb

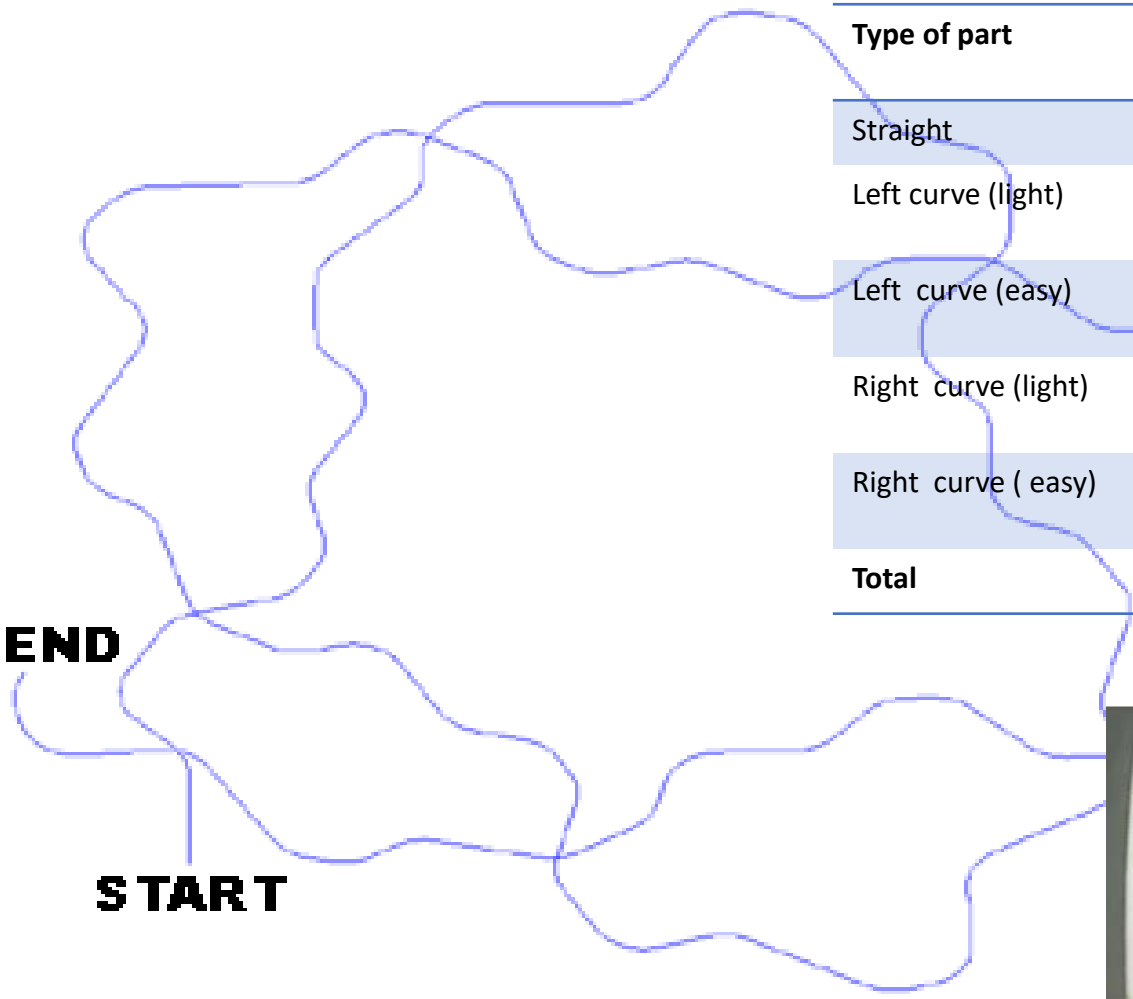
- The first ”big” involving full car body
- 2003-2010 +
- Based on WV simulation systems
- Steady based simulation system
- Full car
- 360 DEG FOV
- 270 projection system hexagonal without blending plus LCD mirrors
- Target research– drowsiness

Basic setup of simulator lab



Long time fatigue experiments

Type of part	Length [Km]	Type of part [%]	Radius [m]
Straight	105	033	8
Left curve (light)	38	512	46500
Left curve (easy)	42	313	61500
Right curve (light)	66	521	46500
Right curve (easy)	58	218	71500
Total	**310**		**5100**



Duration: 2-4 hours

Sleep deprivation: at least 24 hours

Visual features (fatigue c.m.)

- *Body and head movements*
  - Head tilt and rotations
  - Head and shoulders shake
  - Body stretching, readjusting sitting position
  - Touching face (rubbing nose, eyes)
- *Eye behavior*
  - Eye closures (blinking and longer closures)
  - Direction of sight (control panel/road)
- *Mimics (face)*
  - Stretching face muscles
  - Fresh looking vs. relaxed face expression
- *Steering and hands position*

Fixation of driver initial state

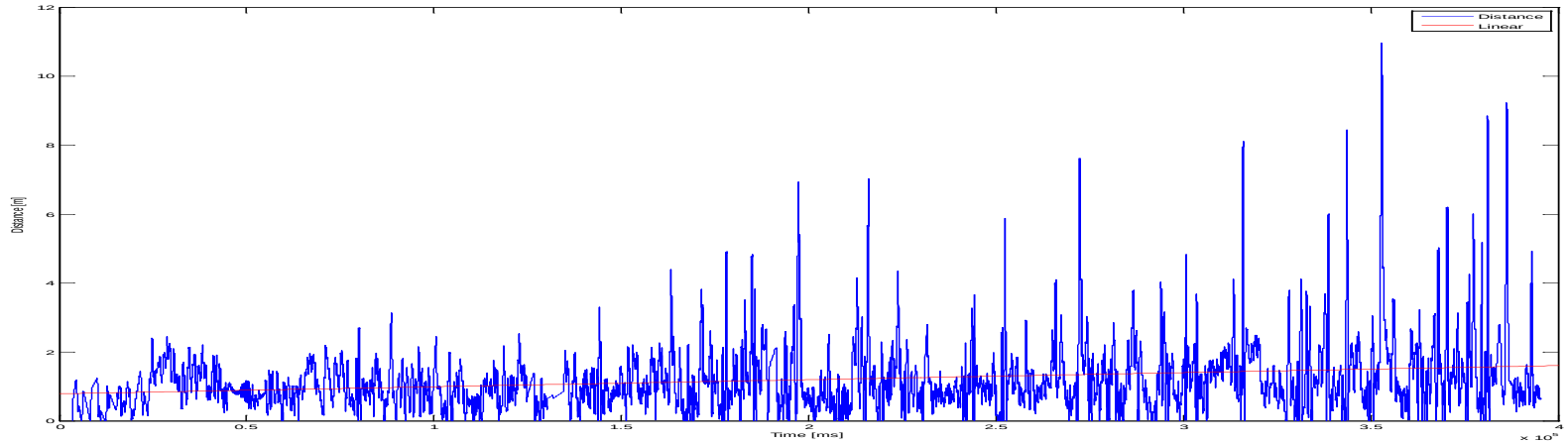
- Straight seated driver
- Eyes are wide (but naturally) open
- Driver looking on the road and dashboard with regular/usual frequency
- Blinking is normal (yet, often increased as compared to person after regular sleep)
- Both hands on wheel (upper part)
- Car is in the middle of the traffic lane

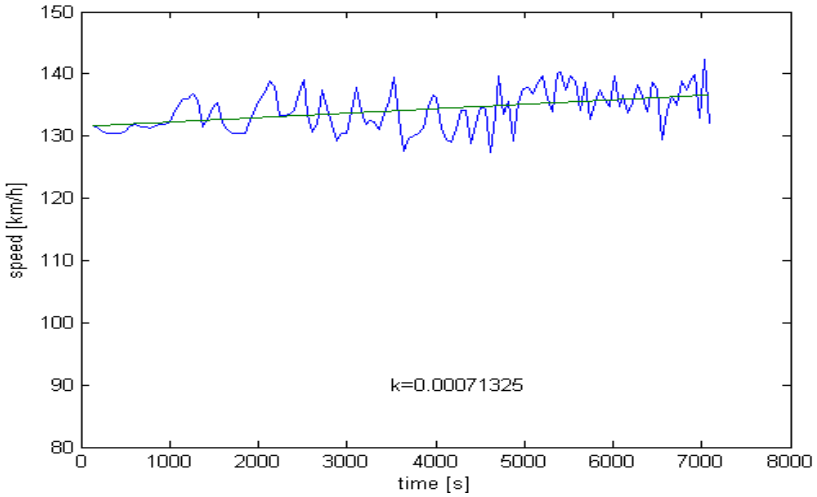
Initial s

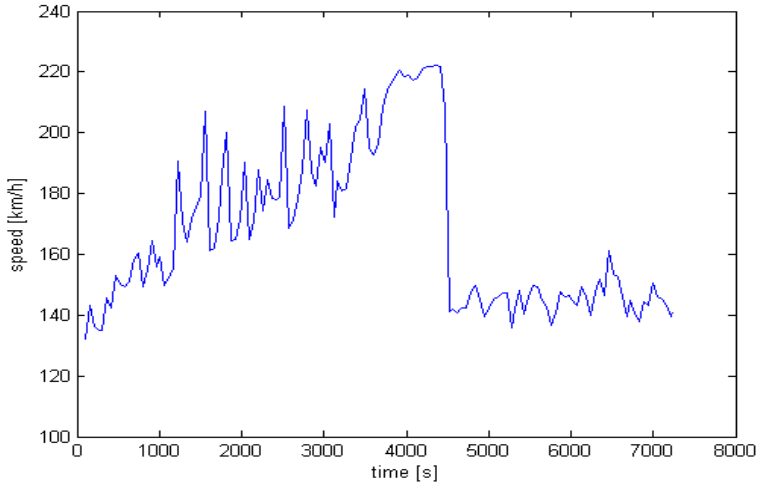
Distinguished patterns of drowsy behavior

- Increasing of blinking frequency, “prolonged” blinks– eye closures – sleep.
- Adjustment of self in a seat – seeking for more comfortable position
- Leaning back or to the sides
- Relaxation of body muscles – shoulders and gradually the whole body go down
- Relaxation of face muscles
- Lip biting and lip licking
- Forced straightening or stretching of body
- Hands on the wheel go down from typical initial 10/2 o’clock position
- Vehicle control loss (weaving up to lane departure)

Weaving and speed typical development







Continuous increase	Steady behavior or decrease	Driver cannot keep the speed in 'reasonable' boarder / goes much faster than required
60,87%	17,39%	21,74%

Conclusion and discussions

- It was possible to identify common patterns of behavior among the tested cohorts
- Time stamp (in the course of experiment), duration and character of such traits is different:
  - i.e. blink count, frequency, time of blinking before longer eye closures, or absence of the latest for some participants
  - Less feasible traits for particular probands who lost control unexpectedly
  - Different ability of individual for self control (as in self-awakening movements)
- *It is suggested to extend the research to following eye behavior with eye-tracking technology*

VIDEO

THANK YOU FOR YOUR ATTENTION!