K. Nakano Lab

Estimation of Drowsiness of Drivers with Haptic Interface

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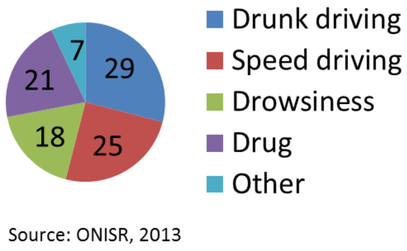
Introduction

Moat of crashes are caused by:

- driver distraction, speeding.
- drunk driving.
- reckless driving.
- drowsy driving.



Source: ONISR, 2013

In the case of drowsiness, driver reaction time drastically increased which induces impaired driving.

Mechanical Arm Admittance:

Mechanical arm admittance is a driving based variable which express the driver state and the arm stiffness.

$$\Upsilon_{fx}(f) = \frac{G_{d\theta}(f)}{G_{df}(f)}$$

Cross spectral density between the torque disturbance *d* and the steering wheel angle *θ*.

Cross spectral density between the torque disturbance *d* and the driver torque *f*.

- Low mechanical arm admittance values represent high resistance to perturbations and vice versa.
- Thus, mechanical arm admittance variations indicate driver current capacities to resist to steering perturbations.

Experiments

Experimental procedure

Comparison of mechanical arm admittance was effectuated between drowsy and alert state.

Accumulation of drowsiness aggravating factors

The day of the experiment

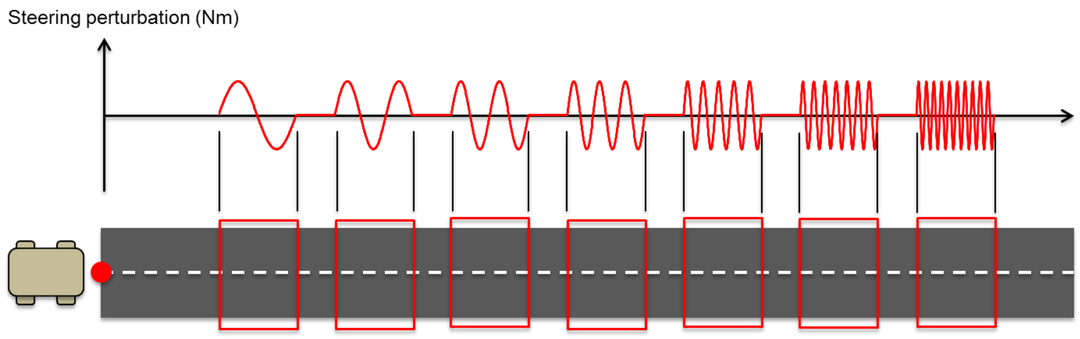
- Shorten the sleep to 5 hours.
- No breakfast.
- Avoid caffeine/theine drink.
- Eat fast food at lunch.

During the experiment

- Perform a long a monotonous driving before estimation of mechanical arm admittance.

Estimation of Mechanical Arm Admittance

- Drivers were asked to follow the center line of the road.
- Participants crossed trigger areas where steering perturbations were applied on the steering wheel.
- Steering speed was set as 40 km/h.

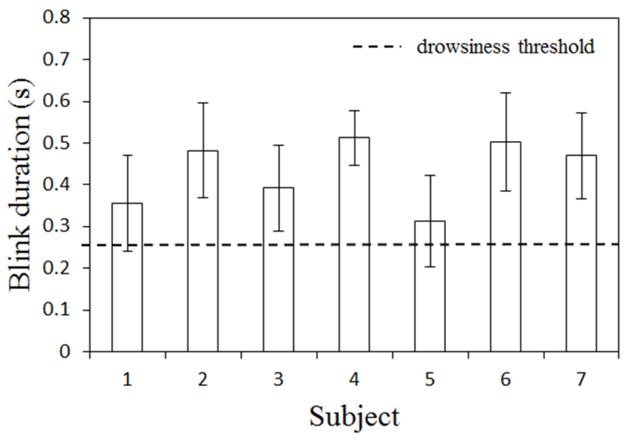


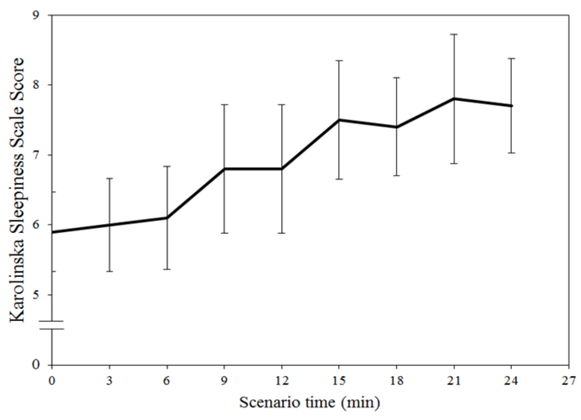
How to estimate drowsiness level?

- Blink duration
- Self evaluation of drowsiness using Karolinska Sleepiness Scale questionnaire

Results

Drowsiness level: Drowsiness inducement was efficient



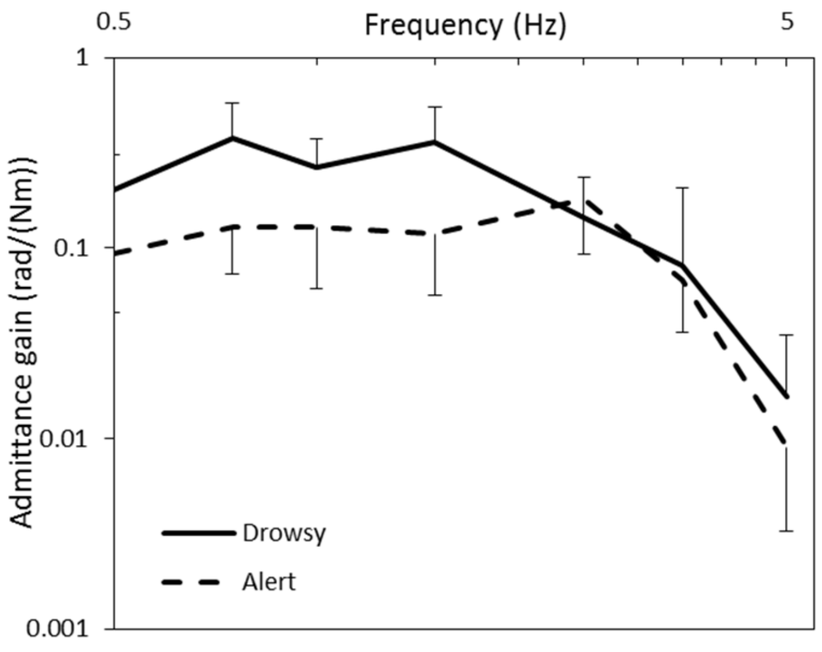


Karolinska Sleepiness Scale

Name: Date:

	Extremly alert	Very alert	Alert	Rather alert	Neither alert no sleepy	Some sign of sleepiness	Sleepy, but no effort to keep awake	Sleepy, some effort to keep awake	Very sleepy, great effort to keep awake, fighting sleep
	1	2	3	4	5	6	7	8	9
0 min									
3min									
6min									
9min									
12min									
15min									

Mechanical arm admittance level:



Review:

- Low mechanical admittance values implies tensed driving.
- Drowsiness increases admittance amplitude at low frequencies.

Conclusion:

- Drowsiness has negative effects on mechanical arm admittance amplitude.
- Whereas, it is confirmed at low steering frequencies. Out of this range, alert/drowsy drivers react similarly.

Publications

Joly A., Nakano K., Zheng R., 2015, Effect of Drowsiness on Mechanical Arm Admittance and Consequences on Driving Performances, ITS World Congress 2015, 4-9 October, Bordeaux, France.

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