

Establishing a gold standard for drivers microsleep detection

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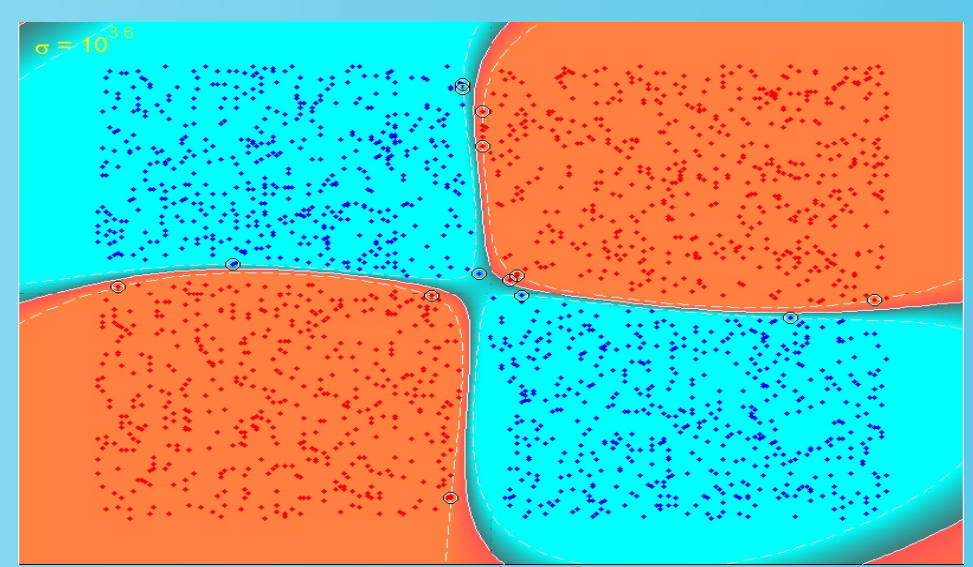
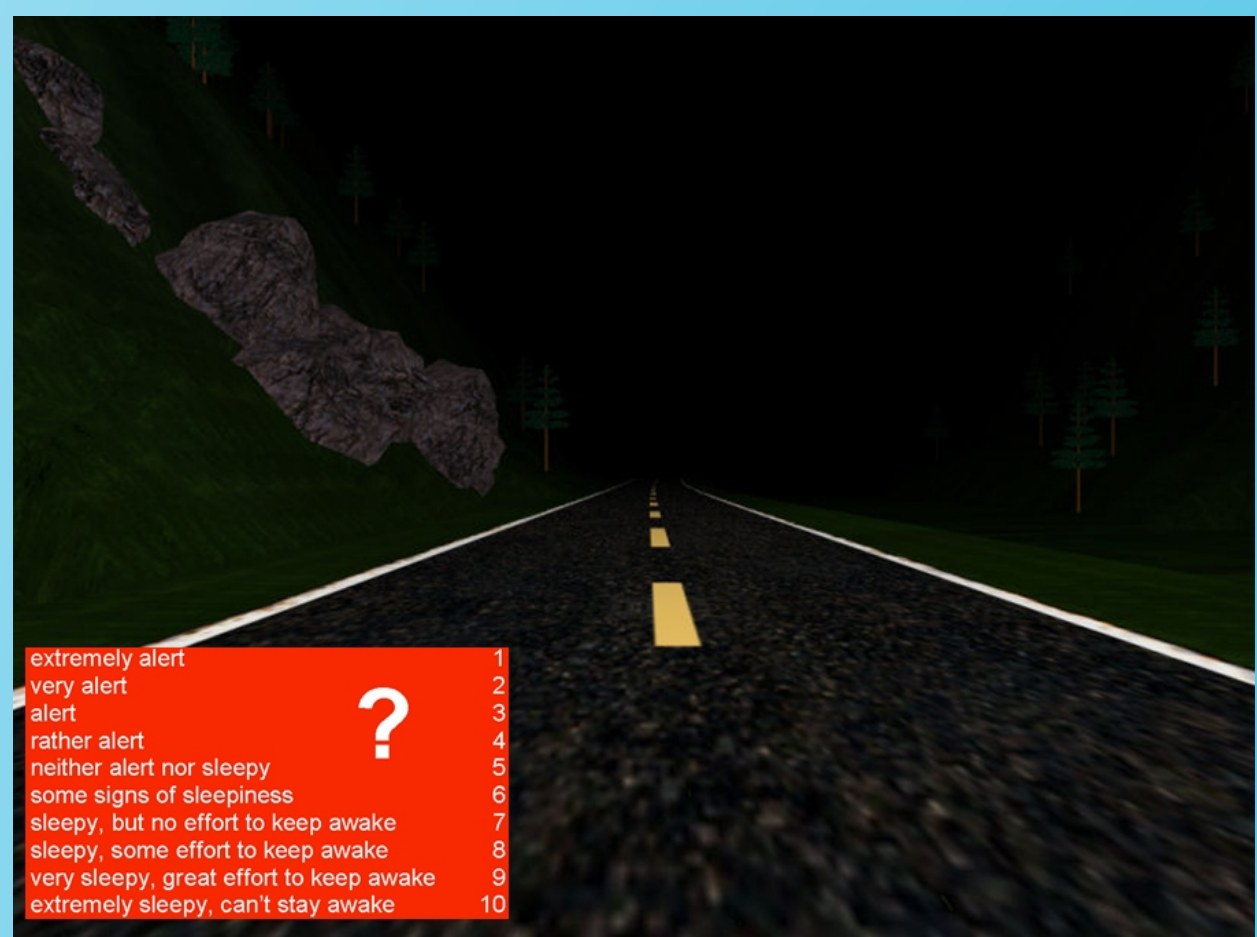


Introduction

- Purpose: Detection of microsleep
- Aim: detection of evidently scored microsleep events against clear episodes of fatigue driving through analysis of spontaneous biosignals
- database: up to now we have 45,957 electrophysiological and video recordings
- utilizing advanced Soft Computing methods

Laboratory: Real Car

- 3D, fully dark, climate controlled
- EEG: 16-ch. AC-amplifier, sampling rate: 256 s⁻¹.
- EOG: 2-ch. DC-amplifier, sampling rate: 1000 s⁻¹.
- Eyetracking: binocular, 6-ch., sampling rate: 250 s⁻¹.
- Video: 3-ch., frame rate: 25 s⁻¹, infrared region
- other: ECG, EMG, EDA, Respiration.
- questionnaires: KSS, Thayer, Microsleep Awareness (online) ESS, Samn-Perelli, PSQI, etc. (offline)



Signal Processing

- Methods
- Feature extraction in
 - o Time domain
 - o Frequency domain
 - o Wavelet domain
 - o State space
- Soft Computing methods
 - o Neural Networks
 - o Support Vector Machines
 - o Genetic Algorithms

Experiments: Overnight Driving Simulation Tasks

- Overnight driving: 7 x 40 min
- Up to now all-in-all 665 driving sessions
- Database containing
 - 21,544 evidently scored microsleep ...
 - 24,413 evidently scored non-microsleep ...
- Visual scoring: 3 independent scorers

Case Studies:

- Detectability
- Prognosis ability
- Individualization

Method	Parameter values	Err _{train} [%]	Err _{test} [%]
LVQ1	#neurons = 500	10.2 ± 0.2	15.7 ± 0.3
LVQ2.1	#neurons = 350	9.6 ± 0.1	15.5 ± 0.4
LVQ3	#neurons = 350	10.3 ± 0.1	15.6 ± 0.4
OLVQ1	#neurons = 500	9.3 ± 0.2	15.7 ± 0.4
RLVQ	#neurons = 500, η ₁ = 0.01	15.8 ± 0.4	19.5 ± 0.4
DSLQV	#neurons = 250, η ₁ = 0.05	8.5 ± 0.2	15.5 ± 0.3
GLVQ	#neurons = 400	9.6 ± 0.1	15.5 ± 0.4
GRLVQ	#neurons = 350, η ₁ = 0.01	6.5 ± 0.2	14.3 ± 0.4
GA-OLVQ1	#generat. = 200, #popul. = 128	8.8 ± 0.2	12.9 ± 0.4
SVM linear kernel	C = 10 ^{-2.75}	15.5 ± 0.1	16.9 ± 0.2
SVM polynomial k	C = 10 ^{2.4} , d = 2	7.1 ± 0.1	14.7 ± 0.3
SVM sigmoid k	C = 10 ^{4.4} , α = 10 ^{-2.3} , θ = -1.6	15.6 ± 0.1	17.4 ± 0.3
SVM Gaussian k	C = 10 ^{0.31} , γ = 10 ^{-2.1}	0.1 ± 0.0	10.1 ± 0.4
LDA	-	15.6 ± 0.1	17.4 ± 0.3
1-NN	-	0.0 ± 0.0	20.1 ± 0.5
k-NN	k = 11	11.6 ± 0.1	14.7 ± 0.2
EBP	#neurons = 8 (hidden layer)	12.3 ± 1.1	18.1 ± 0.7

