INCREASING ROAD SAFETY WITH MACHINE LEARNING
A FATIGUE AND DROWSINESS DETECTION SYSTEM

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MONITORING DRIVERS CONDITIONS

- ❑ Detect **fatigue** and **drowsiness** conditions
- ❑ Use of the ElectroCardioGram (ECG) signal
- ❑ Use of the Steering Wheel Angle (SWA) signal
- ❑ Non-intrusive system; acquisition of signals on the steering wheel

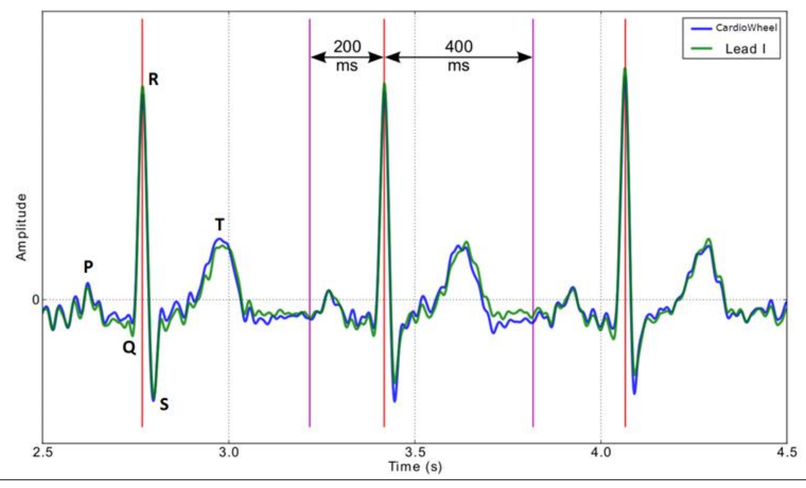
FATIGUE AND DROWSINESS

❑ **Fatigue** is a physical or psychological exhaustion; usually results from doing the same task repeatedly or in an exhaustive way

❑ **Drowsiness** is defined as the state before sleep; when someone is drowsy, one requires to sleep, and one's body is fighting to stay awake

CardioWheel

The ECG signal



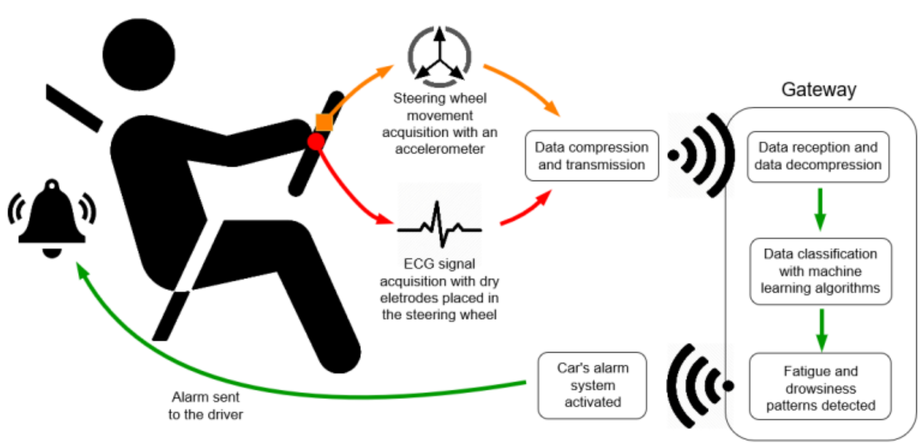
The 10-point Karolinska Sleepiness Scale (KSS)

Level	Description
1	Extremely alert
2	Very alert
3	Alert
4	Rather alert
5	Neither alert nor sleepy
6	Some signs of sleepiness
7	Sleepy, but no effort to keep awake
8	Sleepy, but some effort to keep awake
9	Very sleepy, great effort to keep awake, fighting sleep
10	Extremely sleepy, cant keep awake

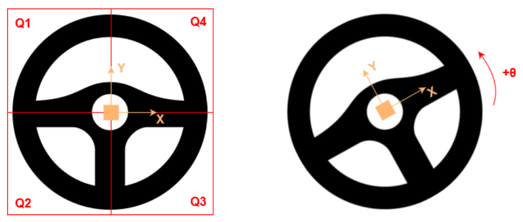
PROPOSED SOLUTION

The rationale is that fatigue and drowsiness modify a person's biological signals and behavior

Using machine learning techniques can detect these conditions and trigger an alarm to the driver



The SWA signal



1) ECG AND SWA SIGNAL ACQUISITION

- **ECG with CardioWheel**
- **SWA with accelerometers signals**

Features

Signal	Feature	Description
ECG + SWA	SDV	Standard deviation
	ENT	Shannon entropy
	RMS	Root-Mean-Square
ECG	NRP	Number of R peaks per window
	DBR	Mean difference between R peaks
	MAR	Mean amplitude of R peaks
	ADR	Amplitude deviation of R peaks
	VLF	Very-Low Frequency power [0, 0.04] Hz
	LFP	Low Frequency power [0.04, 0.15] Hz
	HFP	High Frequency power [0.15, 0.4] Hz
	LHR	Low-High frequency Ratio
SWA	ZCR	Zero-Crossing Rate
	HTR	Holding time below ± 3 degrees
	MAS	Mean acceleration applied to the steering wheel
	ASD	Angular Speed Deviation
	EXT	Number of extremes

2) LOSSY ENCODING

- **Transform-based coding with DCT**
- **Followed by quantisation and lossless encoding**

3) TRANSMISSION

- **Using Bluetooth Low Energy (BLE)**

4) CLASSIFICATION

- **Feature-based classification**
- **Vector of features**
- **Use of SVM and other classifiers for fatigue/drowsiness detection**

❑ Real-World Data

❑ Dataset from the National Road and Transport Research Institute of Sweden (thanks to Professor Christer Ahlström)

❑ Binary classification problem

Method	Accuracy	Specificity	Recall	Precision	F1-Score
LinReg	0.55	0.58	0.52	0.55	0.50
LogReg	0.55	0.60	0.49	0.55	0.51
ANN	0.54	0.55	0.53 4	0.54	0.51
SVM	**0.62**	**0.56**	**0.68**	**0.61**	**0.64**