FFI Resultatkonferens 2019

Tobias Aderum, Veoneer Research

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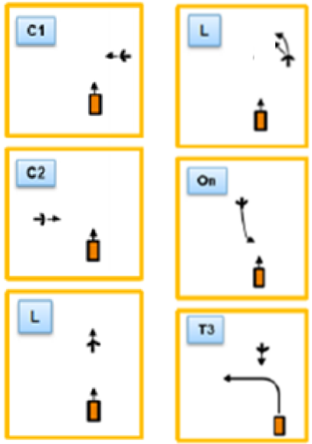
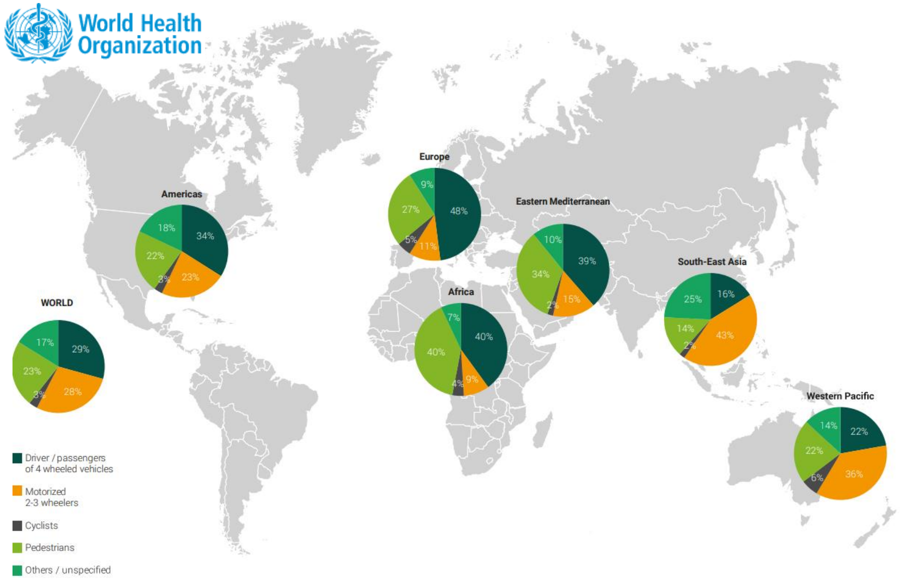
Cyclist Collision Avoidance Using Imagery Sensor

Background

EURO NCAP FOR SAFER CARS





~40 000 fatalities world wide / year

WP1 Data Collection

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WP2 Cyclist Braking Behavior

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Mountain bike (N=8)	
Racer bike (N=1) Thin tyres, bockstyre, saddle higher than handlebar.	
City bike (N=6) Saddle and handlebar at approximately same height, often more than 7 gears, seldom foot brake.	

Electric bike (N=6)	
Comfort bike (N=11) often footbrake, seldom more than 7 gears, handlebar higher than saddle.	

WP2 Braking Results

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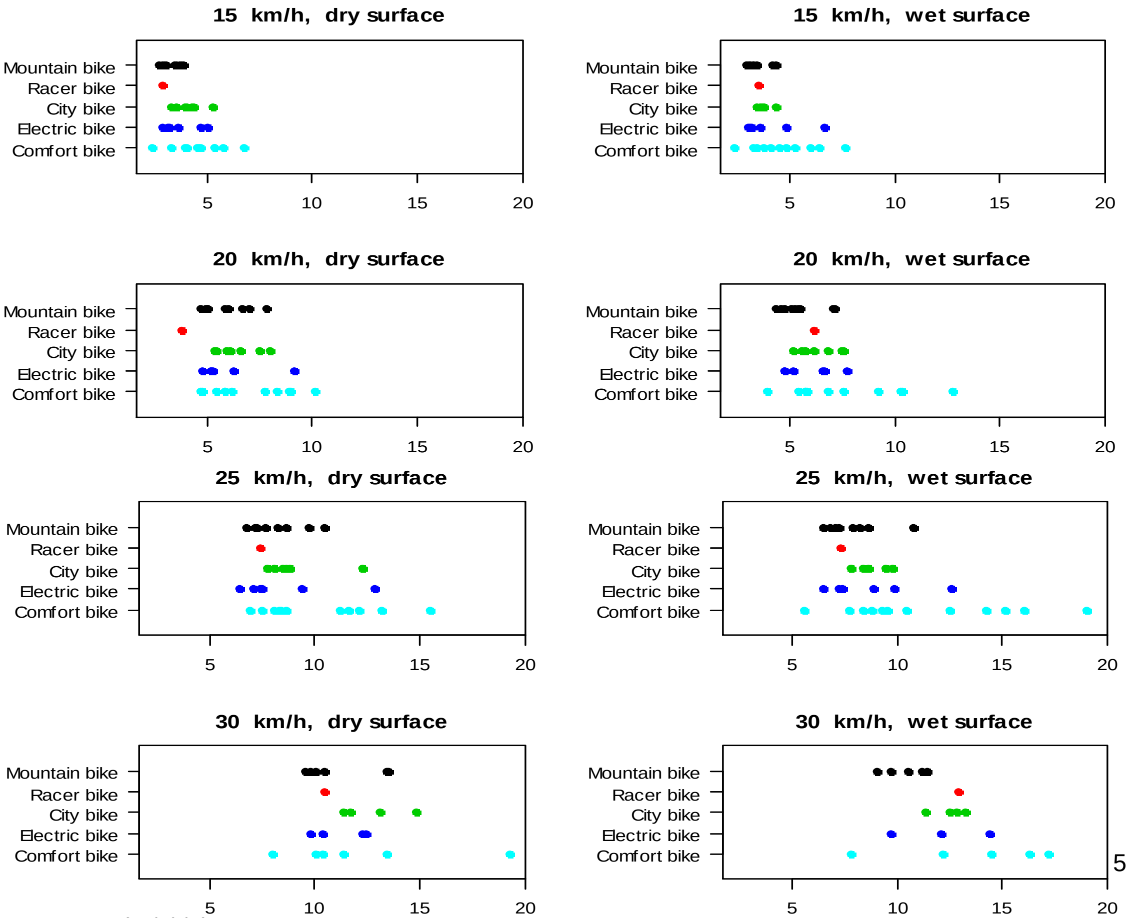
- The average stopping distance is almost the same for different bicycle types
- There is a large variance in stopping distance between cyclists using one or two brakes
- The personality, reflected by cyclist type, is an important underlying factor affecting the stopping distance



WP3 Improved detector

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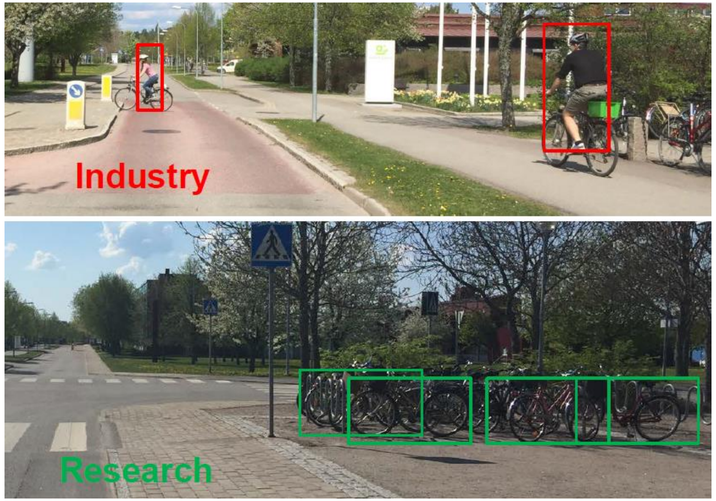
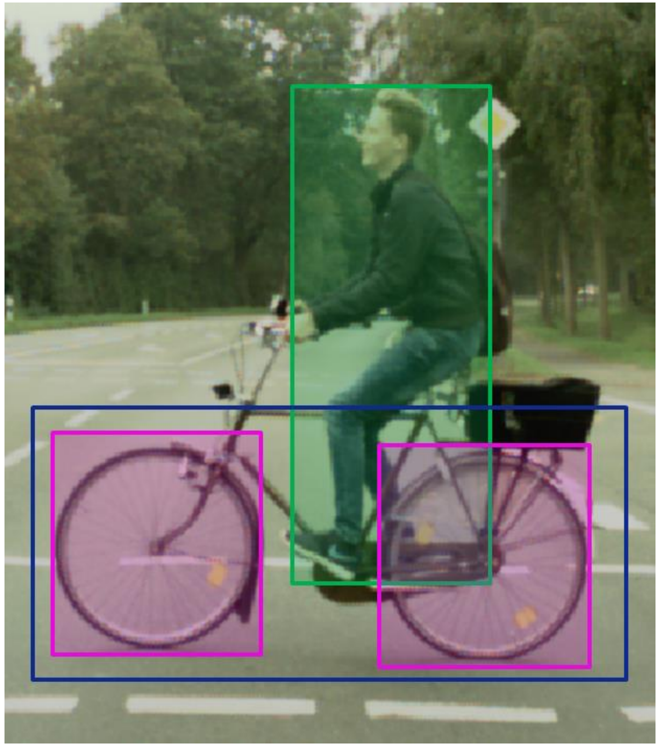
- Classifier that detects pedestrians and person riding on bicycle
- Classification based separator that separates pedestrians and bicyclists
- Classifier that detects bicycle wheels
- Tracker that combines pedestrian measurements and bicycle wheel measurements





WP3 Detections

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WP3 Detections

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WP3 Tracking

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EU-NCAP

Veoneer @Veoneer · May 27
Congratulations - 5 stars to Mercedes A-class and G-class in Euro NCAP! Veoneer is proud supplier of mono vision camera systems to one of the safest car brands in the world.

Vulnerable Road Users Protection		
Passive PP	AEB-Pedestrian	AEB-Cyclists
out of 36 max	out of 6 max	out of 6 max
32,4	5,8	6

WP4 Ellipse extraction

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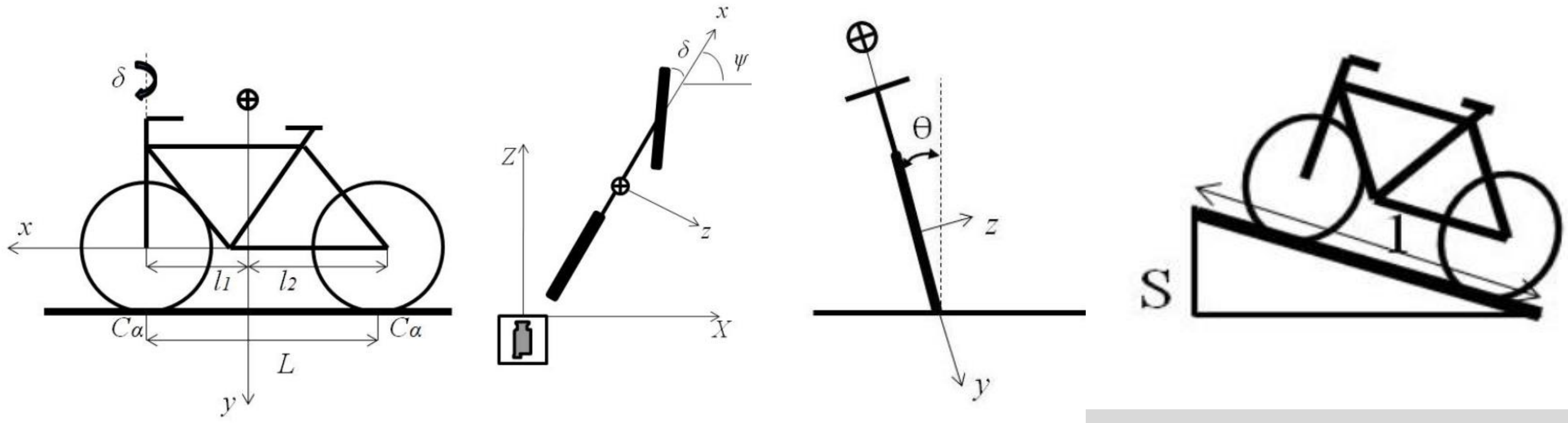
- A bicycle can be modeled in a state-space that facilitates analyzing the cyclist behavior [1].
- Fitting Ellipses to the bicycle wheels defines most of the state space parameters.

$$x = (\psi, X_c, Z_c, \dot{\psi}, v_x, v_z, \delta, \theta, Y_c, S)^T$$



[1] Ardeshiri, Tohid, et al. "Bicycle tracking using ellipse extraction." *14th International Conference on Information Fusion*. IEEE, 2011.

WP4 Solution

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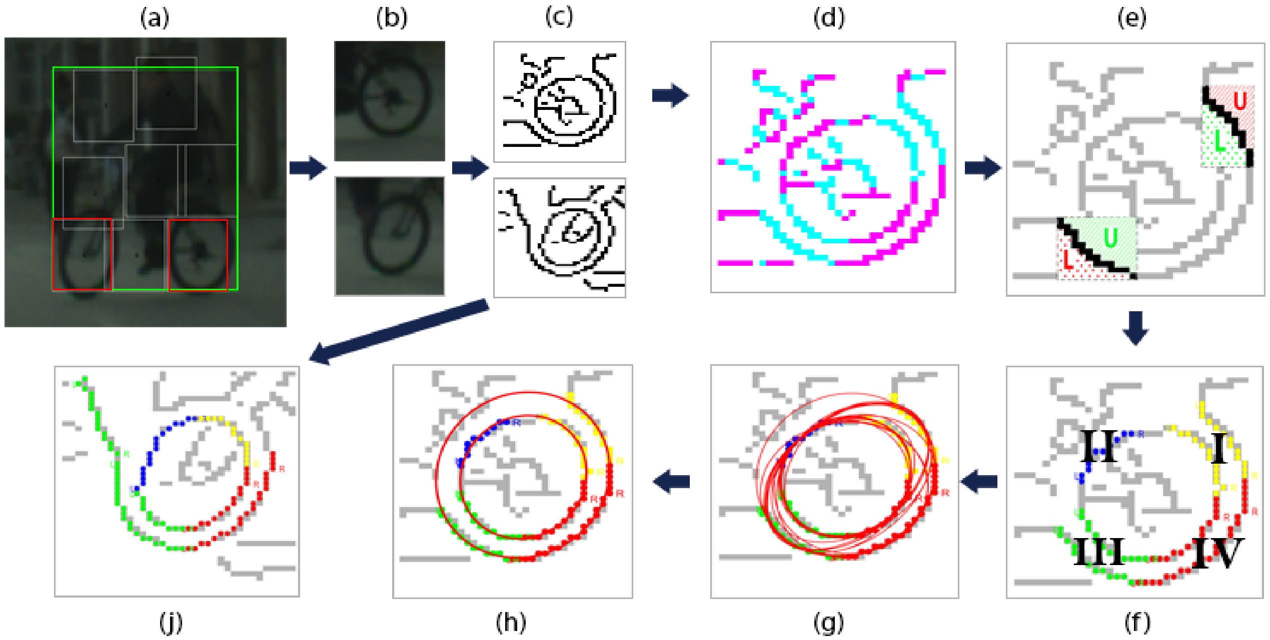
- We proposed a method to **detect cyclists** and **fit ellipses** to bicycle wheels "in-the-wild".



[1] Eldesokey, Abdelrahman et al. "Ellipse Detction for Visual Cyclists Analysis "in the Wild"." 17th International Conference on Computer Analysis of Images and Patterns (CAIP).

WP4 Visualization

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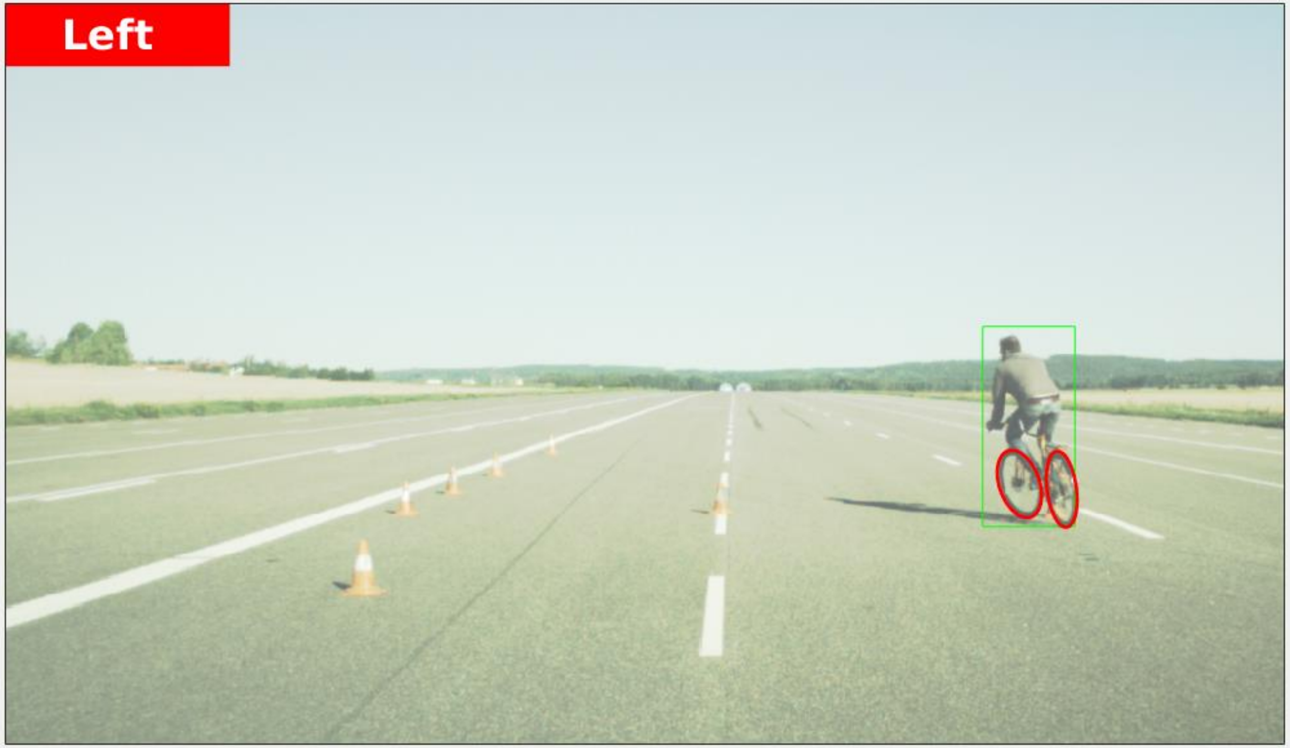

WP4 Visualization

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WP5 Cyclist Intention Detection

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Use DNN to

- Gesture recognition → Intention interpretation → Action prediction

Cyclist Intention Signaling											
Left arm raised	Right arm raised	Looking back	Looking sideways	Waiting (at stop sign or zebra crossing)	Stops pedaling	No action	Foot down	Foot up	Cyclist leaning	Cyclist slowing down	Cyclist standing up
9	10	5	21	26	7	2	98	30	7	1	0

WP5 Intention by Raised Arm

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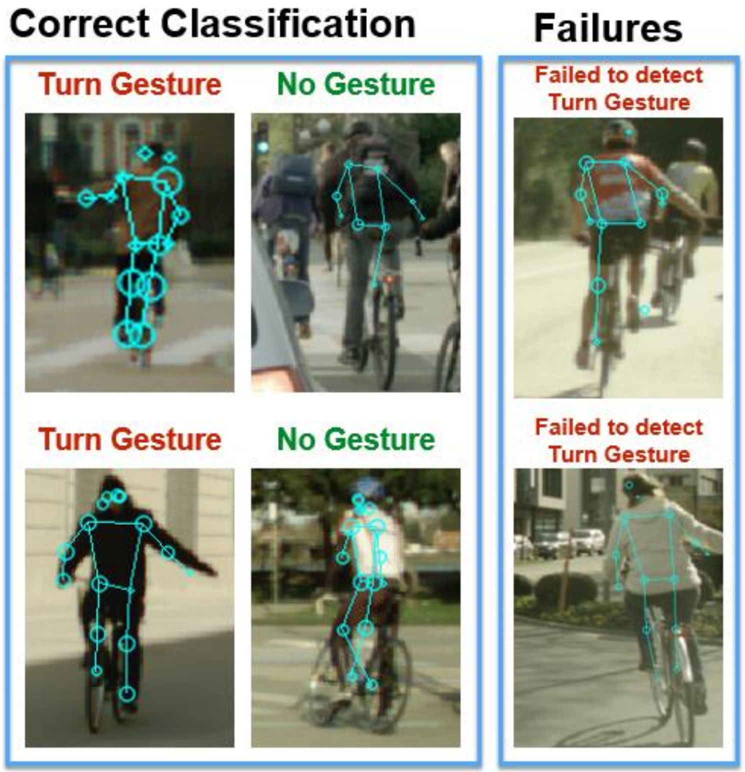
We tackle the “in-the-wild” scenario

Varying weather; cyclist pose, scale, and appearance; location; and time of the day

Examples of a cyclist gesturing account for a very small subset of typical data used for ADAS/AD

We utilize a human keypoint detector (PoseNet) pre-trained on a large human keypoint detection dataset

We use a simple Multivariate Normal Classifier (MVN) on top of the keypoints, trained on examples mined from Autoliv-data



WP5 Intention by Looking

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Another cue is whether the cyclist is looking at the car

Using the same data, we train a simple MVN classifier utilizing features from a ResNet18 pre-trained on ImageNet

> PoseNet seems unable to capture whether the face is turned towards us
>
> Instead we rely on features extracted from a ResNet18

WP7 So where did we end up?

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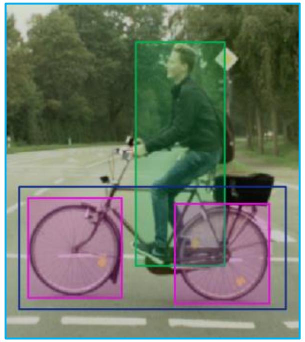

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Real Life Benefits Estimation

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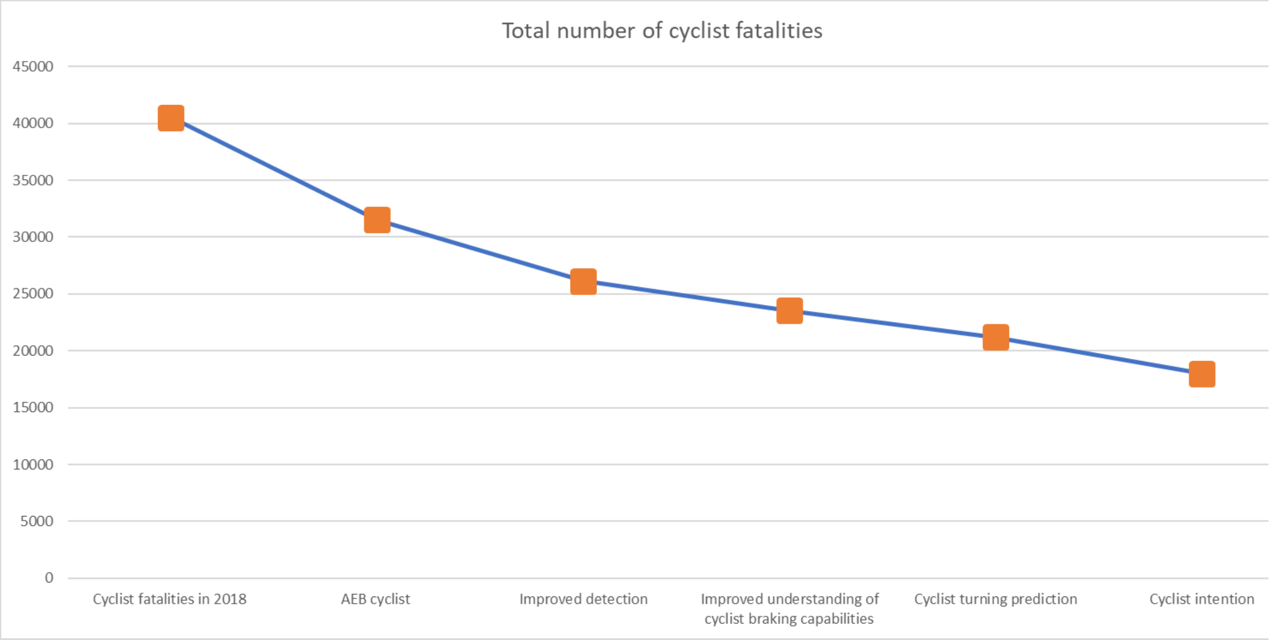
- AEB – cyclist *
  - -M1 vehicle & opponent is a cyclist
    - 5 km/h <= own driving speed <= 40 km/h & cyclist speed <= 30 km/h no visual obstruction &
    - no ice and snow on road & no poor road condition &
    - no unstable vehicle condition & fine weather
  - Addressing crossing and longitudinal cyclist accidents
- 22% reduction in number of fatalities * (GIDAS)
- Improved cyclist detection (WP3) - optimistic estimation ~17%
  - Wider FOV
  - Better classification of the cyclist and pedestrian
  - Resulting in better speed and braking prediction
- Cyclist braking capabilities (WP2) ~10%
  - Understand the capabilities of the cyclist in terms of evasive action (braking) can be considered to improve the threat assessment
  - Understanding the braking capabilities of different type of bicycles ^
- Cyclist turning prediction (WP4) ~10%
- Cyclist intention detection (WP5) ~15%
  - Intention and interaction models of cyclist can improve tracking of objects in a critical situation*



^ WHO, Global status report on road safety 2018, 2018. http://apps.who.int/iris

* N. Lubbe, H. Jeppsson, A. Ranjbar, J. Fredriksson, J. Bärgman, M. Östling, Predicted road traffic fatalities in Germany: the potential and limitations of vehicle safety technologies from passive safety to highly automated driving, (2018) 125–127

^ P. Huertas-Leyva, M. Dozza, N. Baldanzini, Investigating cycling kinematics and braking maneuvers in the real world: e-bikes make cyclists move faster, brake harder, and experience new conflicts, Transportation Research Part F: Traffic Psychology and Behaviour, Volume 54, 2018, Pages 211-222, ISSN 1369-8478, https://doi.org/10.1016/j.trf.2018.02.008.

* Hubmann, C., Schulz, J., Becker, M., Althoff, D., & Stiller, C. (2018). Automated Driving in Uncertain Environments: Planning With Interaction and Uncertain Maneuver Prediction. IEEE Transactions on Intelligent Vehicles, 3(1), 5–17. https://doi.org/10.1109/TIV.2017.2788208

Thank you for listening!

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veoneer ZENUITY Make it real.

FFI Fordonsstrategisk Forskning och Innovation

VINNOVA Energimyndigheten TRAFIKVERKET SCANIA VOLVO