In-Cabin Sensing Systems and simulation with Ansys

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Driver Monitoring System (DMS)

- DMS, a vehicle safety system.
 - The system monitors the driver's attentiveness and co-operate with Pre-Collision System (PCS).
 - Specifically, if the driver is not paying attention to the road (detected via eye tracking) or a dangerous situation is detected (via PCS), the system can warn the driver by flashing lights and warning sounds.
 - Certain ADAS/AS functions can be subject to the driver's awareness and be controlled by DMS.
- DMS supports facial recognition and detection, and is able to:
 - Monitor driver attentiveness.
 - Measure eye blinks.
 - Measure head movements.
 - ...
- In February 2020, NTSB recommended the use of DMS.
- Euro NCAP recognized the importance of DMS(2020)
- Mandatory in the EU in 2022 (2026)



What are the challenges of DMS/OMS physical testing?

Enormous testing time slowing down development progress

Danger to testing team and other road users

Difficulty testing under all driving conditions (day/night, external lighting, driver gender/ethnicity, clothing items permutation, etc...)

Evolving legislative policies requiring new validation campaigns



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DMS – Perception and Feedback



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DMS – Logical Architecture



Abbreviations:

FoV: Field of View FCW: Forward Collision Warning MPU: Micro Processing Unit MCU: Micro Control Unit



DMS – Ansys Solutions



Ansys Solution

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Main capabilities for optical sensors development

CAD-agnostic 3D geometrical environment

- Large road environment
- Moving vehicles and pedestrians
- Driver movement

Light emission

- Natural light: sky and sun
- Artificial lights: luminaires, front/rear lamps
- Thermal sources, up to far infrared

Light-matter interaction

- Spectral BSDF
- Volume scattering

Light collection

- Spectral irradiance sensor (detailed model)
- Camera sensor (simplified model)

Dedicated features

- Pixel grid projection
- Image processing interface (plugin, API)





Speos Lens System (SLS)

Zemax OpticStudio[®]







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Camera Projected Grid

• Packaging and positioning of the camera

 Graduation

 Primary step
 50

 Secondary step
 5



 Graduation

 Primary step
 10

 Secondary step
 1



- Evaluate if camera is correctly positioned to consider all the driver sizes.
- Evaluate how many pixels correspond to the eye to detect blinking







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• Frames export from Blender.

🔊 Blender [D:\Projects\HF\Radar\Breathing\radar04.blend]



• Animation of Realistic Targets





Ansys Solutions – IR Camera



Simulation Results





Perception

Ansys Solutions – Time-of-Flight Camera



- Camera Setup:
 - Light source: 950 nm
 - FoV 49° x 37° (HxV)
 - 320 x 240 px
 - Spatial accuracy 2 mm







Distance [m]



Ansys Solutions – Thermal Camera









• Light sources:

- 55

- 51 - 47

- 43 - 39 - 35

- 31

- Sun radiation
- Blackbody IR radiation -

- Camera Setup:
 - FoV 62° x 49° (HxV)
 - 640 x 480 px



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Ansys Solutions – Radar



- Monitor driver attentiveness
- Measure eye blinks
- Measure head movements
- Respiration rate

• Import into Ansys Electronic Desktop.









Radar Imaging



3D Rendering of Reconstructed Image

End-to-End Simulation Workflow



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SPEOS – optiSLang – Driver Monitoring Post-processing



Ansys Solutions – Visual Feedback



Feedback

Visual





Active sound studies



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Thank you!

And feel free to contact me



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