AI-based Condition Monitoring for Cameras

Maik Wischow
German Aerospace Center (DLR)
Institute of Optical Sensor Systems

Why Monitoring a Camera‘s Condition?


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[2] dlr.de, “DLR tests the City-ATM system at the Köhlbrand Bridge in Hamburg“, https://www.dlr.de/content/en/articles/news/2019/02/20190515_dlr-tests-the-city-atm-system-at-the-koehlbrand-bridge-in-hamburg.html, 2019.
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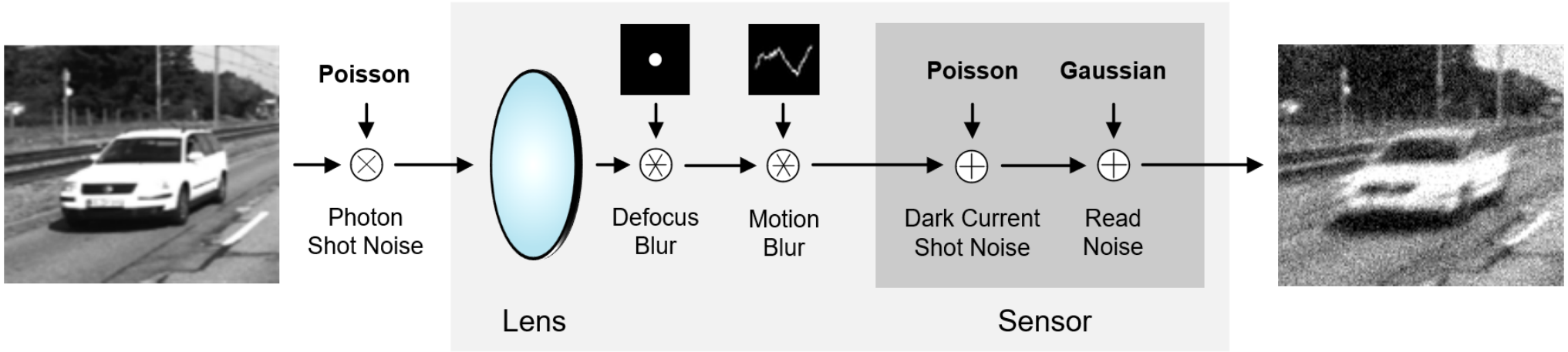

Source: Wischow, M., Gallego, G., Börner, A. (2021). Camera Condition Monitoring and Readjustment by means of Noise and Blur. Unpublished manuscript.

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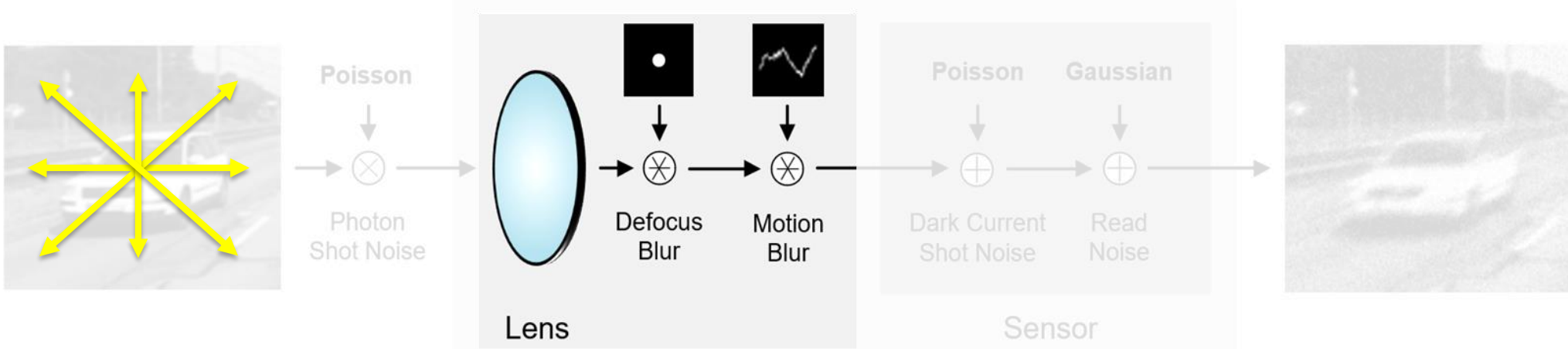

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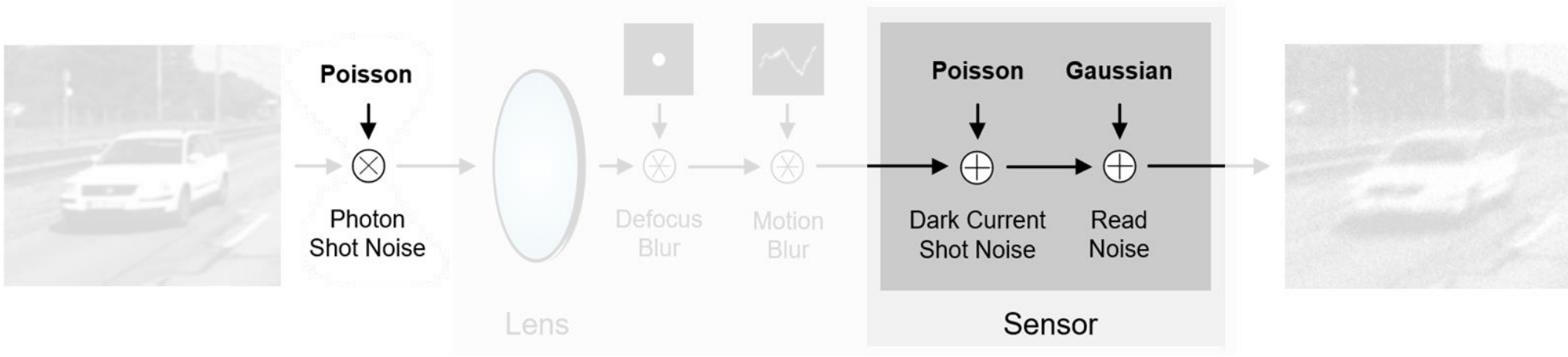

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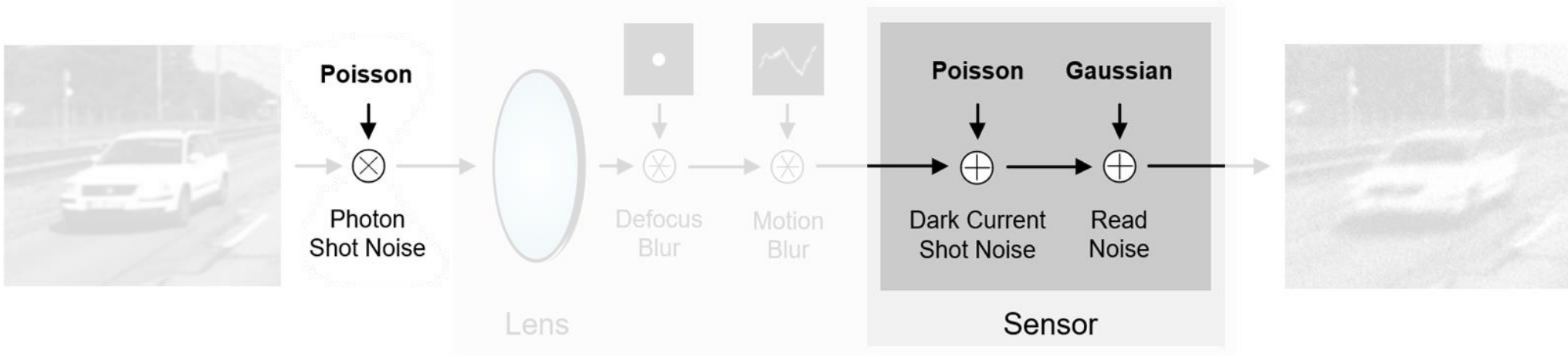

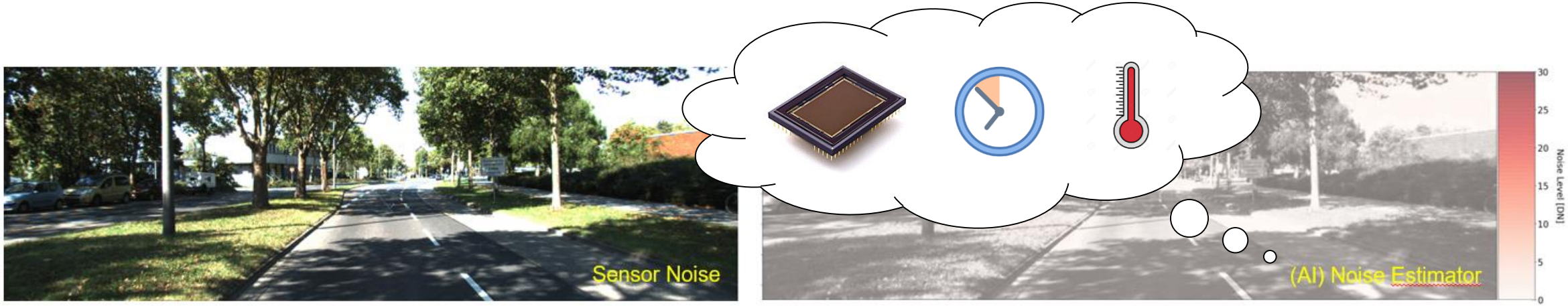

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What is considered a bad condition?

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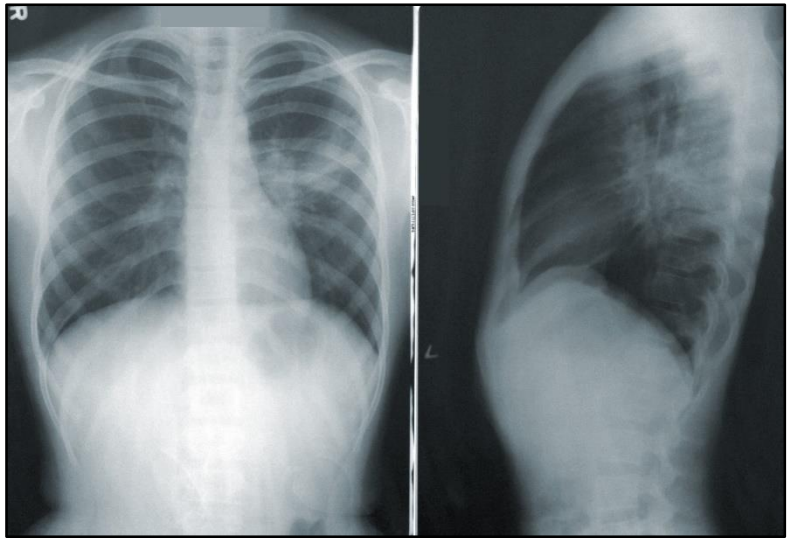

Blur undesired

Source: Cody Glickman, “Data Augmentation on Medical Images”, https://towardsdatascience.com/data-augmentation-in-medical-images-95c774e6eaae, 2020.

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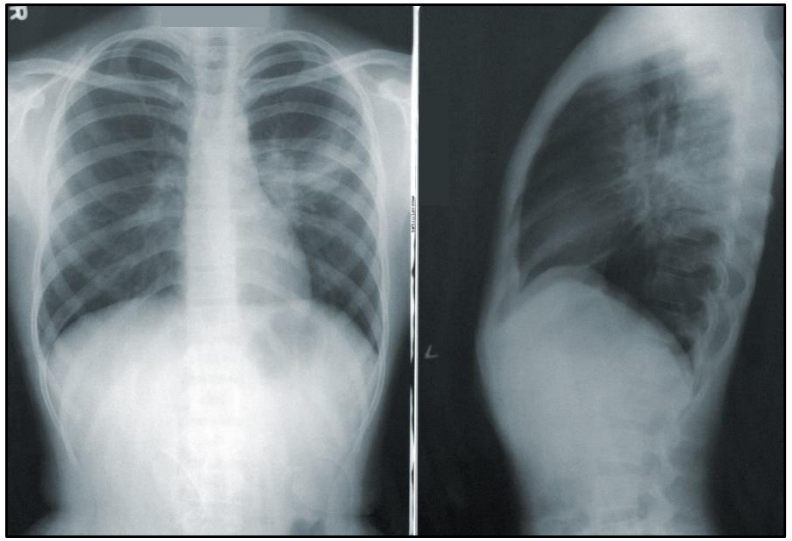

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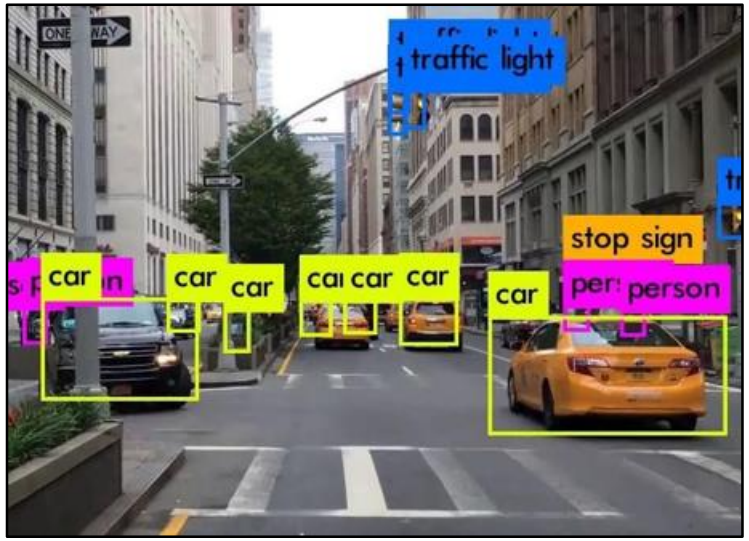

Blur might be good

Source: Sreedhar Achari, “Practical Implementation of Object Detection On Video with OpenCV and Yolo v3 pre-trained weights on coco data”, https://medium.com/@vsreedharachari/practical-implementation-of-object-detection-on-video-with-opencv-and-yolo-v3-pre-trained-weights-a2d2995aac41, 2020.

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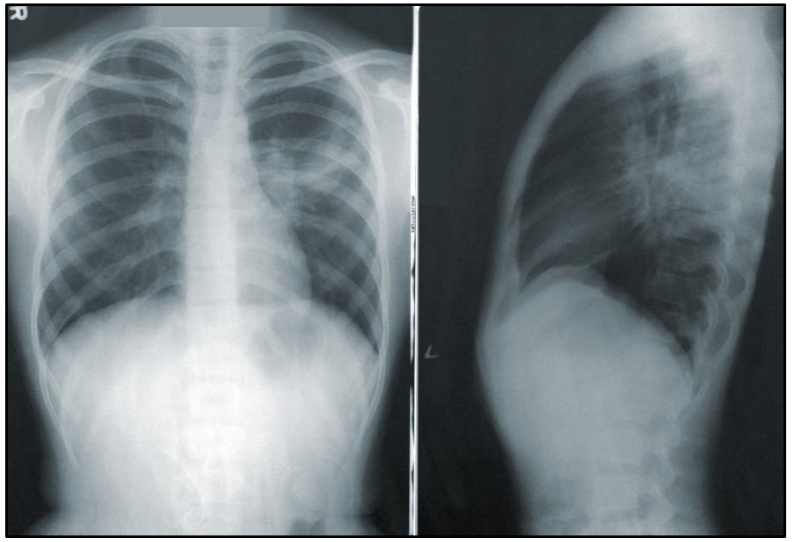

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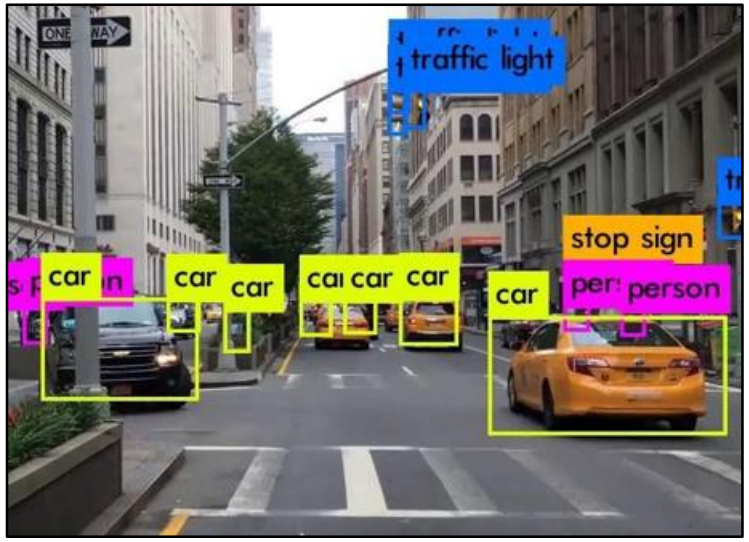

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Blur desired

Source: dlr.de, “Die ESA-Mission PLATO wird ab 2026 nach erdähnlichen Exoplaneten suchen”, https://www.dlr.de/content/de/bilder/2019/4/plato-mission-suche-nach-exoplaneten.html, 2019.

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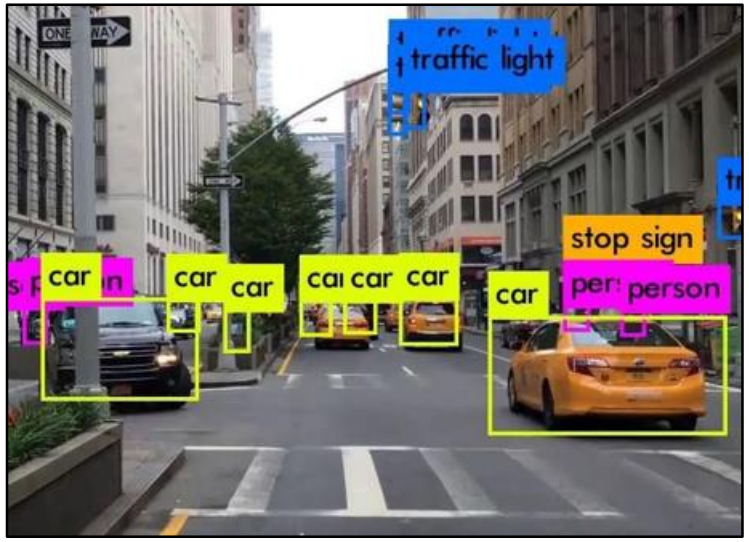

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Blur desired

What is considered a bad condition?

Camera Conditions: Motion Blur and Sensor Noise

Performance Profile
(AI) Object-Detector #1

9.6	9.9	9.4	8.5	8.3	8.0
15.8	15.2	13.5	12.4	12.0	10.7
19.0	18.0	17.0	16.1	15.2	14.8
21.7	21.5	20.0	17.9	17.0	15.5
26.6	26.1	24.9	23.3	21.9	21.5
33.9	26.3	24.0	22.6	20.4	19.7

More Blur

More Noise

Detection Performance
(the higher, the better)

Source: Wischow, M., Gallego, G., Börner, A, “Camera Condition Monitoring and Readjustment by means of Noise and Blur”, Unpublished manuscript, 2021.

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21.7	21.5	20.0	17.9	17.0	15.5
26.6	26.1	24.9	23.3	21.9	21.5
33.9	26.3	24.0	22.6	20.4	19.7

Performance Profile (AI) Object-Detector #2

18.2	15.9	14.4	12.3	10.6	10.2
13.8	16.4	17.1	16.5	16.1	15.1
24.8	23.5	21.7	19.8	18.4	17.7
23.6	23.5	22.2	21.7	20.3	18.3
18.6	19.6	18.7	18.4	17.6	15.7
26.9	18.8	17.6	16.0	14.1	13.9

More Blur

More Noise

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How can we use this knowledge?

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Camera Conditions: Motion Blur and Sensor Noise

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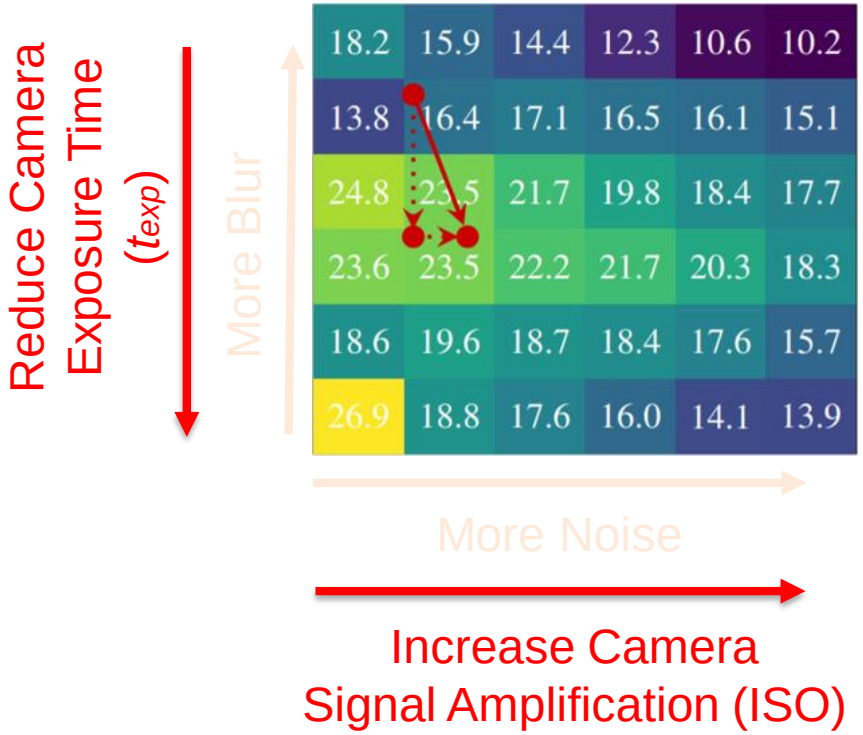
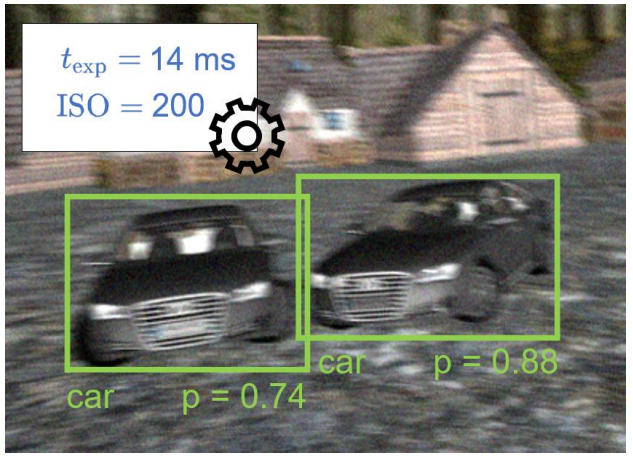


Camera in undesired Condition

(Automatically) Readjusted Camera



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How can we use this knowledge?

- Applicable to different types of sensors.
- Decide requirements beforehand (e.g. for crack detection).

Source: Modern Contractor Solutions AG, “Infrared & Visible Bridge Scoping”, https://mcsmag.com/infrared-visible-bridge-scoping, 2013.

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Source: Pexels@pixabay.com, https://pixabay.com/photos/dawn-drone-dusk-mountains-outdoors-1868870, 2016.

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- Applicable to different types of sensors.
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- Assess expected experiment success beforehand.
- Increase safeness.

Source: “I am a friend of u sam”, “Night drive india”, https://www.youtube.com/watch?v=Ls9nYk7zitM&list=UUB4osmKckmypSnWidphrRAg, 2017.

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Summary

- Development of AI-based methods for monitoring the health state of cameras.
- Physical knowledge about cameras (system models, configuration, …) not only optional, but **essential**!
- Desired camera conditions in close connection with the target application.
- Sensitivity-Analyses …
  - … tackle black-box approaches.
  - … safeguard data acquisition and prevent applications that are doomed to fail.
  - … increase safety.
  - … **require** accurate, reliable, real-time “Sensor AI” condition estimators.

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Many Thanks!