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► **To cite this version:**

Josué Manuel Rivera Velázquez, Louahdi Khoudour, Guillaume Saint Pierre, Pierre Duthon, Sébastien Liandrat, et al.. Thermal imaging under foggy weather conditions. Première Seminaire NeoCampus, Jul 2022, Toulouse, France. hal-04438900

HAL Id: hal-04438900

<https://hal.science/hal-04438900v1>

Submitted on 7 Feb 2024

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Thermal imaging under foggy weather conditions

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Context

This research work is part of the European project AWARD, which goal is to analyse the behaviour of thermal cameras under the presence of extreme weather conditions, specifically under thick fog conditions.

In autonomous vehicles, thermal imaging is part of the most suitable solutions for detecting and recognizing the environment in the most extreme conditions (night, fog, rain).

The objective of the study is to find what is the breaking point, i.e. the very degraded fog situation beyond which the thermal sensor becomes unusable.

Tools and methods

The experiments were performed within Cerema's PAVIN Fog and Rain platform using four thermal cameras with different Field of Views: 18°, 30°, 60° and 90°. Two scenarios were implemented:



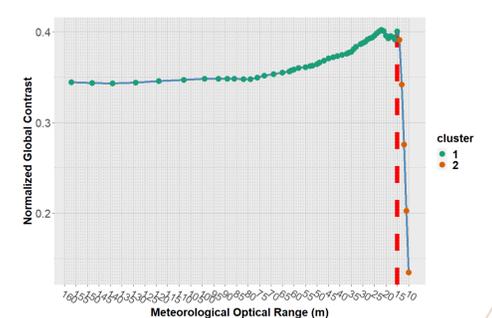
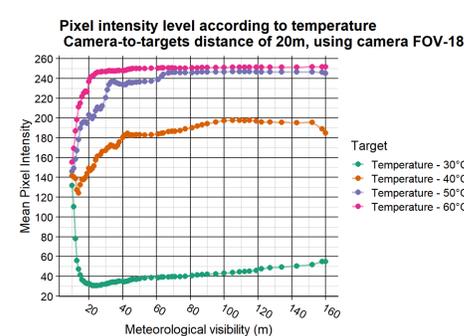
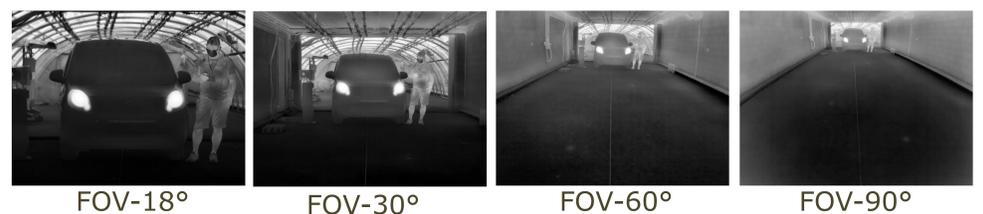
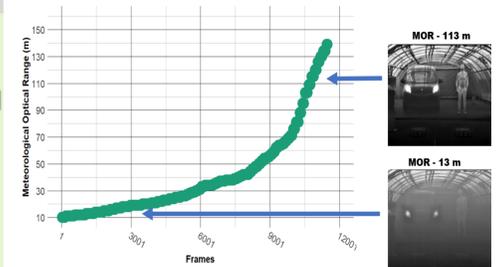
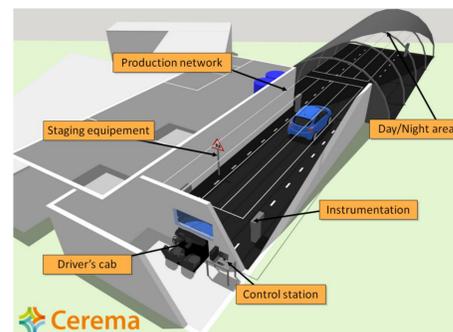
1) Scenarios using four motionless heated blackbodies



2) Scenarios involving an electric car and a pedestrian

Results

- The Mean Pixel Intensity and the Contrast were the two indicators used in this study.
- It was observed that under the presence of fog, the field of view of a thermal camera is a determining parameter: The greater the field of view, the greater the sensitivity to fog.
- From scenarios with heated blackbodies, it was concluded for cameras with a field of view of 18° and 30°, blackbodies can be distinguished as long as Meteorological Optical Range (fog intensity) is above 15 meters.
- For cameras with a field of view of 60° and 90°, blackbodies can be distinguished as long as Meteorological Optical Range is above 30 and 40 meters, respectively.
- Using thermal images as input in YOLOv5, it was observed a higher detection rate for the pedestrian than for the car for a low Meteorological Optical Range (high fog intensity).
- Using thermal images as input in YOLOv5, and assuming a detection rate of 90% as the operability limit, it was observed that cameras with a field of view of 18° and 30° can operate when Meteorological Optical Range is above 14 meters.
- The camera with a field of view of 60° can operate when Meteorological Optical Range is above 16 meters.
- The camera with a field of view of 90° presented for all cases a detection rate below the 90%.



Conclusions

The analysed thermal cameras were able to recognize objects in static or dynamic mode even under thick fog conditions. This is very encouraging for the application involving autonomous vehicles.

Thermal images are compatible with detection and recognition algorithms based on artificial intelligence and neural networks. Using a good combination of thermal sensor and detection software, very high performance could be achieved.



<https://award-h2020.eu/>

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