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# Neuromorphic vision and transfer learning for autonomous driving

Hajer Fradi

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# NEUROMORPHIC VISION AND TRANSFER LEARNING FOR AUTONOMOUS DRIVING



Bienvenue



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NOETIC Project

Hajer Fradi

hajer.fradi@imt-atlantique.fr



IMT Atlantique  
Bretagne-Pays de la Loire  
École Mines-Télécom

## INTRODUCTION

### ❖ Frame-based vision:

- More than 60 years, research has been focused on frame-based cameras.
- Some limitations:



Overexposure



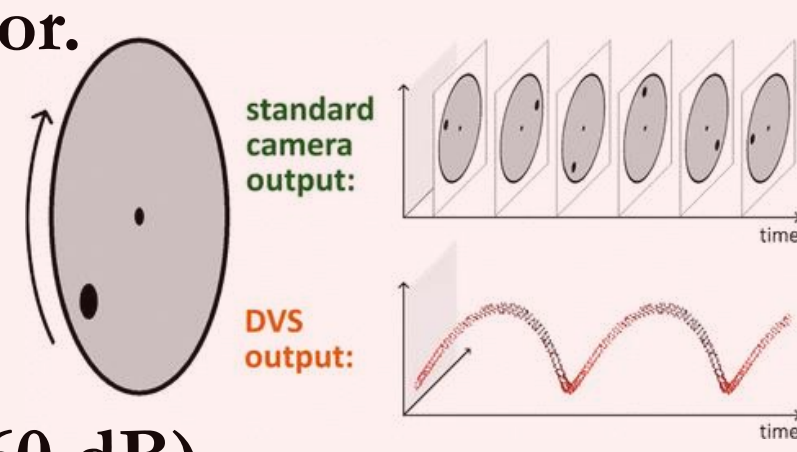
Motion blur



Low-light

### ❖ Event-based vision:

- Novel sensor that measures motion in the scene.
- First introduced in 2008 as the Dynamic Vision Sensor.
- Low latency ( $\sim 1 \mu\text{s}$ ).
- Free from motion blur.
- High dynamic range (140 dB compared to the usual 60 dB).
- Low power consumption.

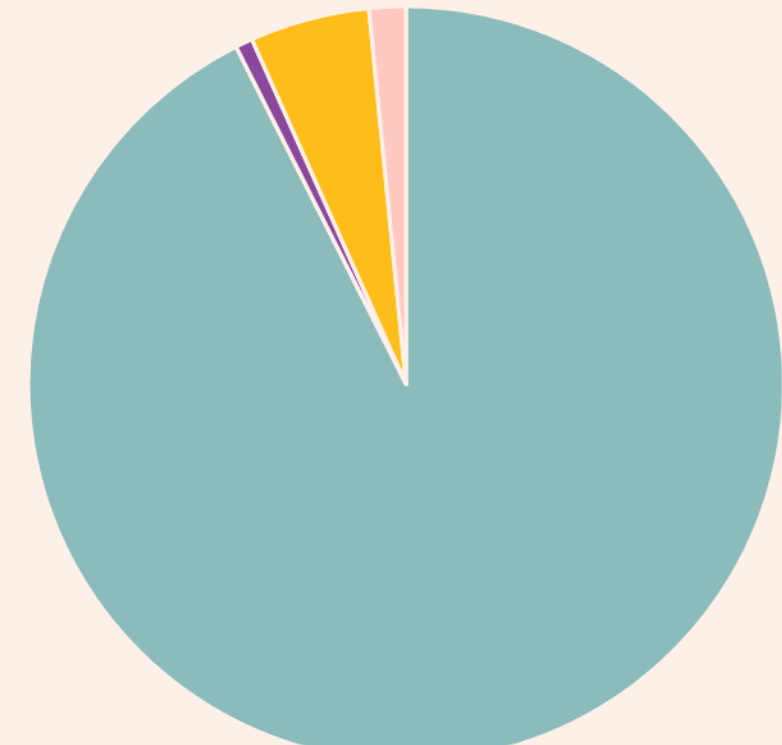


## CHALLENGES & MOTIVATION

### ❑ Challenges:

- Unconventional, asynchronous and sparse output of event-cameras
- In view of the recency of event-cameras, the full potential of deep-learning is not yet full unlocked.

RGB Event Depth Thermal

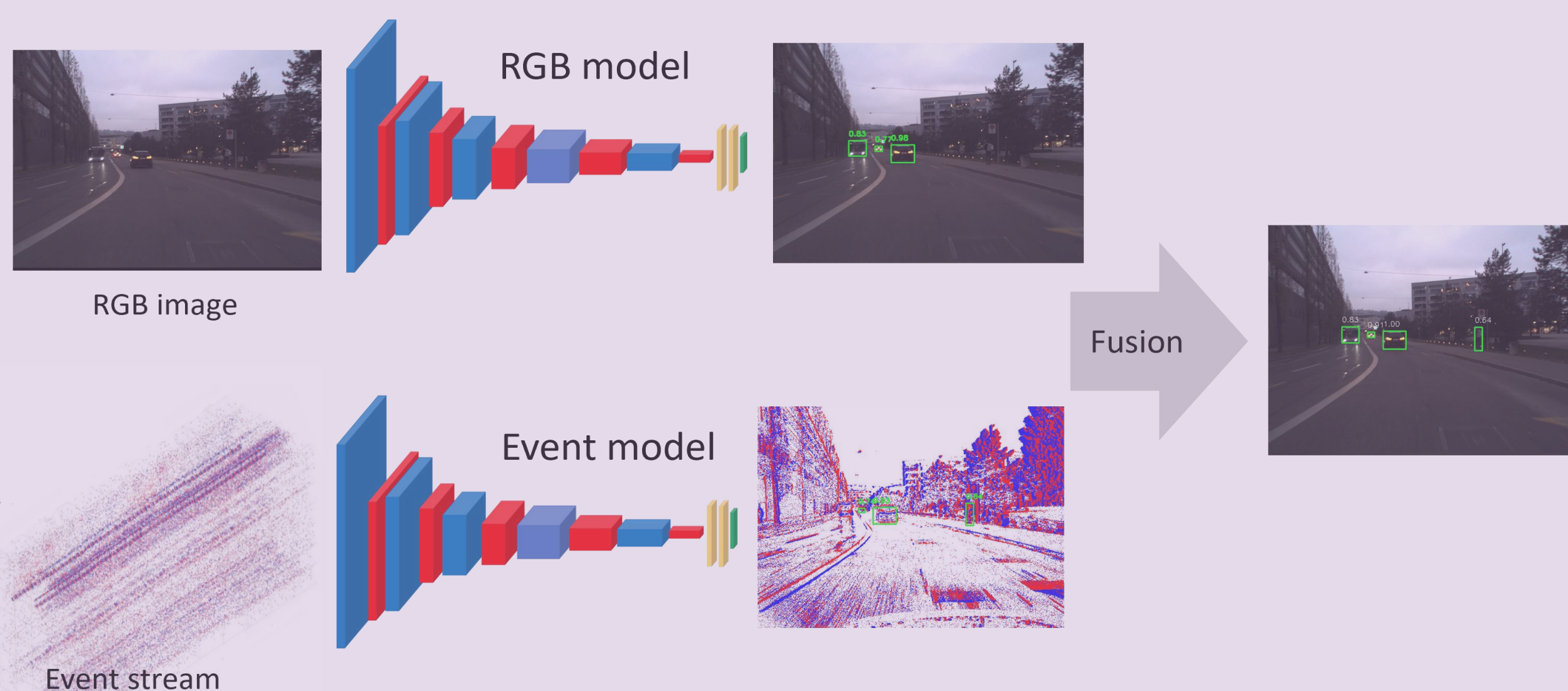


Computer Vision Datasets

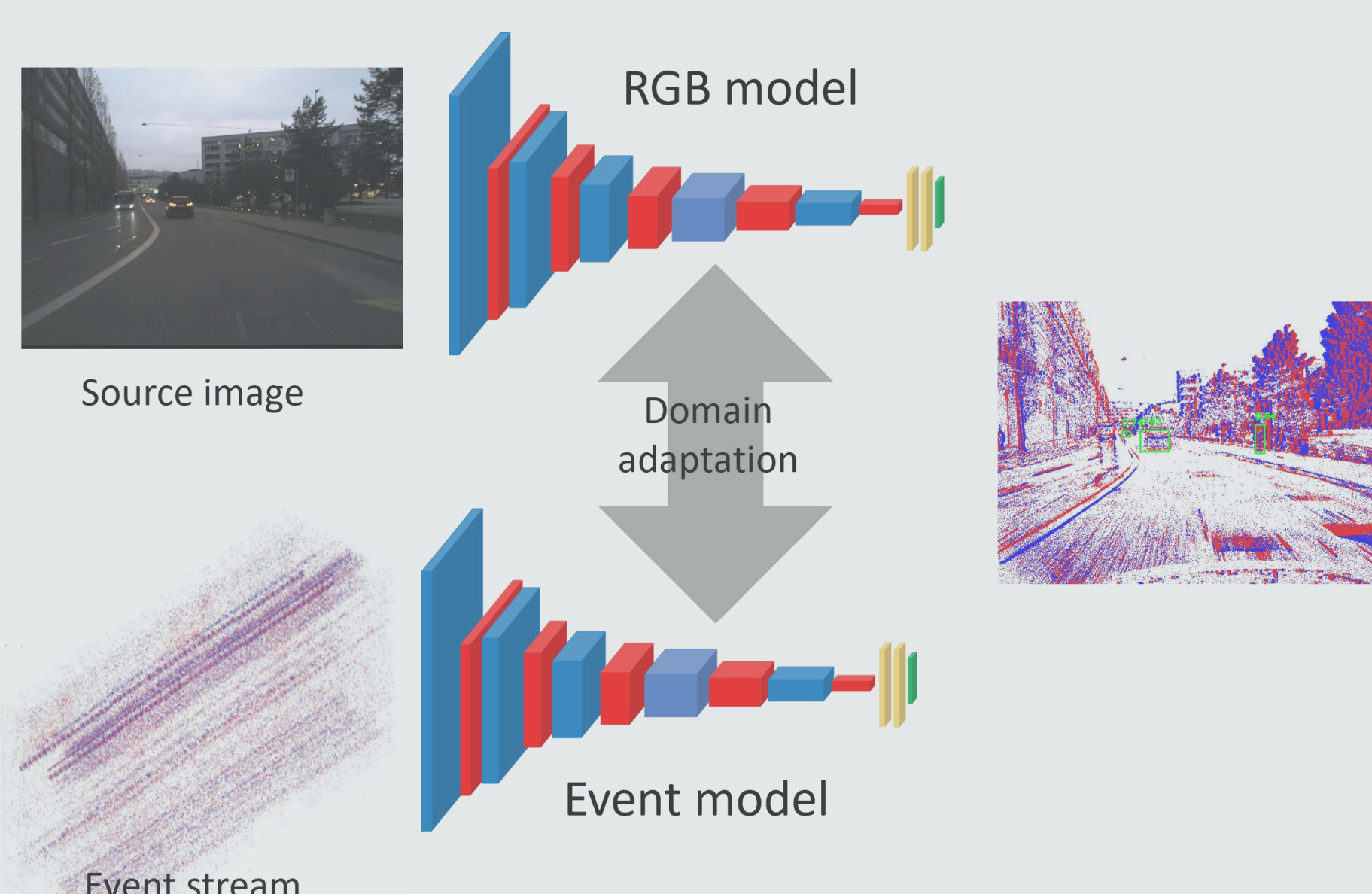
Data from: <https://homepages.inf.ed.ac.uk/rbf/CVonline/Imagedbase.htm>

### ❑ Research axes:

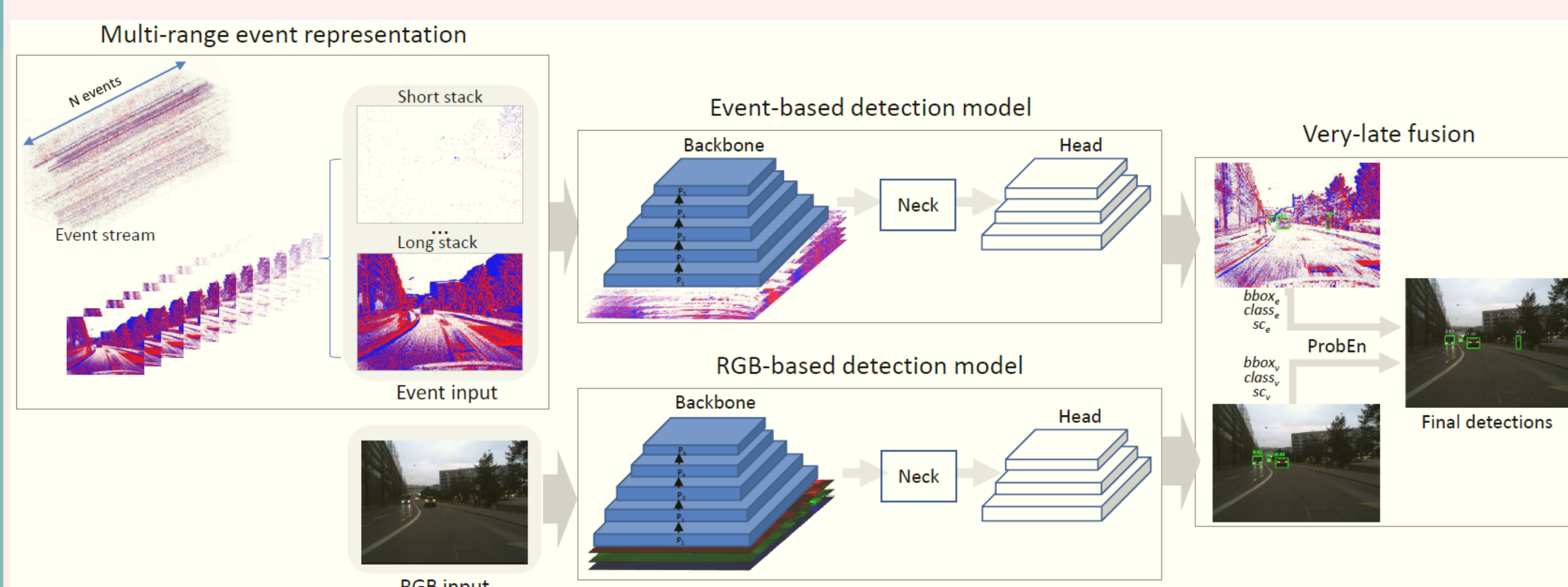
- The complementarity of frame-based and event-based modalities through fusion schemes.



- Transfer the knowledge from data-rich RGB (conventional frame-based) domain to data-scarce event-based domain



## PROPOSED FUSION APPROACH



### ❑ Step 1: Input event representation

- An important step that involves mapping event streams to event frames.
- Stacking based on the number of events [1].
- Opting for a multi-channel representation for highly detailed description.
- The number of channels and events is optimized by measuring the distortion between the raw events and their representations.

### ❑ Step 2: Backbone network

- YOLOv7 [2] detector is chosen as a good compromise between accuracy and time complexity.
- YOLOv7 is updated and configured to support multi-channel inputs.

### ❑ Step 3: Very late fusion

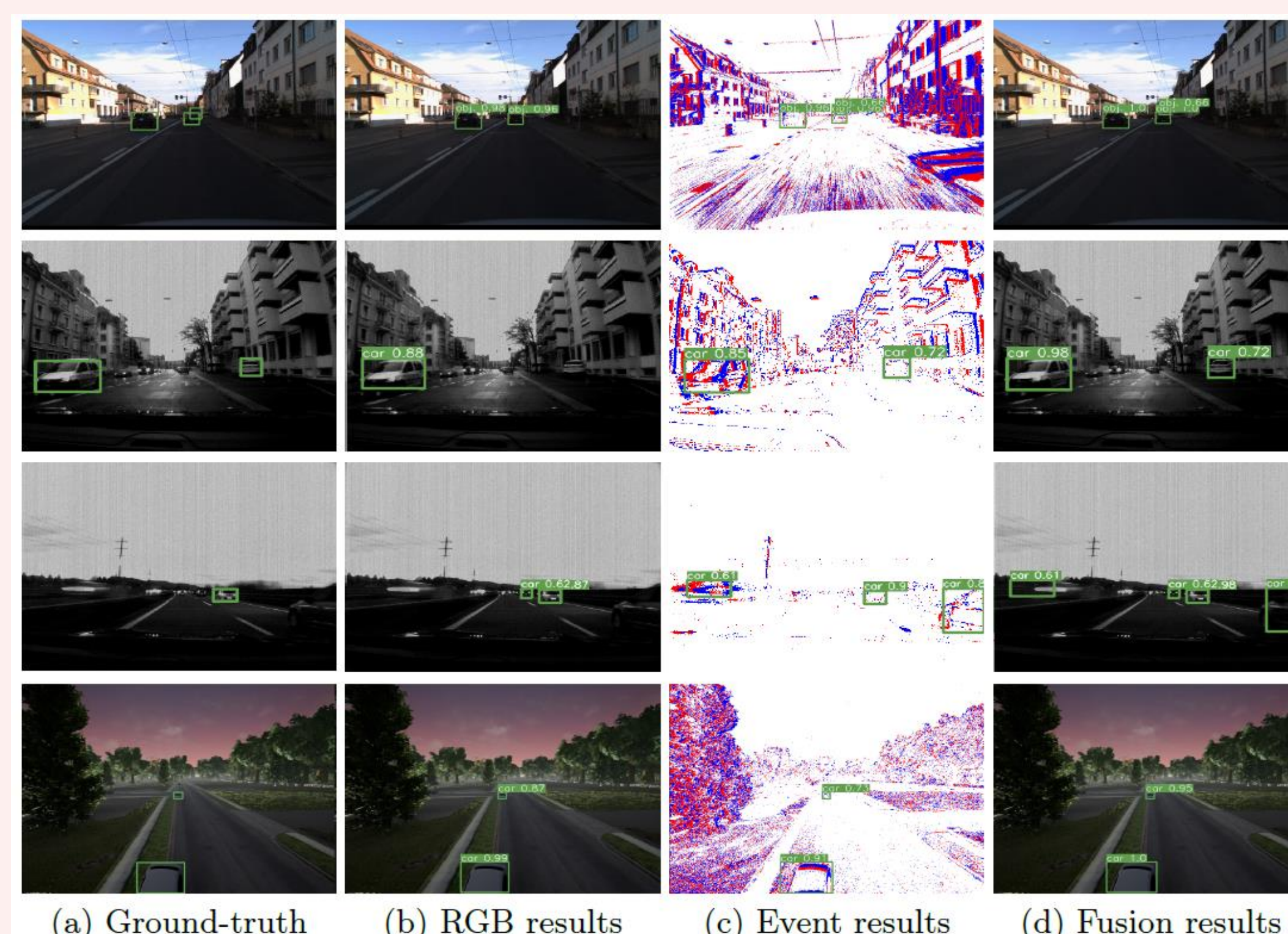
- Very-late fusion through probabilistic ensembling derived from Bayes' rule [3].
- The class posteriors and bounding boxes from single-model detectors are probabilistically fused.

## EXPERIMENTAL RESULTS

### ❑ Datasets:

- DSEC-MOD [4] for detecting moving objects of 8 classes.
- PKU-DDD17 [5] for car detection in driving scenarios.
- SimCar: Synthetic data generated within a simulated drone navigation environment using AirSim and Unreal Engine, and v2e toolbox.

### ❑ Qualitative results:



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