Deep Learning for Radar Data Exploitation in Autonomous Driving

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Motivations

- Autonomous driving requires a high perception around the ego-vehicle for scene understanding.
- Camera and lidar are commonly used to detect objects.
- **Automotive radar** is the only one to be resiliant to adverse weather conditions.

Problems

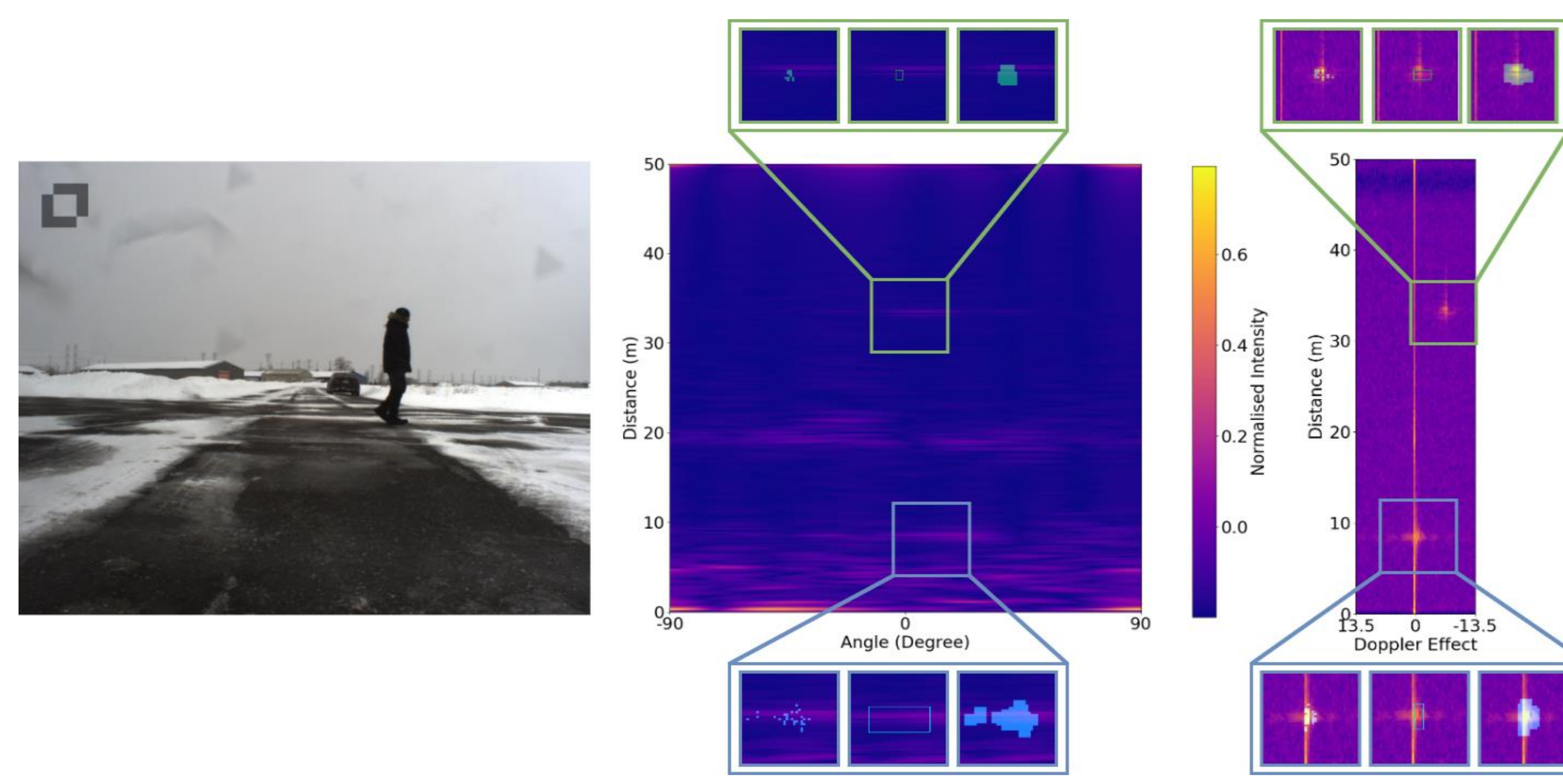
- How to find annotated raw radar data?
- How to create a suitable deep learning architecture for radar scene understanding?

CARRADA Dataset: Camera and Automotive Radar with Annotations [1]

- **Objective**: create a dataset with a semi-automatic annotation tool to generate annotations in the raw radar data

- **Method**:
 1. Detect and track objects in the camera images.
 2. Compute their physical properties.
 3. Project them in a processed radar representation.
 4. Cluster and track the objects in the processed radar sequence.
 5. Project the clusters in the raw radar representation to obtain various annotations.

- **Results**: release of the **first raw radar dataset with Range-Angle-Doppler annotations for scene understanding**.

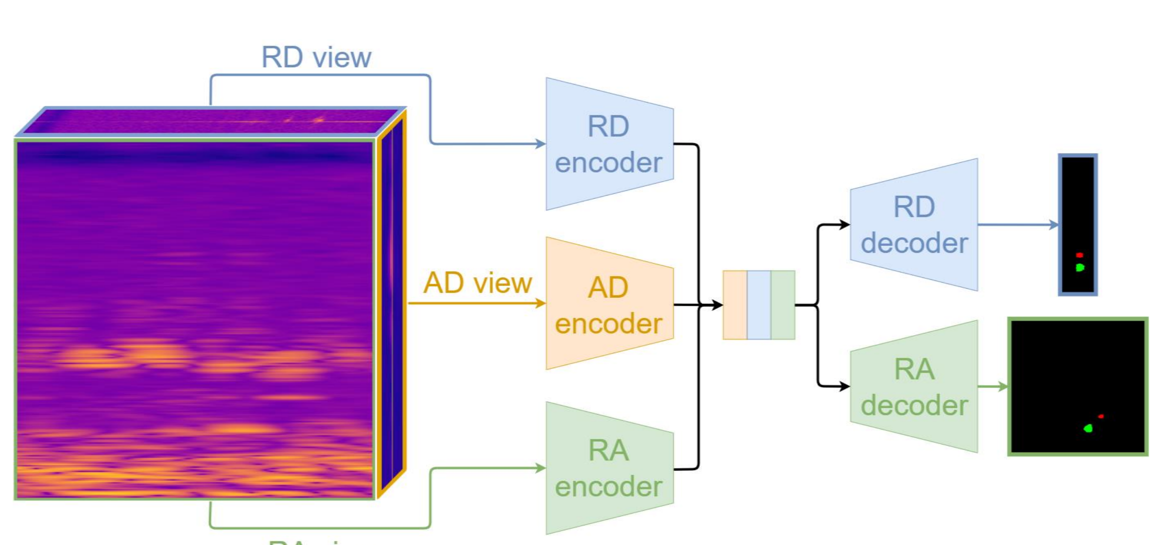


A scene from CARRADA dataset, with a pedestrian and a car. (left) Video frame provided by the frontal camera, showing a pedestrian at approximately 8m from the sensors and a car in the background at approximately 33m; (middle-right) Radar signal at the same instant in range-angle and range-Doppler representation respectively. Three types of annotations are provided: sparse points, bounding boxes and dense masks. The blue squares correspond to the pedestrian and the green ones to the car.

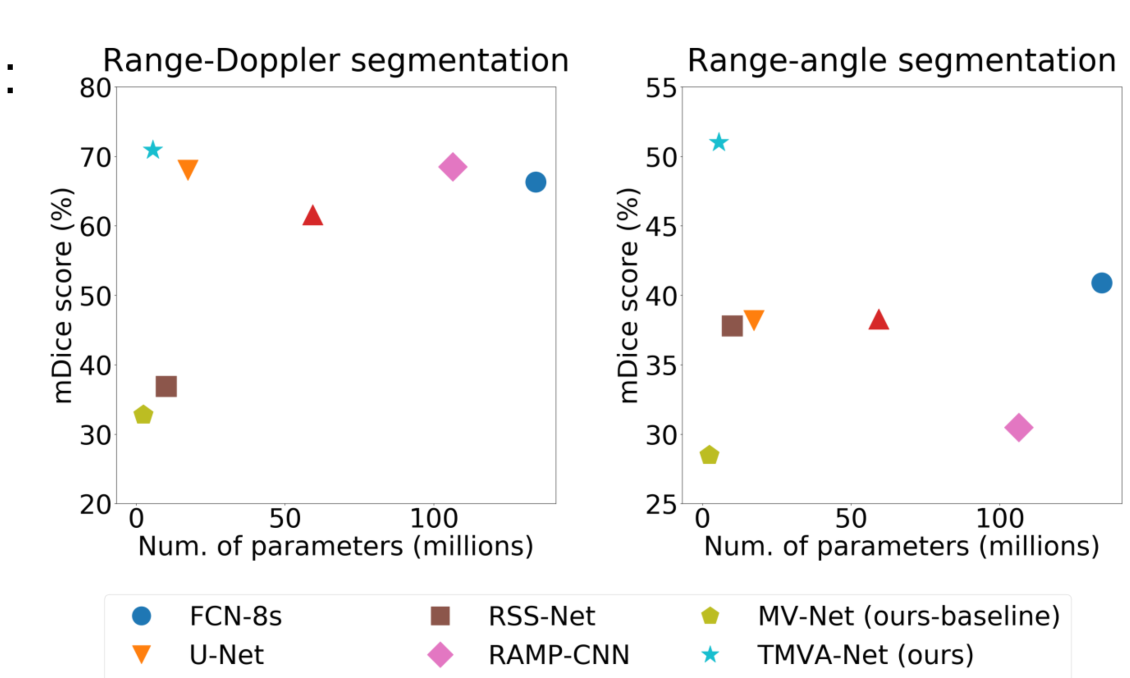
Radar Scene Understanding: Multi-View Radar Semantic Segmentation [2]

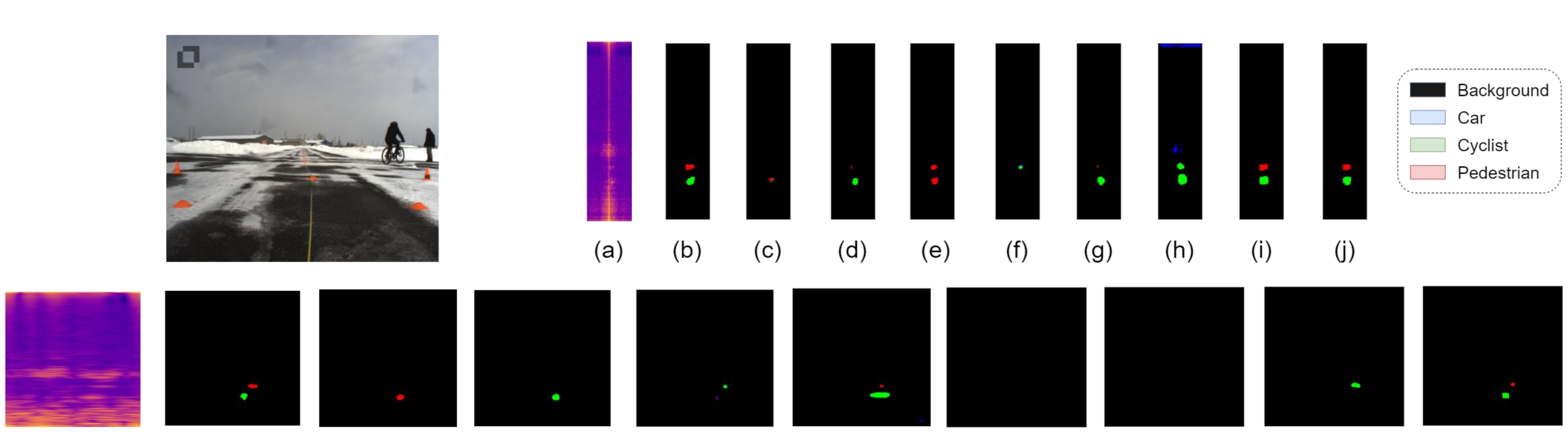
- **Objective**: propose a deep learning architecture for scene understanding using raw radar data.

- **Contributions**:
 1. **Architectures** for multi-view radar semantic segmentation.
 2. **Combination of losses** using a new coherence term.



- **Results of our method**:
 1. **Outperforms** adapted methods with significantly **fewer parameters**.
 2. Provides **consistent** temporal and multi-view predictions based on qualitative results.
 3. **Generalizes** well on complex urban scenes.





Qualitative results on a test scene of CARRADA. (Top) camera image of the scene and results of the RD segmentation; (Bottom) Results of the RA Segmentation. (a) Radar view signal, (b) ground-truth mask, (c) FCN8s, (d) U-Net, (e) DeepLabv3+, (f) RSS-Net, (g) RAMP-CNN, (h) MV-Net (our baseline w/ wCE+SDice loss), (i) TMVA-Net (ours, w/ wCE+SDice loss), (j) TMVA-Net (ours, w/ wCE+SDice+CoL loss).

Conclusions and Perspectives

- Create and release the **first raw radar dataset** with Range-Angle-Doppler annotations.
- Propose a **lightweight** and **efficient** framework for multi-view radar semantic segmentation.

- Improve the coherence loss and apply MVRSS framework to recent datasets
- Explore multi sensor fusion in 3D point clouds for scene understanding.

[1] **CARRADA Dataset: Camera and Automotive Radar with Range-Angle-Doppler Annotations**, Arthur Ouaknine, Alasdair Newson, Julien Rebut, Florence Tupin, Patrick Pérez, *ICPR 2020*
[2] **Multi-View Radar Semantic Segmentation**, Arthur Ouaknine, Alasdair Newson, Patrick Pérez, Florence Tupin, Julien Rebut, *Preprint, ArXiv 2021*

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