CAMERA AND RADAR FUSION
HIGH RESOLUTION RADAR DETECTION AND IMAGING

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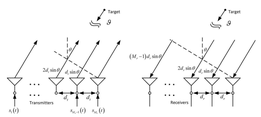
Introduction

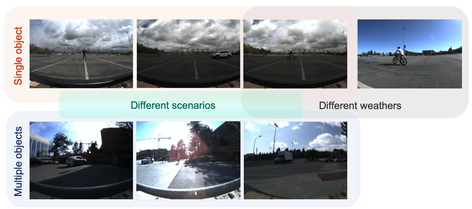
Camera and radar each has different strengths. Camera has high resolution but lacks localization while radar is very good at localizing objects but lacks the ability to identify the objects. We develop a system that effectively combines the strengths of camera and radar. It performs accurate object detection and localization.

Specifications

FMCW **Radar**: TI AWR1843 with 2 transmit & 4 receive



RGB **Camera**: FLIR A400



"Fusion"

The key idea of our method is using estimated classification of object from images to supervise a network which returns the detection from radar.

In matching the pairs for radar and image objects, we utilizes angles of the objects we get in radar points clustering and tracking. For pair of the angles between image objects and radar objects, we use the angles we get..

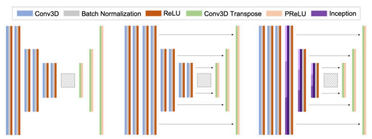


Fig1. Neural network's structure of RODNet part.

Fusion sturcture

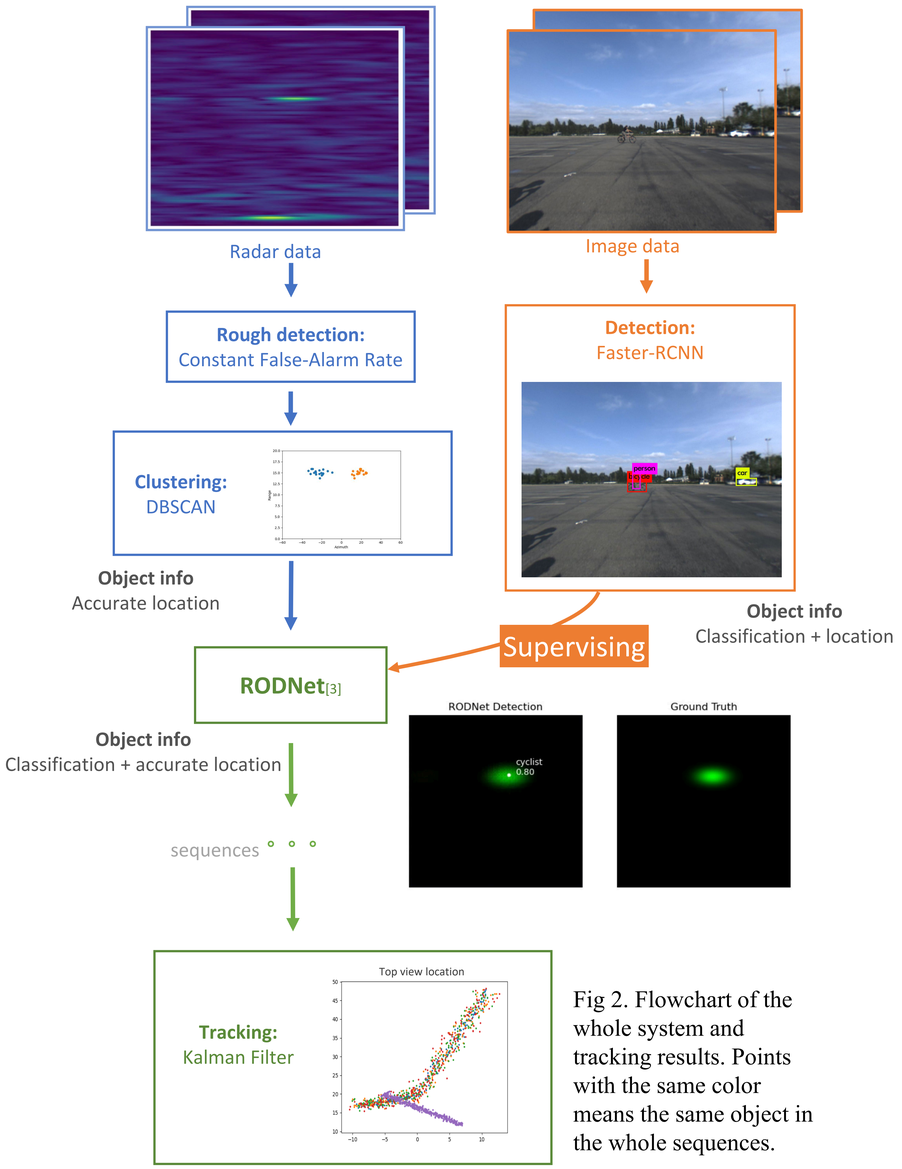


Fig 2. Flowchart of the whole system and tracking results. Points with the same color means the same object in the whole sequences.

Tracking

Use **Kalman Filter** for radar reflection points tracking. Kalman filter provides the estimation of state given measurements overtime. In our case, the state is a tracked point's x, y positions and x, y velocities; the observation is an incoming point's x, y positions.

Conclusion

- Our method effectively combines the strengths of radar and camera and perform object detection and localization with high precision.
- Our method effectively takes the camera's strength at object classification and radar's strength at localization to perform object detection.
- Our fusion method has better performance than the purely vision-based or radar-based methods. With effective fusion of camera and radar, our method can perform the same task as the expensive Lidar can.

Future work

Based on our current performance, there's still some space for substantial improvement.

- One possible direction is that increasing the radar clustering's accuracy through a better neural network instead of the end-to-end structure we use. For end-to-end structures in this case may lead to an uncertainty in inner variables.
- Another direction is that false positive detections still exist and can seriously affect the outputs in some scenarios.

Reference

[1]Gao, Xiangyu, et al. "Experiments with mmWave Automotive Radar Test-bed." arXiv preprint arXiv:1912.12566 (2019).
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[3]Wang, Yizhou, et al. "RODNet: Object Detection under Severe Conditions Using Vision-Radio Cross-Modal Supervision." arXiv preprint arXiv:2003.01816 (2020).
[4]Welch, Greg, and Gary Bishop. "An introduction to the Kalman filter." (1995): 41-95.

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