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E-LAB

AUTOMATIC RADAR-BASED GESTURE DETECTION VIA REGION-BASED DCNN

Introduction

- 77 GHz FMCW radar for automatic gesture detection via a region-based DCNN (R-DCNN).
- Micro-Doppler signatures and phase-difference information are exploited.

Motivation

- Robust under ambient light conditions and privacy-preserving reasons.
- In previous works, manually clipping the data streams is required.

Conclusion

- Automatic radar-based gesture detection based on R-DCNN.
- 95% (96%) average PPV (TPR) for nine gestures.

Front-End Signal Processing

- Spectrogram Channel:

$$MD(q,k) = \sum_{p=0}^{N-1} |B(p,q,k)| .$$

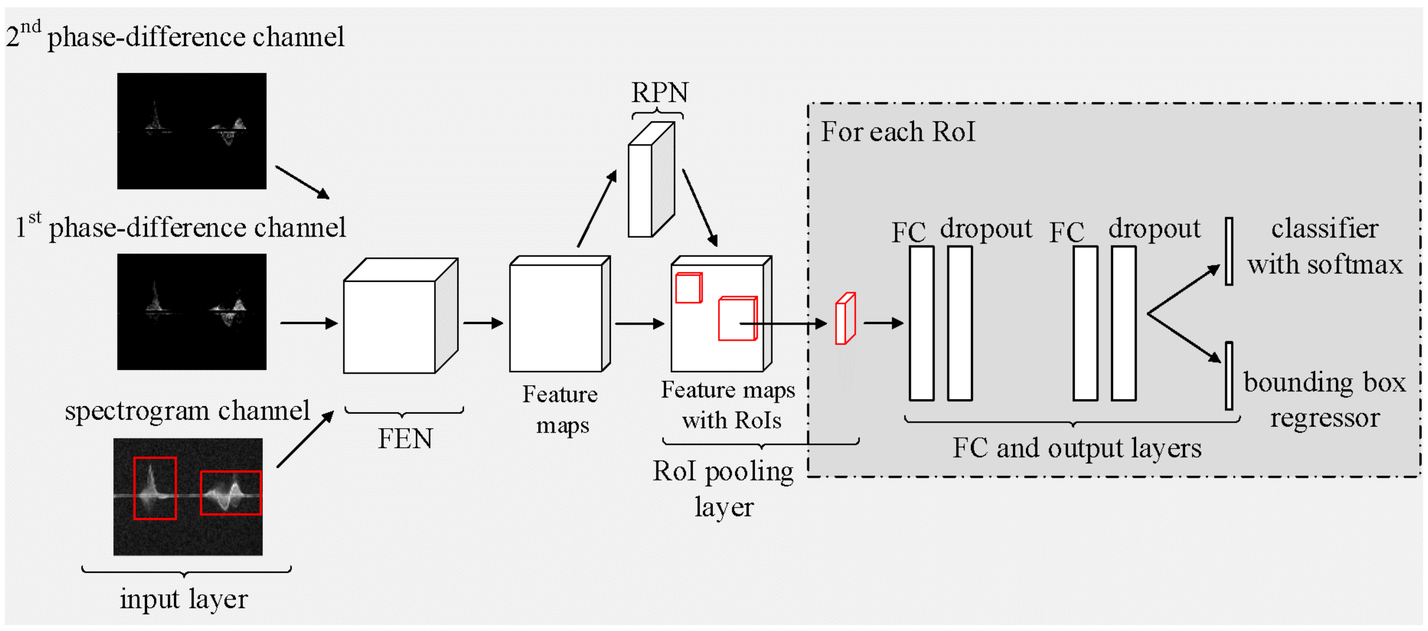
- Phase-difference Channels:

$$PD^{(ij)}(q,k) = \sum_{p=0}^{N-1} \left|\Delta\varphi^{ij}(p,q,k)\right| ,$$

where $B(p,q,k)$ is the 3-D beat signal (range-Doppler-measurement-cycle) in Fourier domain, and $\Delta\varphi(p,q,k)$ is the phase-difference between two Rx.

Radar-Based Gesture Detector

- We followed the Faster R-CNN object detection network.
- The input layers consist of one spectrogram and two phase-difference channels.

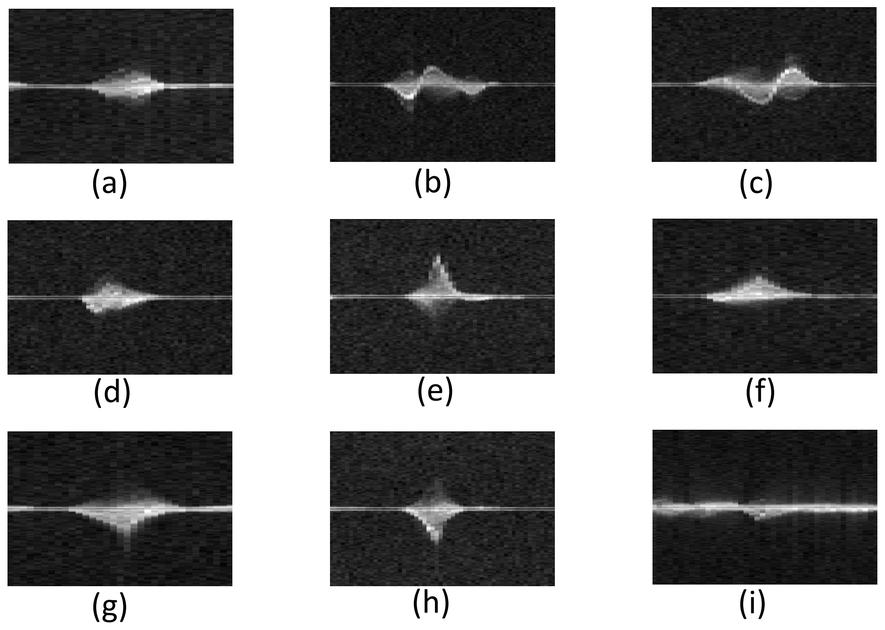


Measurement Scenario

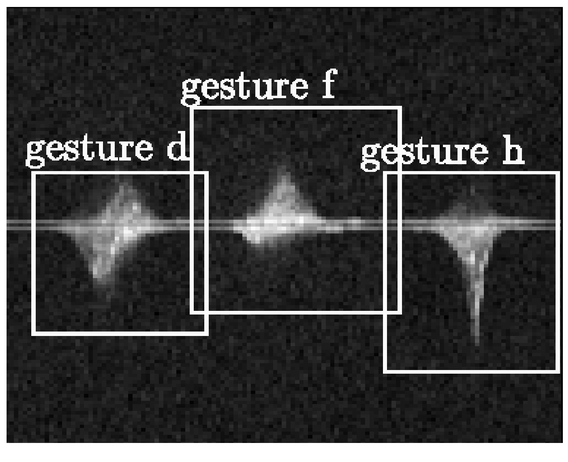
- An 77 GHz FMCW radar mounted in the roof console of a vehicle.
- 3 m detection range and 60° beam width.
- (9 gestures) x (19 subjects) x (10 times) = 1710 (total samples)
- 15 subjects as training set and 4 subjects as test set.

Experiment Results

a) Approach steering wheel
b) Rotate clockwise
c) Rotate counter clockwise
d) Swipe from bottle right to upper left
e) Swipe down
f) Swipe left
g) Swipe right
h) Swipe up
i) Random motion



Detection Examples



P/T	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	PPV	TPR
(a)	40	0	0	0	0	3	0	0	0	0.93	1
(b)	0	40	0	0	0	6	0	0	0	0.86	1
(c)	0	1	40	0	0	1	0	0	0	0.95	1
(d)	0	0	0	40	0	0	0	2	0	0.95	1
(e)	0	0	0	0	40	3	0	0	0	0.93	1
(f)	0	0	0	0	0	27	0	0	0	1	0.67
(g)	0	0	0	1	0	0	40	0	0	0.97	1
(h)	0	0	0	0	0	0	0	40	0	1	1
(i)	0	0	0	0	0	1	0	0	40	0.97	1
	Average									0.95	0.96

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