Radar-based traffic analysis in smart cities



In demand during the pandemic: anonymous, affordable traffic monitoring



Application examples of radar



Easily acquired statistics of urban mobility, e.g. to monitor the spread of the pandemic and current willingness of the population to stick to the rules



Tracking of bicycle traffic: where to build or not to build new bike lanes?

Smart traffic lights, safer & faster intersections



Dynamic highway use regulation depending on the time of the day







Data: challenges

- a very small dataset (375 radar maps, mostly one ta
- overlapping boxes

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- resolution often not sufficient for pedestrians
- the classes are not equally represented (5 pedestrians, 66 cars, 332 trucks)
- no directional information (only range)
- high noise background



Solution 1: decision tree on higher feature vectors



1. CFAR to detect peaks (preceded by Gaussian filter). Count objects



2. Place bounding boxes of uniform size around peaks

4. Train decision tree

classifier on higher

feature vectors

3. Extract higher feature vector containing box statistics

?

5. simultaneously evaluate object detection and classification





Solution 1: results

- Pure classifier accuracy: 92.9%
- Detection + classification accuracy: 70.7%
- Counting accuracy: 73.1%

Solution 2: peak detection → CNN classification





1. Optional: detect peaks to generate bounding boxes, e.g. using DBscan

2. Pad bounding boxes of targets to make them uniformly sized



3. Apply CNN classifier to cutouts

CNN architecture





Solution 2: results





Solution 3: R-CNN for simultaneous detection and classification

- Problem: number and size of radar targets not fixed
- Solution: region based CNNs: region detection and classification
- We used: Fast R-CNN (2015)



Source: https://arxiv.org/pdf/1504.08083.pdf

Outlook and remaining tasks

- More pedestrians and cars needed in the data to test the classifiers
- More data needed to train Faster R-CNN. May need to change significant parts
- Bottleneck: error-prone peak detection.
- Solution: try new peak/blob detection algorithms, preprocessing of radar images in advance, or forego peak detection completely

The radarheads



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