

Ten years of pedestrian detection, what have we learned ?



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This presentation: paper overview + my 3 surprises



Great progress in pedestrian detection during last decade



Caltech-USA is currently the most active dataset.



Pedestrian detection is still very active





























[Viola & Jones 2004] [Dalal & Triggs 2005] [Felzenszwalb et al. 2008] [Dollar et al. 2009] [Ouyang & Wang 2012] [This paper 2014]



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- solution family (DPM, deep networks, decision forests)
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better features

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Surprise 1: There is no clear winner regarding solution family (DPM, DN, or DF) or classifier type.





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training data

- additional (test time) data
- exploiting context
- better features



Training data matters (you knew this already)

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Training data matters (you knew this already)

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- solution family (DPM, deep networks, decision forests)
- better classifiers
- deformable parts
- multi-scale models
- deep architectures
- training data

additional (test time) data

⇒ using more frames (flow or stereo) helps (you knew this already)

- exploiting context
- better features



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Using context helps (expect ~5 pp improvement)





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Experiments

(some of them)



Features alone can explain 10 years of progress



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Strong features/Flow/Context are very complementary

Method	Results	Improvement	Expected improvement
SquaresChnFtrs	34.81%	-	-
+Better features (DCT)	31.28%	3.53	-
+Flow (SDt)	30.34%	4.47	-
+Context (2Ped)	29.42%	5.39	-

Results in MR (lower is better). Improvement in MR percent points.

[DCT: Nam et al. ArXiv 2014] [SDt: Park et al. CVPR 2013] [2Ped: Ouyang & Wang CVPR 2013]



Strong features/Flow/Context are very complementary

Method	Results	Improvement	Expected improvement
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+Flow (SDt)	30.34%	4.47	-
+Context (2Ped)	29.42%	5.39	-
+DCT+2Ped	27.40%	7.41	8.92
+SDt+2Ped	26.68%	8.13	9.86
+DCT+SDt	25.24%	9.57	8.00
All-in-one (Katamari)	22.49%	12.32	13.39

Results in MR (lower is better). Improvement in MR percent points.

Surprise 2: no diminishing return observed (yet).

Strong features/Flow/Context are very complementary



Merging all methods over time



Surprise 3: Model capacity has not saturated





Surprise 3: Model capacity has not saturated





Rodrigo Benenson | CVRSUAD @ ECCV 2014

What have we learned ?

- "Sooner or later, everything old is new again." Stephen King Decade-old ideas still rule detection quality.
- Switching training data is not comparing apples-to-apples.
- Flow, context, and strong features are very complementary (still).
- All other aspects have yet to make a "definitive statement".
- Features alone can explain a decade of detection quality progress.
- There is room for further improvement by increasing model capacity (and better features).



How to further improve quality?

- Stronger use of additional data (scene flow on KITTI ?)
- Better context (exploiting scene geometry)
- Further developing deep architectures (end-to-end fine tuning)
- Most importantly: understanding what makes good features good?



Questions?

See you at the poster !

Rodrigo Benenson http://rodrigob.github.com





- solution family (DPM, deep networks, decision forests)
- better classifiers

deformable parts

⇒ no clear case for their use in pedestrians

- multi-scale models
- deep architectures
- training data
- additional (test time) data
- exploiting context
- better features



- solution family (DPM, deep networks, decision forests)
- better classifiers
- deformable parts

multi-scale models ⇒ helps a bit, but not key for quality in Caltech-USA

- deep architectures
- training data
- additional (test time) data
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- better features



- solution family (DPM, deep networks, decision forests)
- better classifiers
- deformable parts
- multi-scale models

deep architectures ⇒ active area, has yet to reach top quality: CVPR 2015 ?

- training data
- additional (test time) data
- exploiting context
- better features

