Play and Learn: Using Video Games to Train Computer Vision Models

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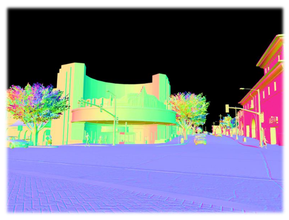
Video Games vs. Reality

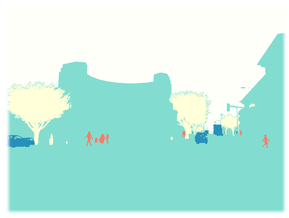
Video game

Google street view

Are existing video games visually realistic enough to improve computer vision models in practice?

Why Video Games?





- **Free Groundtruth Annotation**: image segmentation, depth maps, surface normals, shadows, precise localization, optical flow, etc.
- **Controllable Environment**: variations of seasons, times of the day, climate settings, points of view, interactions, etc.
- **Automation and Scalability.**

Method

- **Dense Image Classification**. Measure the performance of FCN8s [3] in two approaches: (i) fine-tuning on a real-world dataset with various pre-training strategies, and (ii) cross-dataset evaluation.
- **Depth Estimation.** Measure the improvement in image patch ordering task under the method of Zoran *et al*. [4].

Summary of Results

- A convolutional network trained on synthetic data achieves a similar test error to a network that is trained on real-world data for dense image classification on a new dataset.
- The video game dataset can deliver similar or better results compared to the real-world datasets if a simple domain adaptation technique is applied.
- Pre-training on synthetic data results in better initialization and final local minima in the optimization of convolutional networks.
- Video games can offer an alternative way to compile large datasets for direct training or augmenting real-world datasets.

Selected References

[1] Gabriel J. Brostow, Julien Fauqueur, and Roberto Cipolla. Semantic object classes in video: A high-definition ground truth database. *Pattern Recognition Letters*, 2009.

[2] Marius Cordts, Mohamed Omran, Sebastian Ramos, Timo Rehfeld, Markus Enzweiler, Rodrigo Benenson, Uwe Franke, Stefan Roth, and Bernt Schiele. The Cityscapes dataset for semantic urban scene understanding. In *CVPR*, 2016.

[3] Jonathan Long, Evan Shelhamer, and Trevor Darrell. Fully convolutional networks for semantic segmentation. In *CVPR*, 2015.

[4] Daniel Zoran, Phillip Isola, Dilip Krishnan, and William T. Freeman. Learning ordinal relationships for mid-level vision. In *ICCV*, 2015.

Datasets

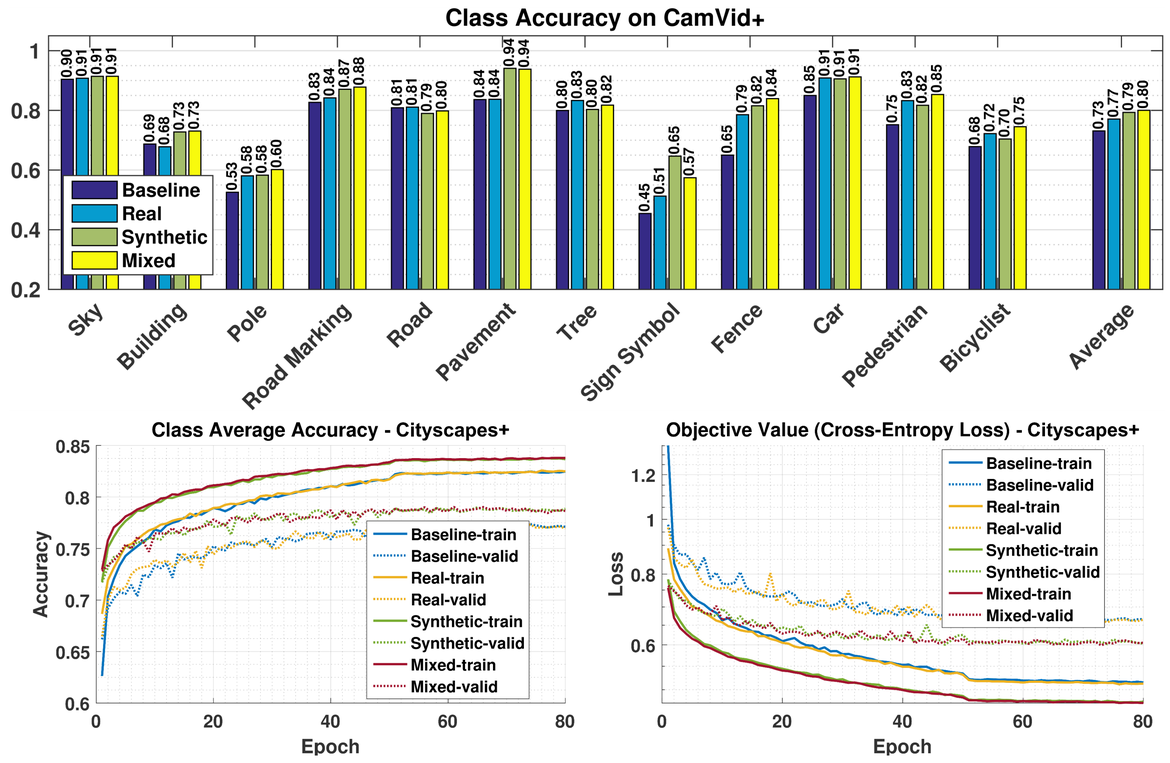
Synthetic

CamVid [1]

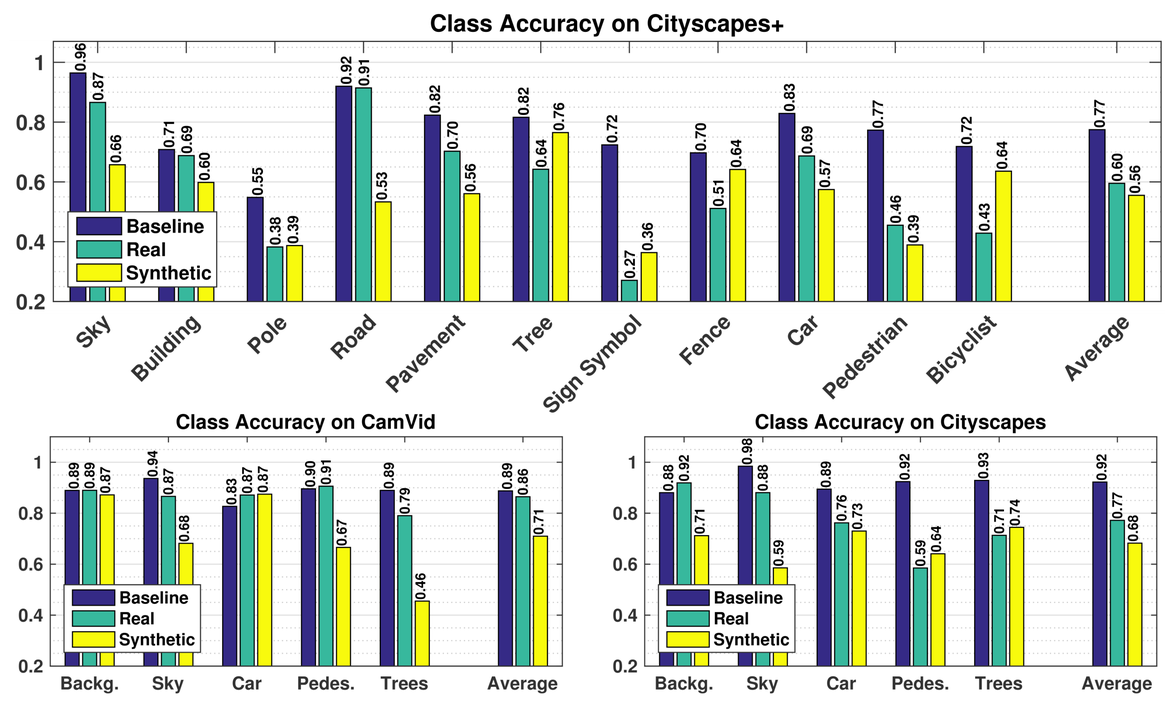
Cityscapes [2]

- **Synthetic.** A camera is mounted on a car, and an autonomous driver wanders around the city while a separate process captures data. We collect over 60,000 samples with annotation.
- **CamVid and Cityscapes.** A 5-class annotation of the data.
- **CamVid+ and Cityscapes+.** A 12-class annotation of the data.

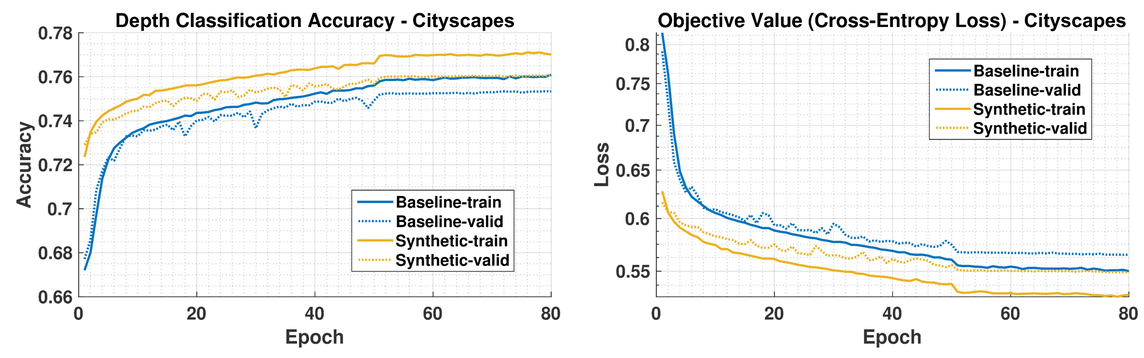
Fine-tuned Dense Image Classification



Cross-dataset Dense Image Classification



Depth Estimation from RGB



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