Viewpoint-Aware Object Detection and Pose Estimation

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Abstract

- Object detection & pose estimation of rigid 3D objects from single 2D images.
- Class model integrates 3D shape and 2D appearance allowing for simultaneous viewpoint invariant detection and pose estimation.
- Efficient search in 6D transformation space allows for continuous estimation of object's pose.

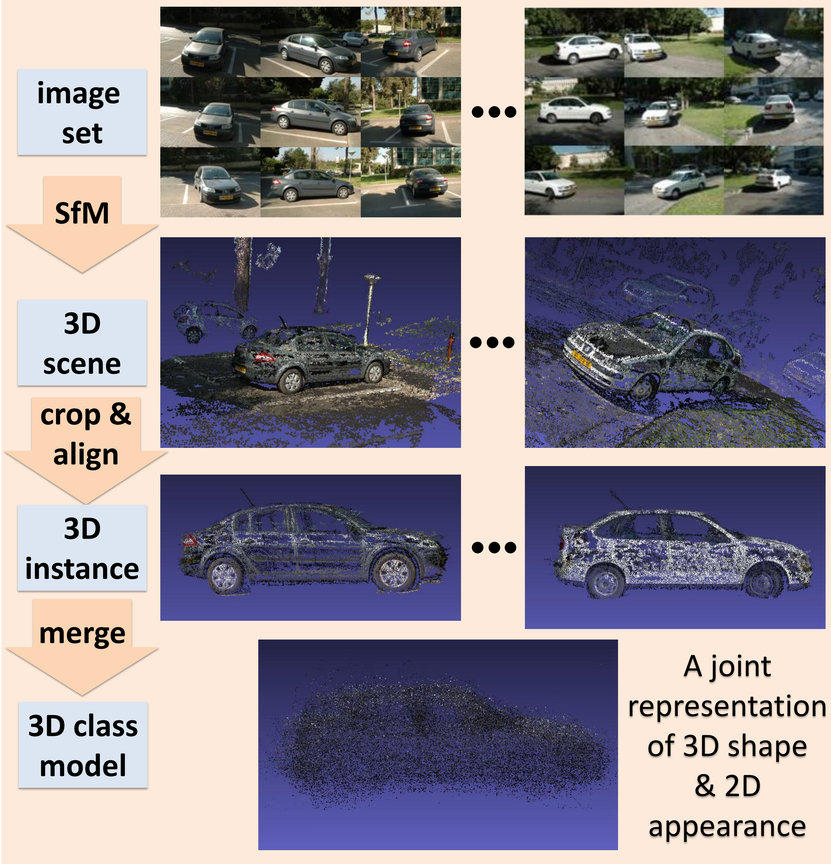
Challenges

Acquire a 3D representation of an object class

Search 6 DOF space of 3D→2D transformations

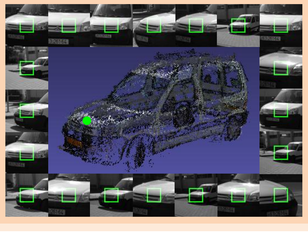
Integrate detection and pose estimation

3D representation of object class



A joint representation of 3D shape & 2D appearance

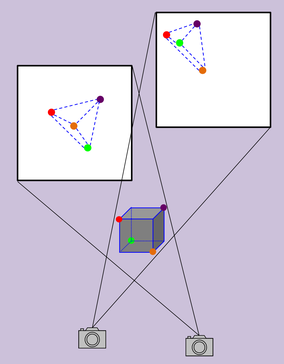
Each 3D point is associated with multiple 2D appearance patches from different viewpoints and scales.



Search 6D transformation space

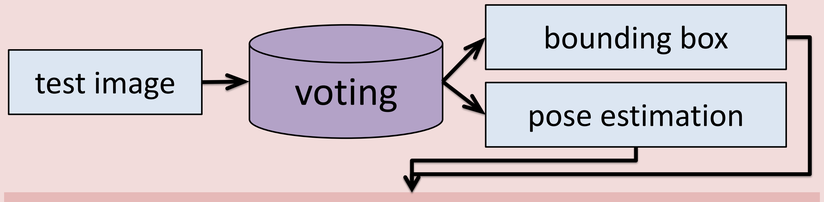
Weak perspective model
scaling (1 DOF) →
rotation (3 DOF) →
in-plane translation (2 DOF)

Parameterization



representation is amenable to clustering

Integrating detection & pose estimation



SVM re-ranking & refinement

pose correction

refined bounding box & score

Experiments

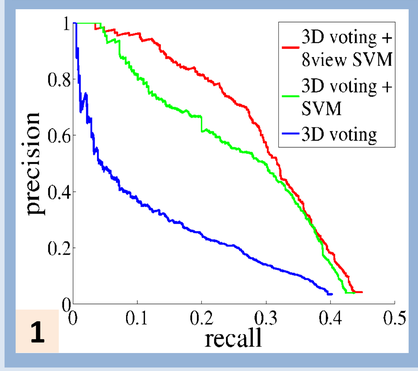
Pascal VOC 2007: 5000 test images with 1541 cars

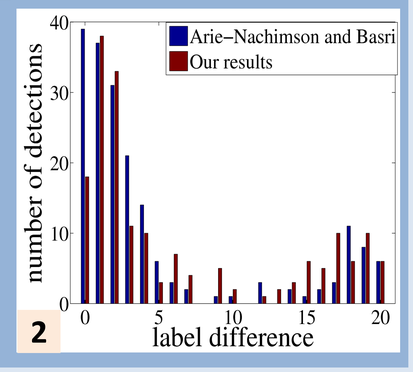
	2D voting	2D voting + SVM	3D voting	3D voting + SVM	3D voting + 8view-SVM
AP	15.86%	24.34%	16.29%	27.97%	**32.03%**

Positive	Negative
Our cars, Stanford & EPFL	Pascal 07 training set
No positive Pascal data used	

Pascal pose

180 Pascal 2007 test cars, labeled with 40 different pose labels.



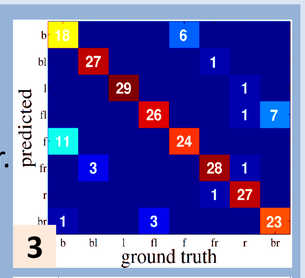


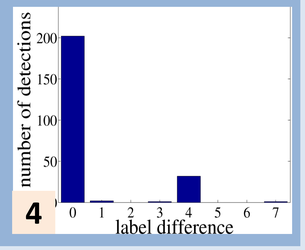
Stanford 3D-pose:

240 images 5 cars, 3 scales,
8 viewpoints 2 elevations.
All test images contain exactly one car.

	voting	voting + SVM	Voting + 8view-SVM
AP	90.17%	94.85%	**99.16%**
AA		83.88%	**85.28%**

Positive	Negative
Our cars & Stanford train	Pascal 07 training set Stanford train

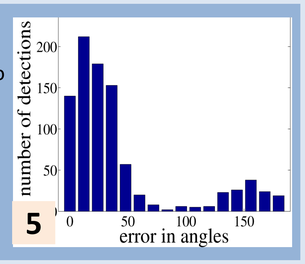




EPFL car show:

~1000 images, 10 cars, photo every 4°

Positive	Negative
Our cars, Stanford & EPFL	Pascal 07 training set



Our car data: 3 splits of ~1500 images, 22 cars (⅔ train ⅓ test)

Positive	Negative
Our cars (current split training set)	Pascal 07 training set