Attribute-based Vehicle Recognition using Viewpoint-aware Multiple Instance SVMs

Kun Duan[1], Luca Marchesotti[2], David Crandall[1]
[1]Indiana University, [2]Xerox Research Centre Europe

IEEE 2014 Winter Conference on Applications of Computer Vision
WACV 14

1. Overview:

- *Problem: Fine-grained vehicle recognition, to classify amongst different makes and models of car photos taken from varying viewpoints.*
- *Discover local attributes (mid-level features that are discriminative and semantically meaningful) from exemplars with or without viewpoint labels.*
- *Approach: Generalization of Multiple Instance SVM (MI-SVM) with pairwise constraints among positive examples.*

red headlight, red bumper, blackwindshield, black back tire, round wheel

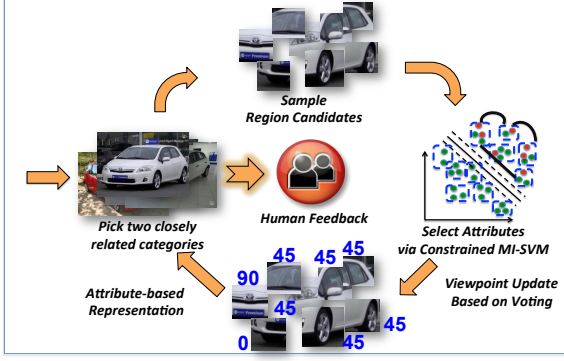
black tire, round wheel, black window

red headlight, white back

yellow door, black windshield, disk brake

2. Approach:

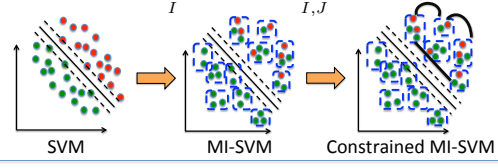
- *Workflow for discovering local attributes for vehicles*



- *Constrained Multiple Instance SVM framework*
  - Looks for regions that: (1) **occur in positive images but not in negative images**, learning an SVM classifier on visual features of regions, while also (2) **occur at roughly the same position on the car**, by adding pairwise constraints to the MI-SVM framework.

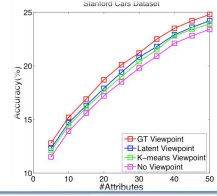
Region Classifier Score **Spatial Constraint Score**

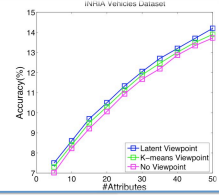
$$E(\{l_I\}|\{v_I\}) = \sum_I \phi(l_I|v_I) + \sum_{I,J} \delta(l_I, l_J|v_I, v_J)$$



3. Experiments:

- *Datasets*
  - Stanford Cars Dataset[2]: 14 classes; Viewpoints are annotated.
  - INRIA Vehicles Dataset[3]: 29 classes; Viewpoints are not known.
  - **Features**: Fisher vector computed on dense SIFT + COLOR.
- *Classification using Attributes*
  - Binary attribute feature vectors and nearest neighbor classifier:

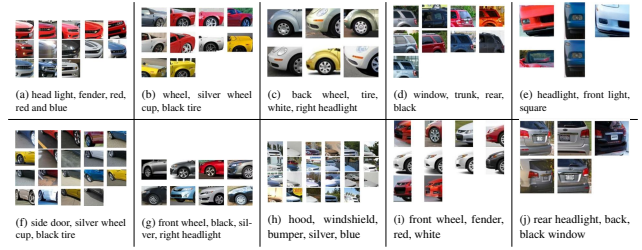




- *Classification using Fisher Vectors + Attributes*

	Fisher Vectors	Fisher Vectors + Attributes
Stanford Cars	88.2	**89.7**
INRIA vehicles	33.6	**34.5**

- *Discovered Attributes*



(a) head light, fender, red, red and blue
(b) wheel, silver wheel cup, black tire
(c) back wheel, tire, white, right headlight
(d) window, trunk, rear, black
(e) headlight, front light, square
(f) side door, silver wheel cup, black tire
(g) front wheel, black, silver, right headlight
(h) hood, windshield, bumper, silver, blue
(i) front wheel, fender, red, white
(j) rear headlight, back, black window

4. Conclusions:

- *Explicitly modeling viewpoint during attribute discovery significantly improves attribute-based classification.*
- *Discovered attributes are both discriminative and semantically meaningful, and increase classification performance when combined with low-level features.*
- *Discovered attributes are also useful for image annotation tasks.*

References:

[1] Discovering localized attributes for fine-grained recognition. Duan et al., CVPR 2012.
[2] Fine-grained categorization for 3d scene understanding. Stark et al., BMVC 2012.
[3] Instance classification with prototype selection. Krapac et al., ICMR 2014.

This work was supported in part by an NSF CAREER award (IIS-1253549), by the Indiana University Office of the Vice Provost for Research through the Faculty Research Support Program, and by the ANR Fire-ID project.