Object Detection
Lecture 10.1 - Descriptor-based detection

Idar Dyrdal
Recognition

Scene analysis and object recognition are still among the most challenging tasks in computer vision:

• Difficult to accurately name all possible objects in an image
• Objects may appear in different poses
• Cluttered scenes and occlusions
• Intrinsic variability within a class
• Non-rigid objects (people, animals)

Approaches:
• Object detection (trying to find objects of a specific type, i.e. faces, pedestrians, dogs etc.)
• Instance recognition (trying to find a specific object or individual, i.e. faces, rigid objects)
• Class recognition (Lecture 9.3)
Object detection

Possible approach:
• Apply a recognition algorithm to every possible sub-window in the image (template matching)
• Generally slow and unreliable.

Better approach:
• Use special purpose detectors to rapidly find likely regions with objects of interest.

Topics:
• Face detection
• Pedestrian detection.

(from Szeliski)
Pedestrian detection (example: Dalal-Triggs, 2005)

Navneet Dalal and Bill Triggs, Histograms of Oriented Gradients for Human Detection, CVPR05:

1. Extract windows of fixed size (64 x 128) at each position and scale
2. Compute histogram of gradient (HoG) features within each window
3. Compute a score for the window with a linear Support Vector Machine (SVM) classifier
4. Perform non-maximum suppression to remove overlapping detections with lower scores.
Pedestrian detection (2)

Gradient image → HoG (weighted and interpolated) → SVM weights

Positive weights     Negative weights
Pedestrian detection (3)

HoG weighted with SVM-weights

$\mathbf{w}^T \mathbf{x} - b$

Score = 0.16 > 0 => «Pedestrian»
Feature descriptors

HOG (Histogram of Gradients)

SIFT (Scale Invariant Feature Transform)
Feature descriptors (2)

- HoG descriptors
- SIFT
- SURF
- Binary descriptors
Instance Recognition

Problem:
• Re-recognition of known objects (2D or 3D)
• Rigid objects viewed from novel viewpoints
• Cluttered background
• Partial occlusions.

Approach:
• Extract informative 2D features from new images and match to corresponding features (descriptors) for objects in the database
• Find geometric transformation aligning the two sets of features.
Scene with clutter and partial occlusions
Descriptor matching
Descriptor matching (2)
Geometric alignment
Summary

Descriptor-based detection:
• Feature Descriptors
• Object Detection
• Instance Recognition

More information: Szeliski 14.1 and 14.3