Hierarchical Scene Annotation

Michael Maire\textsuperscript{1}, Stella X. Yu\textsuperscript{2}, Pietro Perona\textsuperscript{1}

\textsuperscript{1}California Institute of Technology - Pasadena, CA
\textsuperscript{2}University of California at Berkeley / ICSI - Berkeley, CA
What to Annotate?
Objects/Parts

glasses
hat
apple
face
torso
Subparts

- eyes
- beard
- finger
- shirt
- tie
- jacket
Figure/Ground
Rich Annotation
Rich Annotation

- Multiple modalities:
  - Objects, parts, subparts
  - Object-part containment
  - Segmentation
  - Occlusion (figure/ground)
  - Attributes
Rich Annotation

- **Multiple modalities:**
  - Objects, parts, subparts
  - Object-part containment
  - Segmentation
  - Occlusion (figure/ground)
  - Attributes

BMVC 2013 extension
Rich Annotation

- Multiple modalities:
  - Objects, parts, subparts
  - Object-part containment
  - Segmentation
  - Occlusion (figure/ground)
  - Attributes

- Unifying abstraction: region trees

BMVC 2013 extension
Rich Annotation

- Multiple modalities:
  - Objects, parts, subparts
  - Object-part containment
  - Segmentation
  - Occlusion (figure/ground)
  - Attributes

- Unifying abstraction: region trees

- Web-based annotation tool
  - Computer-assisted segmentation
  - Model invariant enforcement
  - Visual feedback
  - “LabelMe on steroids”
Rich Annotation

- Multiple modalities:
  - Objects, parts, subparts
  - Object-part containment
  - Segmentation
  - Occlusion (figure/ground)
  - Attributes

- Unifying abstraction: region trees

- Web-based annotation tool
  - Computer-assisted segmentation
  - Model invariant enforcement
  - Visual feedback
  - “LabelMe on steroids”

- Object segmentation dataset + benchmark
Object Model: Region Tree
Object Model: Region Tree

man

head

shirt

arm

watch

hand

arm
Object Model: Region Tree

- **man**
  - head
  - shirt
  - arm
  - watch
  - hand
  - arm

Object-Part ⇒
Object Model: Region Tree

- Object-Part
- Occlusion Ordering

- man
- head
- shirt
- arm
- watch
- hand
- arm
Object Model: Self Occlusion

Object-Part ⇒ Occlusion Ordering

<table>
<thead>
<tr>
<th>Man</th>
<th>Head</th>
<th>Shirt</th>
<th>Arm</th>
<th>Watch</th>
<th>Hand</th>
<th>Arm</th>
</tr>
</thead>
</table>

Diagram showing the occlusion ordering of a man's parts: head, shirt, arm, watch, hand, arm.
Object Model: Virtual Link

Occlusion Ordering:

- man
- head
- shirt
- arm
- watch
- hand

V - Virtual Link connection
Additional Object Models

envelope

stamp

label

glove
Scene Model: Region Tree

Objects/Parts:
- glove
- envelope
- stamp
- label
- man
- head
- shirt
- arm
- hand
- watch
- glove

Diagram:
- Glove
- Envelope
- Stamp
- Label
- Man
- Head
- Shirt
- Arm
- Hand
- Watch
- Glove
Tree Traversal Recovers Figure/Ground
Annotation Software
Region Tree Navigation
Region Tree Navigation
Containment Constraints
Containment Constraints
Interactive Segmentation

Image

Oversegmentation

Click
Interactive Segmentation

Image  
Oversegmentation  
Drag
Interactive Segmentation

Image  Oversegmentation  Release
Interactive Segmentation

Image  |  Oversegmentation  |  Touch-up
Annotated Scene Dataset
Annotated Scene Dataset
Example Object-Part Hierarchies
Groundtruth UCM vs gPb-UCM
Groundtruth UCM vs gPb-UCM
Groundtruth UCM vs gPb-UCM
Groundtruth UCM vs gPb-UCM
Groundtruth UCM vs gPb-UCM
Boundary Benchmark

Boundary Detection [F=0.66 (R=0.76, P=0.59)]
Hierarchical Boundary Benchmark - Portraits

Boundary Recovery Order by Hierarchy Level

Overall Boundary Recall
Level Recovery Fraction
Boundary Recovery Order by Hierarchy Level

Level 1
Level 2
Level 3