DensePose Challenge Intro:
Joint COCO and Mapillary Recognition Workshop
September 9th, ECCV 2018 Sunday
Rıza Alp Güler, INRIA/CentraleSupélec

Video Source: https://www.youtube.com/watch?v=Dhkd_bAwwMc
Human-body analysis: from coarse to fine

**Image Classification**

**Input Image**

*Is there a person in this image?*

*Yes?  No?*

**Image Classification**
Human-body analysis: from coarse to fine

Image Classification

Person Detection

Localize persons in the image.
Human-body analysis: from coarse to fine

Input Image

Segment person instances

Image Classification
Person Detection
Person Segmentation
Human-body analysis: from coarse to fine

Input Image

Part Segmentation

Segment semantically meaningful body parts.

Image Classification  Person Detection  Person Segmentation  Part Segmentation
Human-body analysis: from coarse to fine

- Image Classification
- Person Detection
- Person Segmentation
- Part Segmentation
- Pose Estimation

Input Image → Pose Estimation
Localize joints of the persons in the images.
Human-body analysis: from coarse to fine

**Image Classification**
- Is there a person in this image?
  - Yes?
  - No?

**Object Detection**
- Localize persons in the image.

**Pose Estimation**
- Localize joints of the persons in the images.

**DensePose (our work)**
- Find correspondence between all pixels and a 3D model.

**Part Segmentation**
- Segment semantically meaningful body parts.

**Input Image**

**Find correspondence between all pixels and a 3D model.**
SMPL Model:


SMPLify:


SMPL Parameter Regression:

Kanazawa et al. “End-to-end Recovery of Human Shape and Pose” CVPR 2018
Pavlakos et al. “Learning to Estimate 3D Human Pose and Shape from a Single Color Image” CVPR 2018
Dense Correspondences to SMPL model

Unite the People Dataset (UP):
"Unite the people: Closing the loop between 3d and 2d human representations.” Lassner, et al. ( CVPR 2017 )

SURREAL Dataset :
"Learning from synthetic humans” Varol, et al. ( CVPR 2017 )

DensePose-COCO Dataset :
"DensePose: Dense Human Pose Estimation” Guler, et al. ( CVPR 2018)
Mesh Charting

Video Source: https://www.youtube.com/watch?v=Dhkd_bAwwMc
Image-to-Surface correspondence
Image-to-Surface correspondence
Image-to-Surface annotations
Quantization replaced by part assignment.

Surface Correspondence

**TASK 1:** Part Segmentation
- sampled points
- rendered images for the specific part

**TASK 2:** Marking Correspondences
- segmented parts
- input image
- rendered images for the specific part

Annotation pipeline -
Annotation pipeline-II

input image → segmented parts → sampled points → rendered images for the specific part

Surface Correspondence
DensePose-COCO Dataset
densepose.org
DensePose-COCO Dataset
densepose.org
densepose.org

DensePose-COCO dataset

DensePose-PoseTrack dataset

Posetrack Dataset:
https://github.com/facebookresearch/DensePose
Annotator Performance

Rendered Image (SURREAL)  Sampled Points  Collected Points  Geodesic distances
Annotator Performance

Average annotator error
Annotator Performance

![Graph showing the ratio of correct points across different body parts with varying geodesic error.]
Evaluation

Geodesic Point Similarity (GPS) for instance based frameworks:

\[
GPS = \frac{1}{|P|} \sum_{p_i \in P} \exp \left( \frac{-d(\hat{p}_i, p_i)^2}{2\kappa(p_i)^2} \right)
\]

- \(P\) → set of ground truth points annotated for a person
- \(d(\hat{p}_i, p_i)\) → Geodesic distance on the surface
- \(\kappa(p_i)\) → per-part normalization factor.

Measure AP between GPS = 0.5 - 0.95
Baseline: DensePose-RCNN
DensePose-RCNN Architecture

Video Source: https://www.youtube.com/watch?v=Dhkd_bAwwMc
### Baseline: DensePose-RCNN

**DensePose-RCNN Model Zoo:**

*see: [github.com/facebookresearch/DensePose](https://github.com/facebookresearch/DensePose)*

<table>
<thead>
<tr>
<th>Model</th>
<th>AP</th>
<th>AP50</th>
<th>AP75</th>
<th>APm</th>
<th>API</th>
</tr>
</thead>
<tbody>
<tr>
<td>ResNet 50 + FPN</td>
<td>0.4892</td>
<td>0.8490</td>
<td>0.5078</td>
<td>0.4384</td>
<td>0.5059</td>
</tr>
<tr>
<td>ResNet 50 + FPN (mask, keypoints)</td>
<td>0.5075</td>
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<td>0.5373</td>
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<tr>
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DensePose-RCNN Results
DensePose-RCNN Results
DensePose-RCNN Results
Quantization replaced by part assignment.

DensePose-RCNN Results Visualization

Video Source: https://www.youtube.com/watch?v=Dhkd_bAwwMc
Quantization replaced by part assignment.

DensePose-RCNN Results Visualization

Textures from SURREAL dataset:
"Learning from synthetic humans"
Varol, Gül, et al. CVPR 2017
Winning entry

Parsing R-CNN

Team members:

Lu Yang (BUPT Priv Lab); Qing Song (BUPT Priv Lab); Zhihui Wang (BUPT Priv Lab)
## Winner

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<tr>
<td>Sound of silent</td>
<td>0.57  (4)</td>
<td>0.87  (5)</td>
<td>0.66  (2)</td>
<td>0.48  (5)</td>
<td>0.61  (3)</td>
</tr>
<tr>
<td>ML_Lab</td>
<td>0.57  (3)</td>
<td>0.89  (3)</td>
<td>0.64  (4)</td>
<td>0.51  (3)</td>
<td>0.59  (4)</td>
</tr>
<tr>
<td>PlumSix</td>
<td>0.58  (2)</td>
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<td><strong>BUPT-PRIV</strong></td>
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**Winner!**
DensePose Team

Rıza Alp Güler  Natalia Neverova  Vasil Khalidov  Iasonas Kokkinos