Nonparametric Structure Regularization Machine for 2D Hand Pose Estimation

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2D Hand Pose Estimation

- Application: AR/VR, HCI, gesture recognition ...
- Challenge: self-occlusion due to articulation, viewpoint and object

Pose Estimation with segmentation

• Multi-task learning: hand mask segmentation + hand pose estimation

• Mask annotation is costly to obtain

• Can we get mask annotations from keypoints?

Yangang Wang, Cong Peng and Yebin Liu, Mask-pose Cascaded CNN for 2D Hand Pose Estimation, TCSVT 2018
NSRM: Limb Mask Representation

- **Hand Model:** 21 Keypoints + 20 Limbs (Line Segment)

- **Limb Deterministic Mask (LDM):** 0/1 mask around a limb

- **Limb Probabilistic Mask (LPM):** Gaussian heatmap around a limb
NSRM: Limb Composition

- **G1**: coalesce 20 limbs together (whole hand mask)
- **G6**: coalesce 20 limbs into 6 groups (5 fingers + palm)
NSRM: Hand Structure Representations

LDM-G1 (synthetic mask)

LDM-G6

LPM-G1

LPM-G6
NSRM: Network Architecture

- Based on Convolutional Pose machines (CPM)
- End-to-end training
- Structure modules can be added to other networks

Shih-En Wei, Varun Ramakrishna, Takeo Kanade, Yaser Sheikh, Convolutional Pose Machines, CVPR 2017
## Quantitative Results

Probability of Correct Keypoint (PCK) on Panoptic Hand dataset

<table>
<thead>
<tr>
<th>$\sigma_{PCK}$</th>
<th>0.04</th>
<th>0.06</th>
<th>0.08</th>
<th>0.10</th>
<th>0.12</th>
<th>ave</th>
<th>improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPM</td>
<td>55.25</td>
<td>73.23</td>
<td>81.45</td>
<td>85.97</td>
<td>88.80</td>
<td>76.94</td>
<td>-</td>
</tr>
<tr>
<td>LDM-G1</td>
<td>59.20</td>
<td>75.98</td>
<td>83.45</td>
<td>87.28</td>
<td>89.81</td>
<td>79.14</td>
<td>+2.20 (+2.86%)</td>
</tr>
<tr>
<td>LDM-G1&amp;6</td>
<td>59.16</td>
<td>76.32</td>
<td>83.63</td>
<td>87.46</td>
<td>90.03</td>
<td>79.32</td>
<td>+2.38 (+3.09%)</td>
</tr>
<tr>
<td>LPM-G1</td>
<td>59.81</td>
<td>76.82</td>
<td>84.16</td>
<td>87.86</td>
<td>90.26</td>
<td>79.78</td>
<td>+2.84 (+3.69%)</td>
</tr>
<tr>
<td>LPM-G1&amp;6</td>
<td>59.73</td>
<td>76.86</td>
<td>84.43</td>
<td>88.23</td>
<td>90.87</td>
<td>80.03</td>
<td><strong>+3.09 (+4.01%)</strong></td>
</tr>
</tbody>
</table>
Qualitative Results

CPM

NSRM
Thanks