

Nonparametric Structure Regularization Machine for 2D Hand Pose Estimation

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Yifei Chen^{*1}, Haoyu Ma^{*2}, Deying Kong², Xiangyi Yan² ,
Jianbao Wu¹ , Wei Fan¹ , and Xiaohui Xie²

¹ Tencent Hippocrates Research Lab

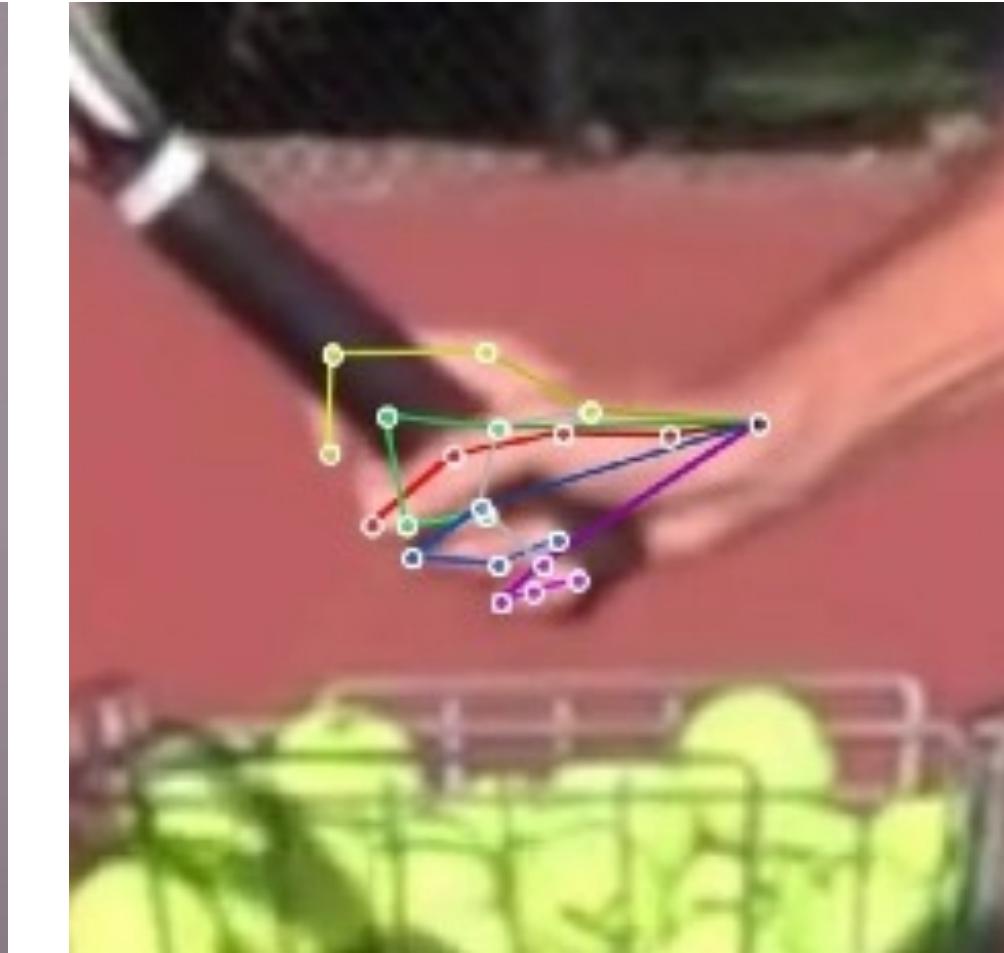
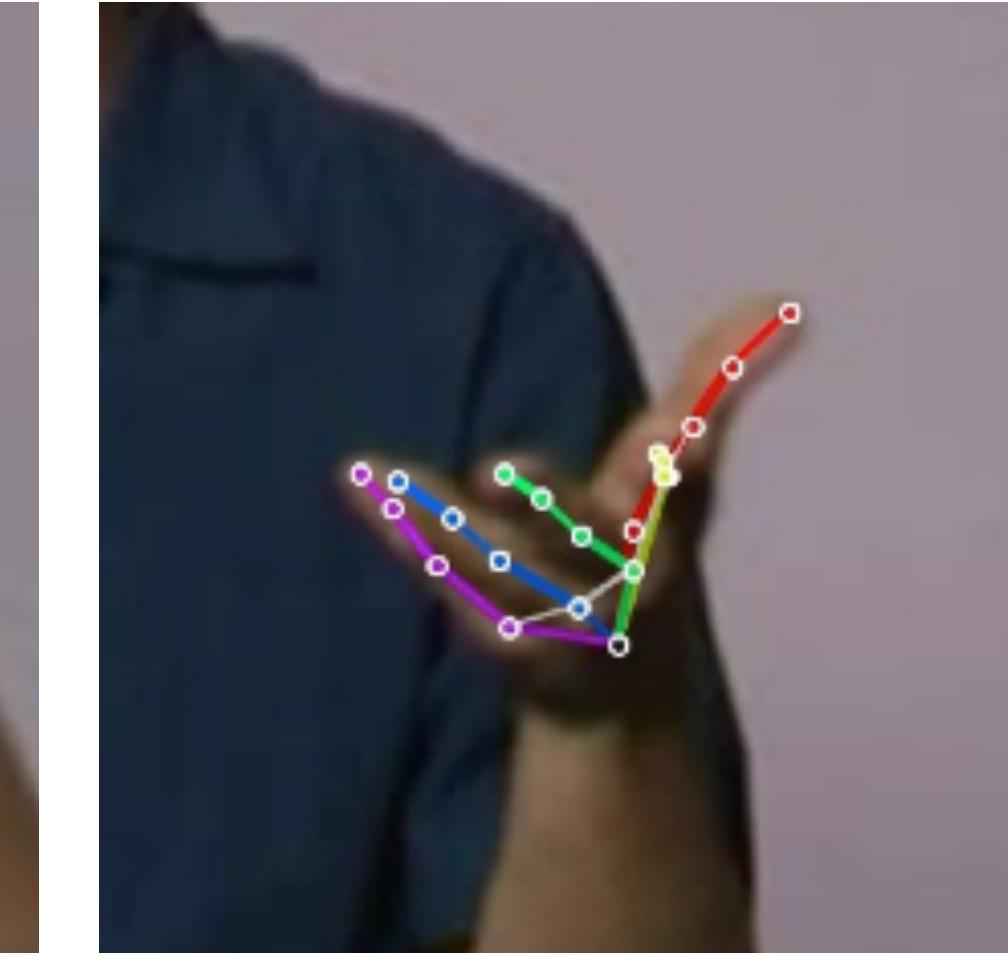
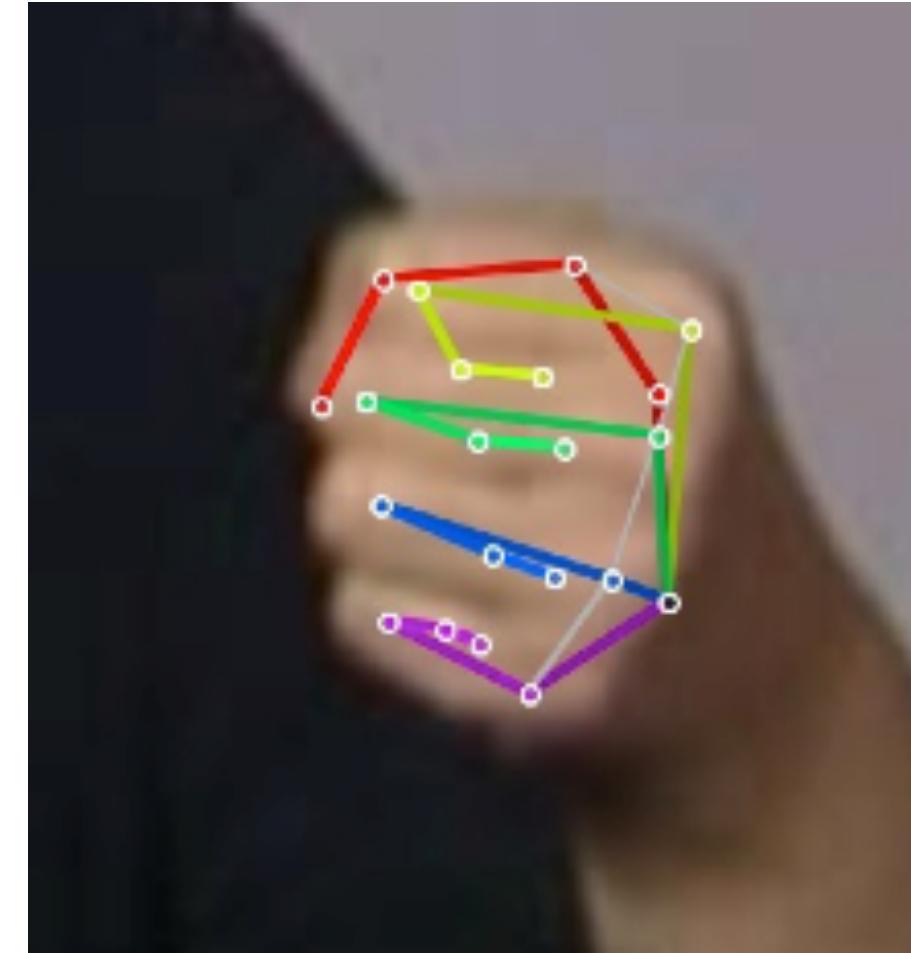
² Department of Computer Science, University of California at Irvine

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2D Hand Pose Estimation

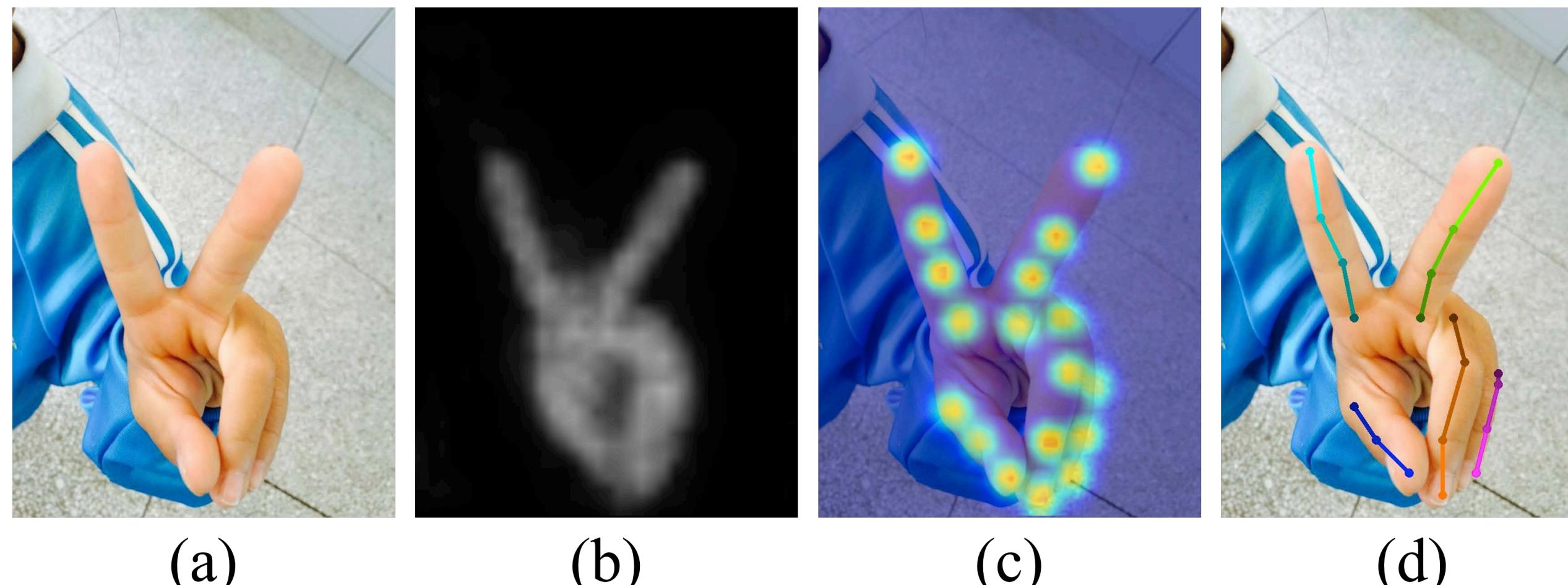
- Application: AR/VR, HCI, gesture recognition ...
- Challenge: self-occlusion due to articulation, viewpoint and object



Tomas Simon, Hanbyul Joo, Iain Matthews, Yaser Sheikh, Hand Keypoint Detection in Single Images using Multiview Bootstrapping, CVPR 2017

Pose Estimation with segmentation

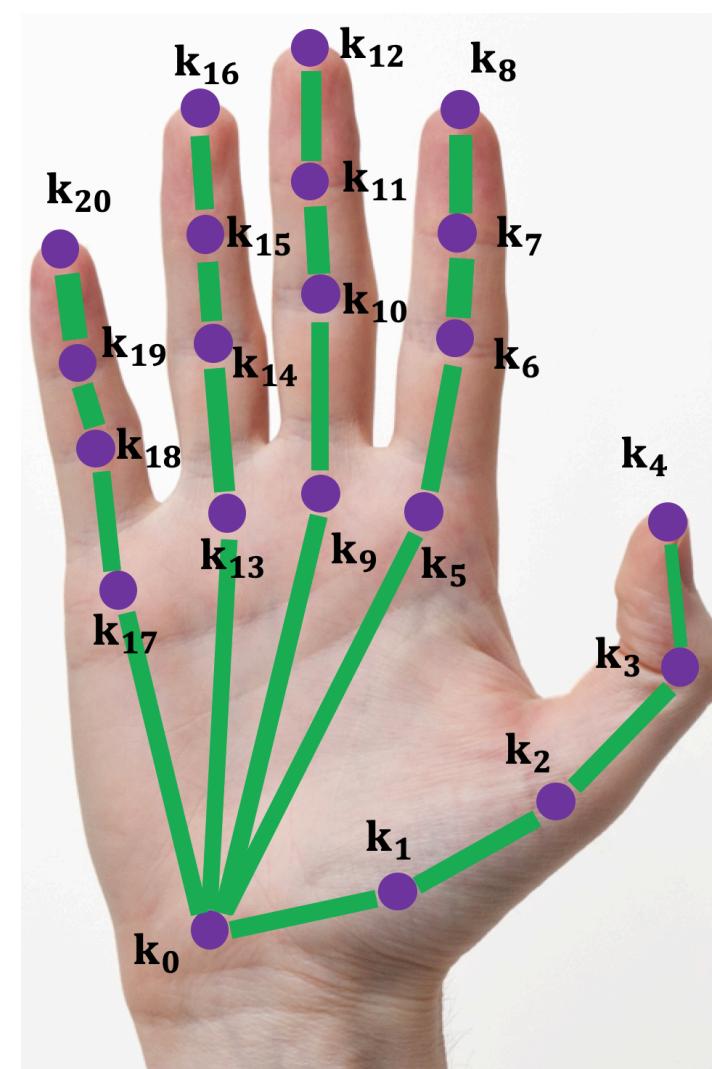
- Multi-task learning: hand mask segmentation + hand pose estimation
- Mask annotation is costly to obtain
 - **Can we get mask annotations from keypoints?**



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

NSRM: Limb Mask Representation

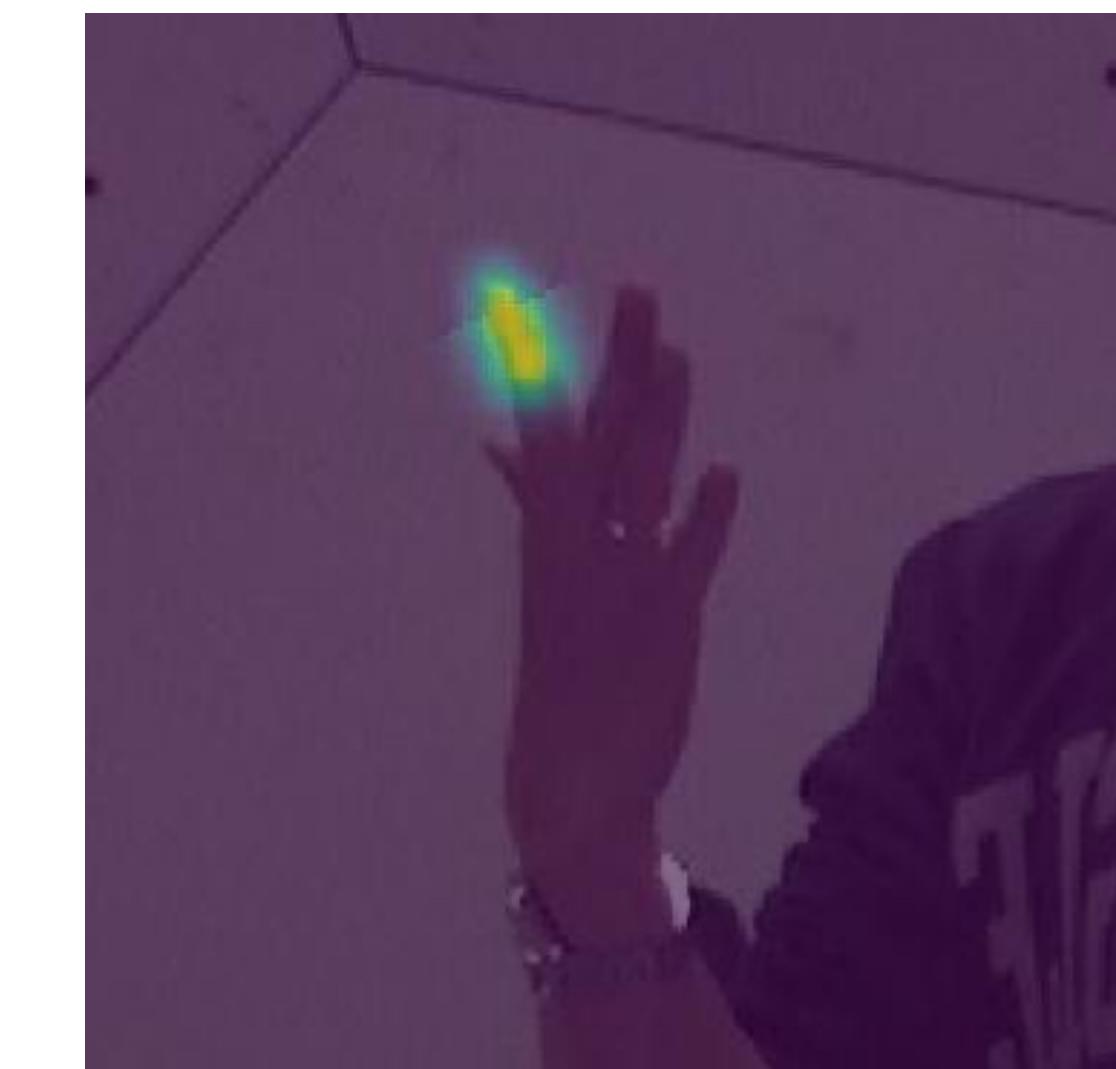
- **Hand Model:** 21 Keypoints + 20 Limbs (Line Segment)
- **Limb Deterministic Mask (LDM):** 0/1 mask around a limb
- **Limb Probabilistic Mask (LPM):** Gaussian heatmap around a limb



Hand Model



LDM



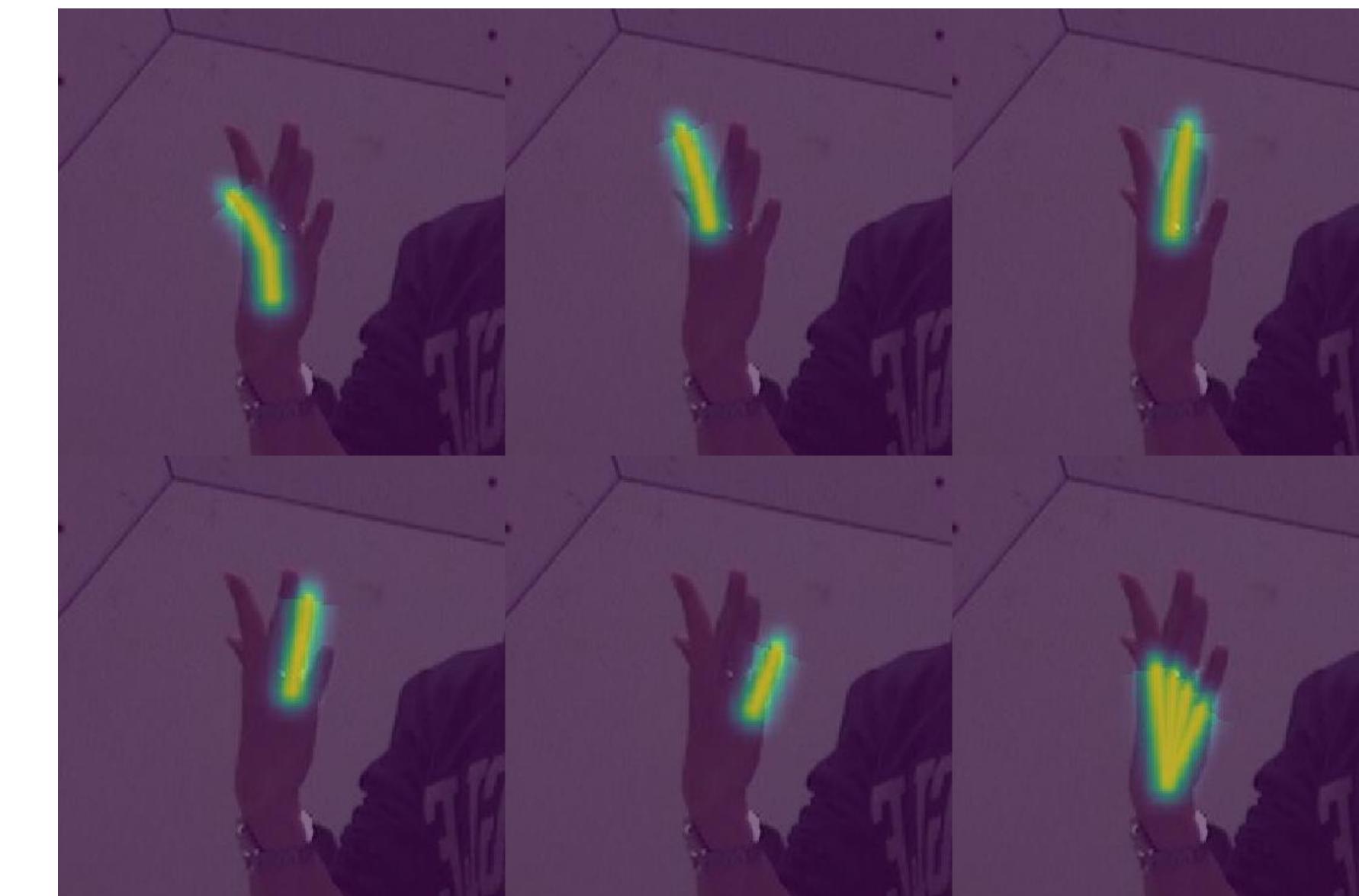
LPM

NSRM: Limb Composition

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

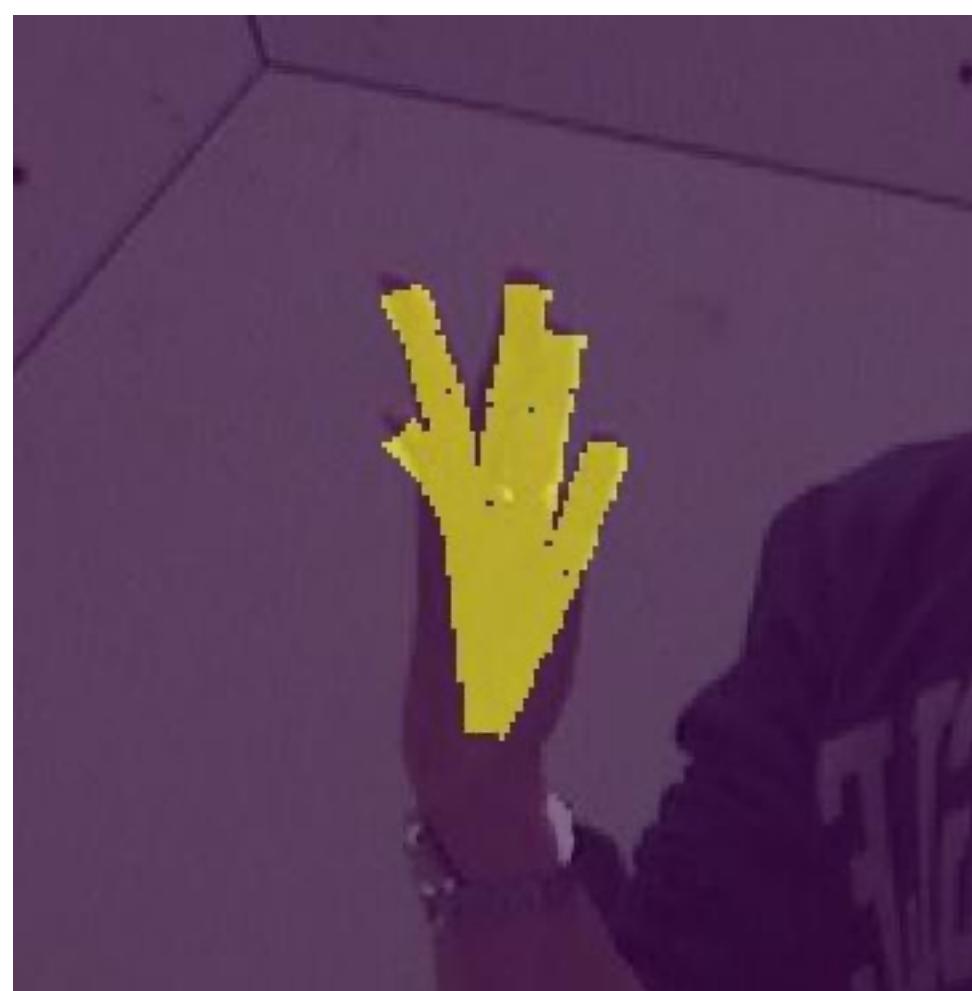


G1

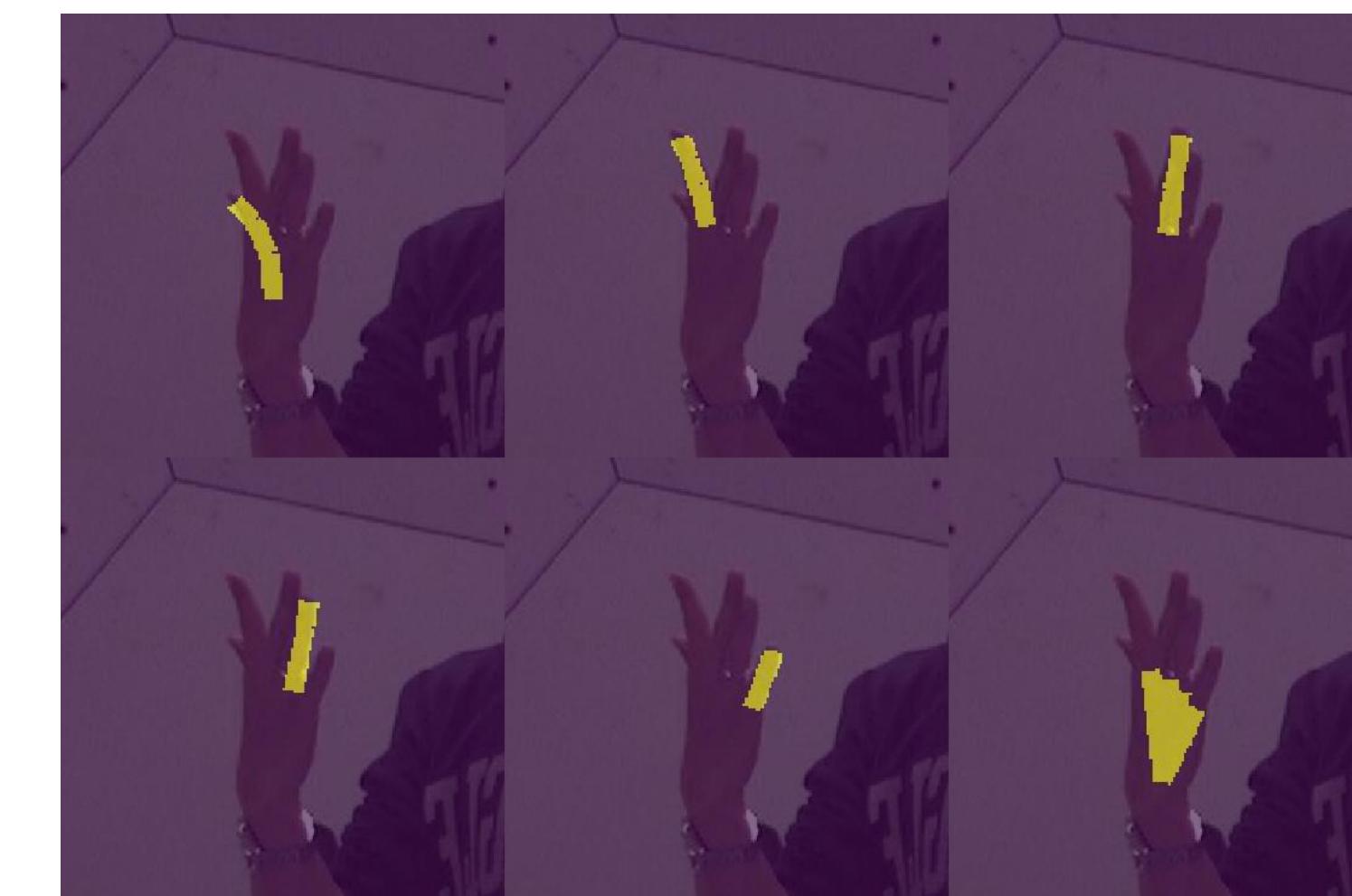


G6

NSRM: Hand Structure Representations



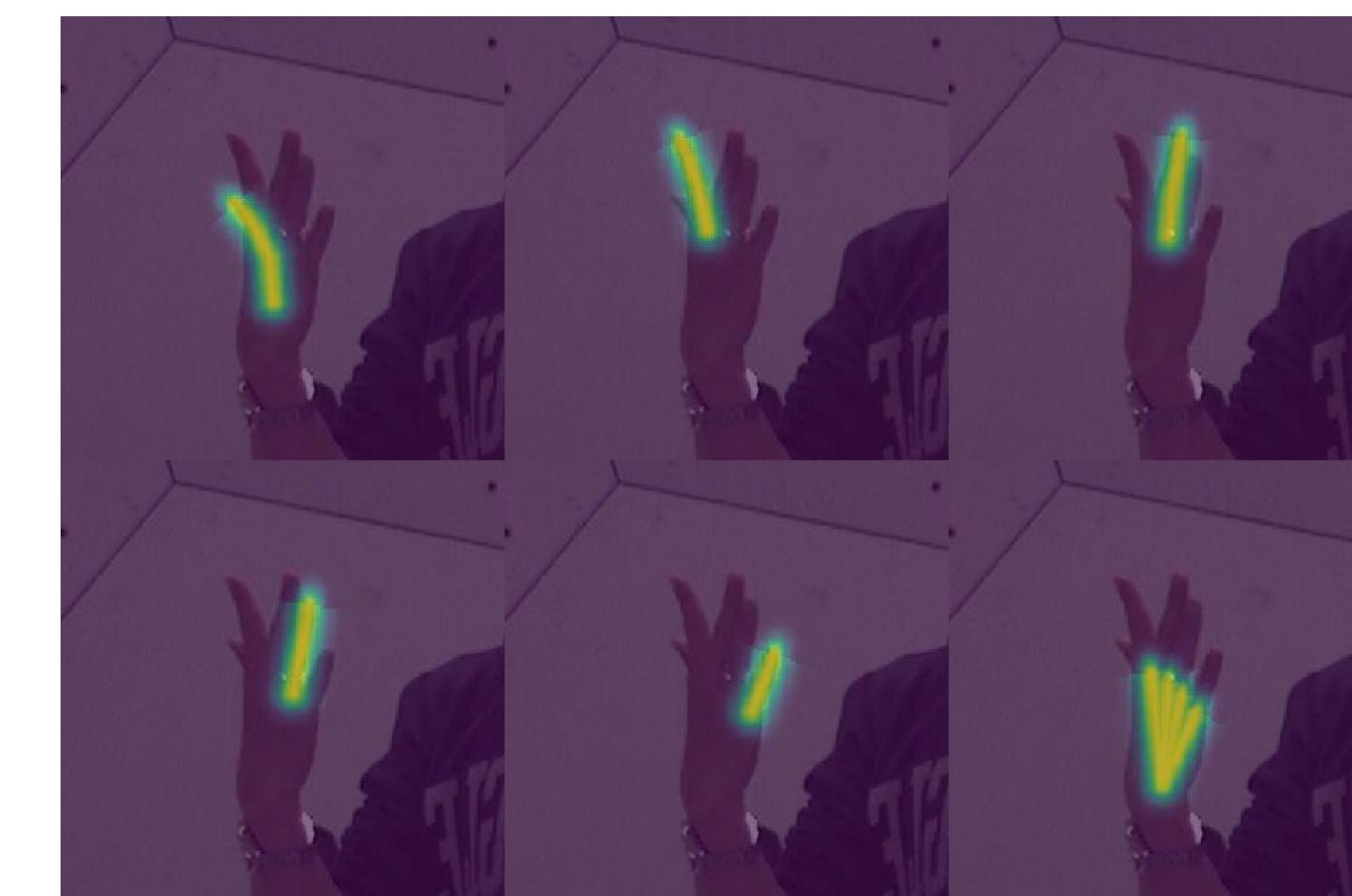
LDM-G1
(synthetic mask)



LDM-G6



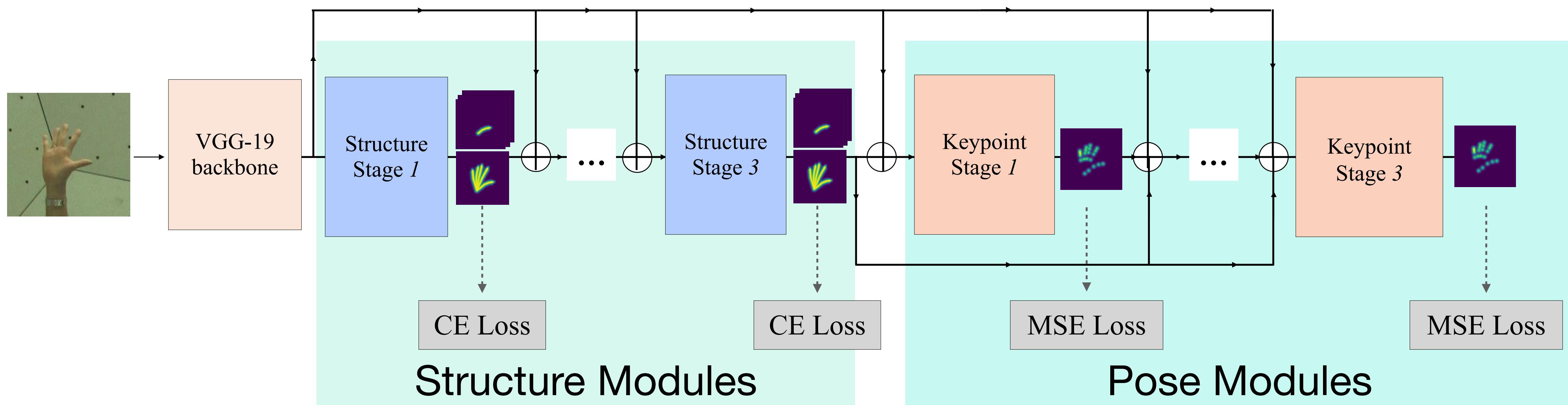
LPM-G1



LPM-G6

NSRM: Network Architecture

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



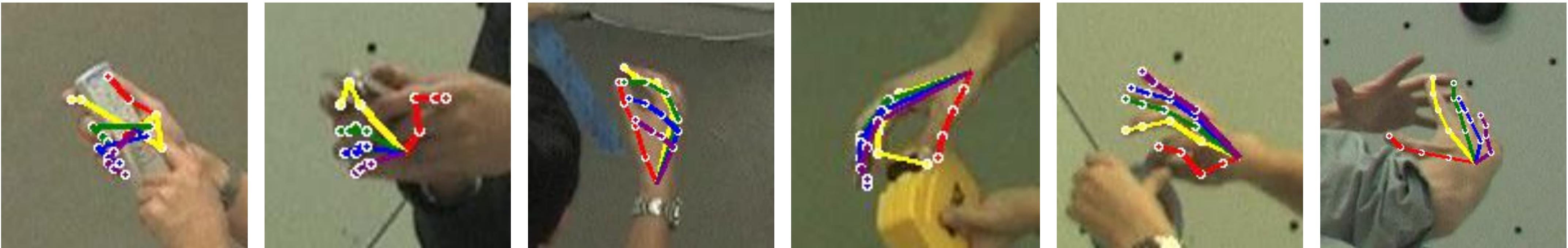
Quantitative Results

Probability of Correct Keypoint (PCK) on Panoptic Hand dataset

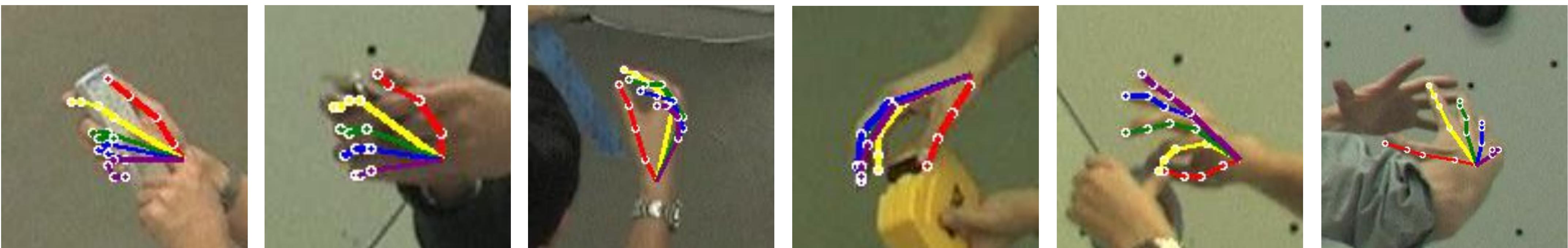
σ_{PCK}	0.04	0.06	0.08	0.10	0.12	ave	improvement
CPM	55.25	73.23	81.45	85.97	88.80	76.94	-
LDM-G1	59.20	75.98	83.45	87.28	89.81	79.14	+2.20 (+2.86%)
LDM-G1&6	59.16	76.32	83.63	87.46	90.03	79.32	+2.38 (+3.09%)
LPM-G1	59.81	76.82	84.16	87.86	90.26	79.78	+2.84 (+3.69%)
LPM-G1&6	59.73	76.86	84.43	88.23	90.87	80.03	+3.09 (+4.01%)

Qualitative Results

CPM



NSRM



Thanks