CLIFF: Carrying Location Information in Full Frames into Human Pose and Shape Estimation

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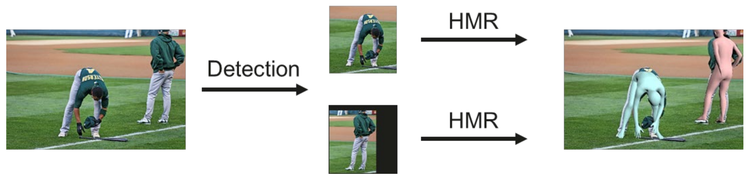
1. Introduction

Task: reconstruct human body meshes in an image

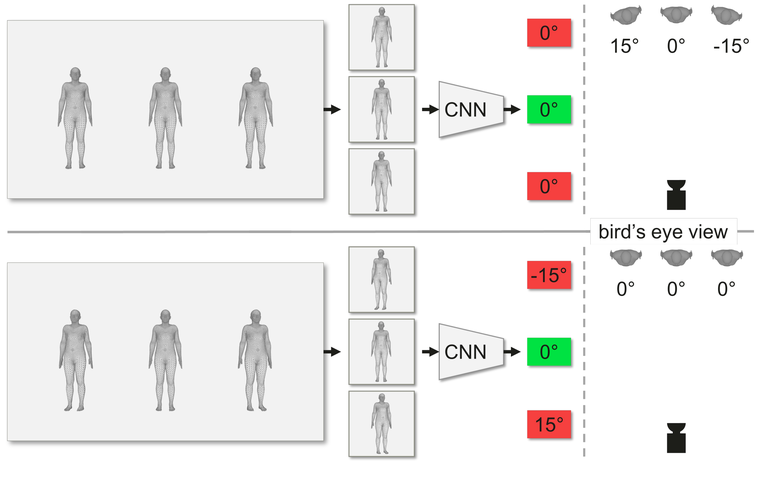
- Top-Down Approach (dominating)



- Bottom-up Approach

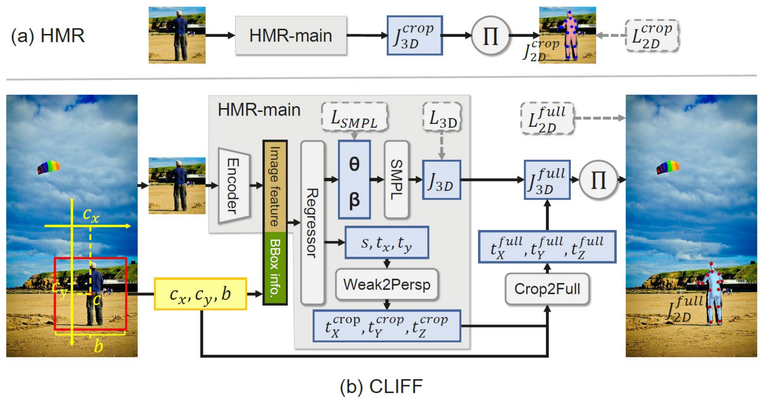
2. Motivation

- Cropping discards location information, and causes inaccurate global rotation estimation.
- Pseudo-GT of in-the-wild images helps regression-based models a lot.



3. Approach

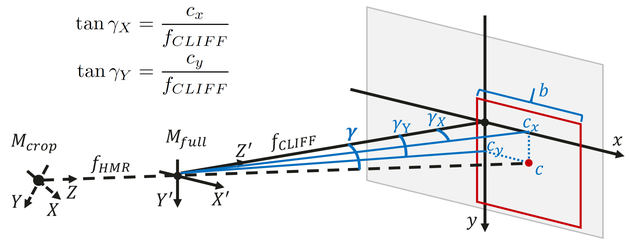
- Take HMR as baseline, and make two modifications



1. Additional input: bounding box information

$$I_{bbox} = [\frac{c_x}{f_{CLIFF}}, \frac{c_y}{f_{CLIFF}}, \frac{b}{f_{CLIFF}}]$$

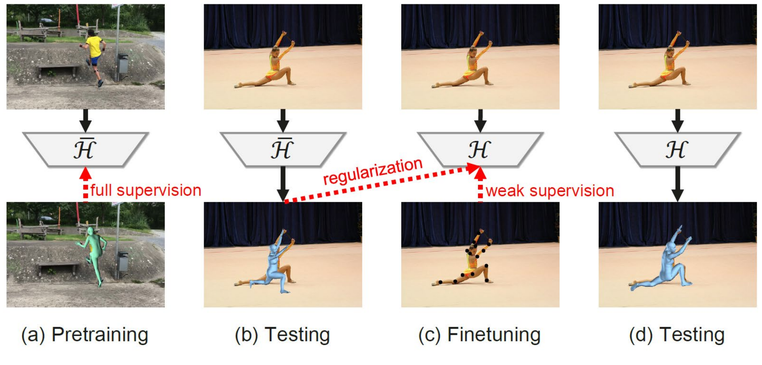
$$\tan\gamma_X = \frac{c_x}{f_{CLIFF}} \qquad \tan\gamma_Y = \frac{c_y}{f_{CLIFF}}$$



2. 2D Reprojection loss in the full image

$$t_X^{full} = t_X^{crop} + \frac{2 \cdot c_x}{b \cdot s}, \quad t_Y^{full} = t_Y^{crop} + \frac{2 \cdot c_y}{b \cdot s}, \quad t_Z^{full} = t_Z^{crop} \cdot \frac{f_{CLIFF}}{f_{HMR}} \cdot \frac{r}{b}$$

- CLIFF+: CLIFF-based pseudo-GT annotator



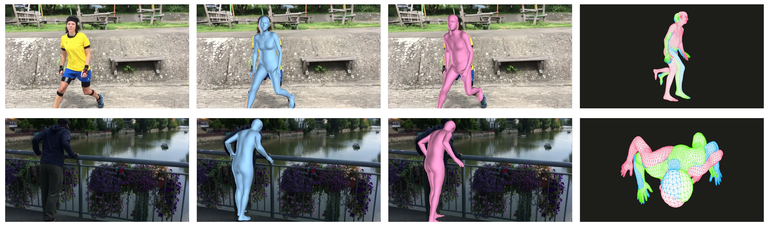
4. Experiments

- CLIFF outperforms SOTA by significant margins

Table 1. Performance comparison between CLIFF and state-of-the-art methods on 3DPW, Human3.6M and AGORA

	Method	3DPW MPJPE ↓	3DPW PA-MPJPE ↓	3DPW PVE ↓	Human3.6M MPJPE ↓	Human3.6M PA-MPJPE ↓	AGORA MPJPE ↓	AGORA MVE ↓
video	HMMR [19]	116.5	72.6	-	-	56.9	-	-
	TCMR [7]	86.5	52.7	102.9	-	-	-	-
	VIBE [22]	82.7	51.9	99.1	65.6	41.1	-	-
	MAED [58]	79.1	45.7	92.6	56.4	38.7	-	-
model-free	I2L-MeshNet [36]	93.2	58.6	110.1	-	-	-	-
	Pose2Mesh [8]	89.5	56.3	105.3	64.9	46.3	-	-
	HybrIK [27]	80.0	48.8	94.5	54.4	34.5	-	-
	METRO [28]	77.1	47.9	88.2	54.0	36.7	-	-
	Graphormer [29]	74.7	45.6	87.7	51.2	34.5	-	-
model-based	HMR [18]	130.0	81.3	-	-	56.8	180.5	173.6
	SPIN [25]	96.9	59.2	116.4	-	41.1	153.4	148.9
	SPEC [24]	96.5	53.2	118.5	-	-	112.3	106.5
	HMR-EFT [17]	85.1	52.2	98.7	63.2	43.8	165.4	159.0
	PARE [23]	79.1	46.4	94.2	-	-	146.2	140.9
	ROMP [54]	76.7	47.3	93.4	-	-	116.6	113.8
	CLIFF (Res-50)	72.0 -13.1	45.7	85.3	50.5	35.1	91.7	86.3
	CLIFF (HR-W48)	**69.0** -5.7	**43.0**	**81.2**	**47.1**	**32.7**	**81.0**	**76.0**

- CLIFF gets better pixel-alignments in full images



5. Conclusion

Disclosure
global rotations cannot be accurately inferred when only using cropped images

Model
CLIFF, a model fed and supervised with global-location-aware information

Annotator
CLIFF+, a novel pseudo-ground-truth annotator

Reference:

Kanazawa, A., Black, M.J., Jacobs, D.W., Malik, J.: End-to-end recovery of human shape and pose. In: CVPR (2018)
Kolotouros, N., Pavlakos, G., Black, M.J., Daniilidis, K.: Learning to reconstruct 3d human pose and shape via model-fitting in the loop. In: ICCV (2019)