Deep 3D Human Pose Estimation under Partial Body Presence

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Agenda

- 3D human pose estimation under partial presence
- Our method: Network architecture
- Our method: Experimental setup and data preparation
- Results: Objective evaluation
- Results: Subjective evaluation
- Conclusion

3D Human Pose Estimation under Partial Presence

3D human pose: Body's main joints' positions in the 3D space

$\boldsymbol{S} = \tau\{\boldsymbol{I}\};$

$\boldsymbol{S} \in \mathbb{R}^{\boldsymbol{3}\times\boldsymbol{j}}$: Estimated human body pose in the 3D space

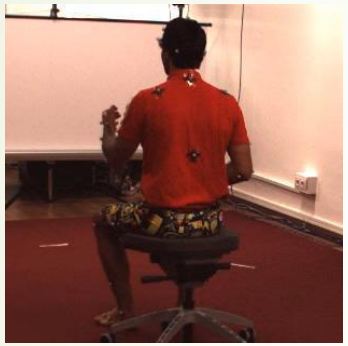
$\boldsymbol{j}$: Number of main body joints (=17 in this paper)

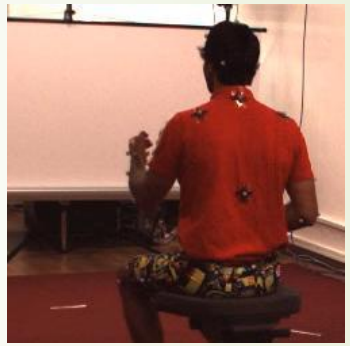
τ : Transformation from the 2D imagery to 3D human poses

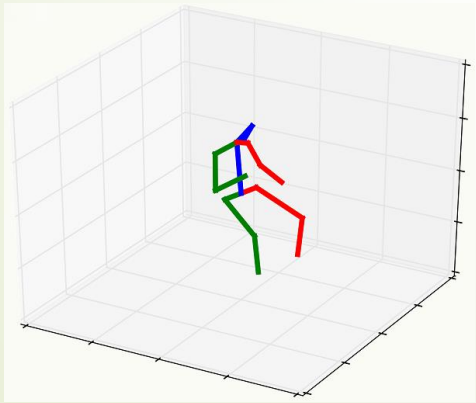
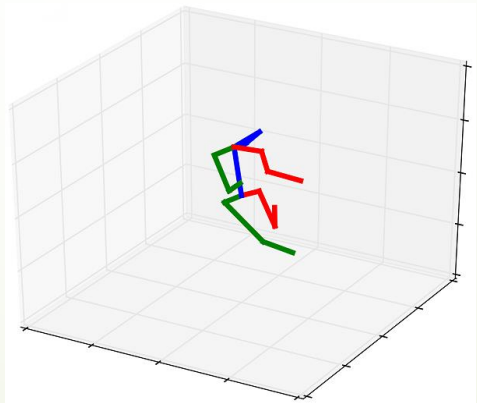
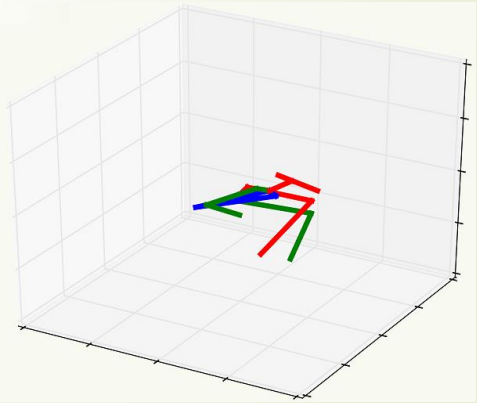
$\boldsymbol{I}$: Digital intensity image

3D Human Pose Estimation under Partial Presence

Partial body presence: Missing some parts of the body





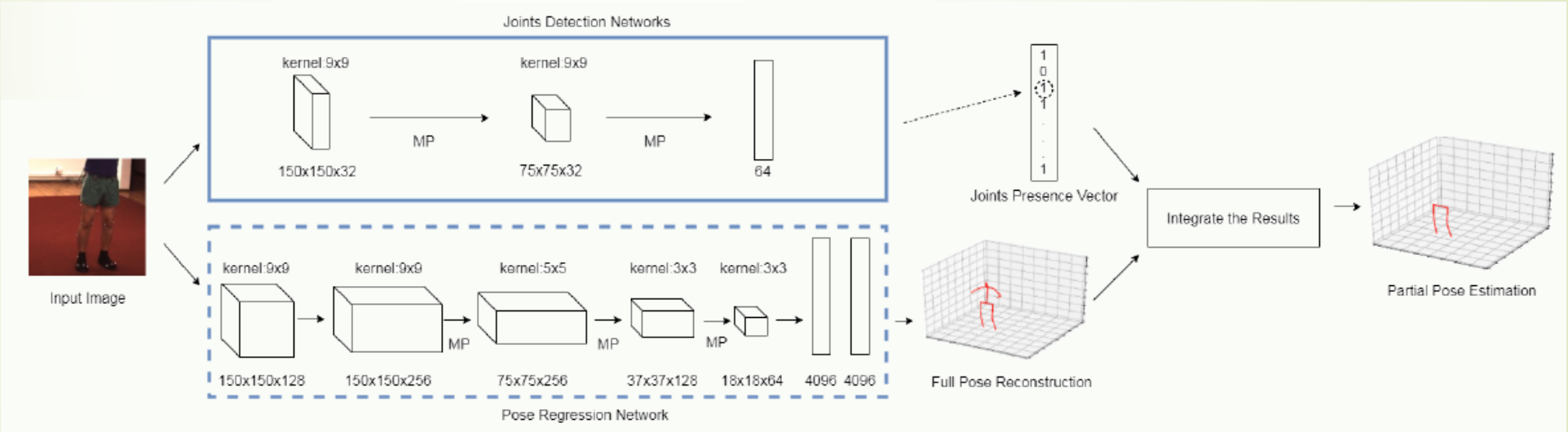
3D Human Pose Estimation under Partial Presence

imperfect segmentation

zoomed-in photography

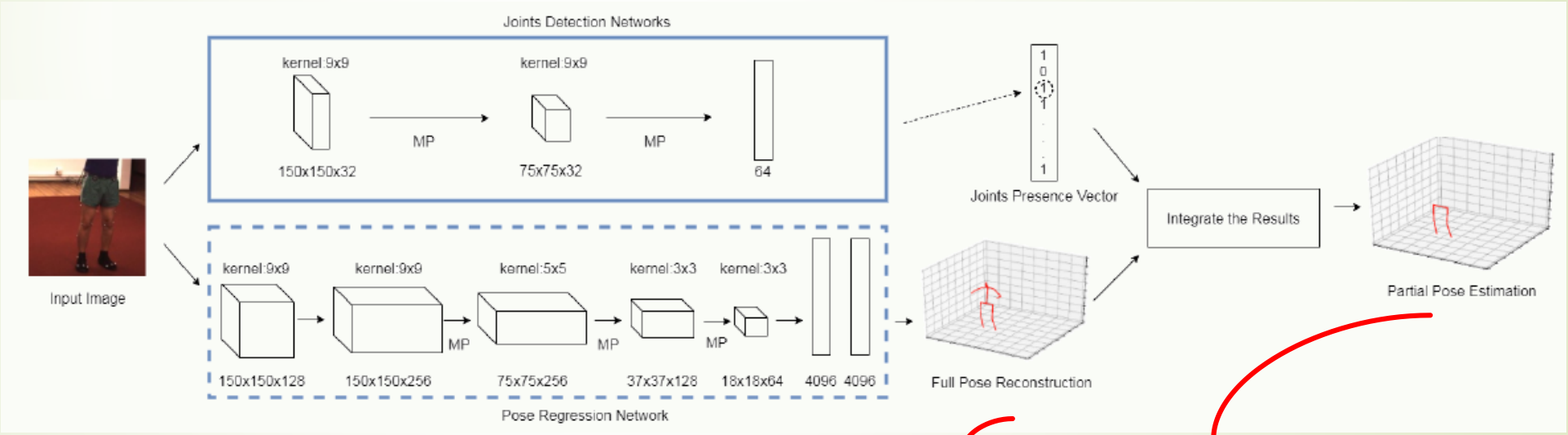
Our method: Network architecture

Deep Convolutional Neural Network: 1) Joints Detection 2) Pose Regression



Our method: Network architecture

Deep Convolutional Neural Network: 1) Joints Detection 2) Pose Regression



Outputs: 1. **Full reconstruction**

2. **Partial reconstruction**

Our method: Experimental setup and data preparation

Experimental Setup:

- Adam optimization
- Batch size 32
- Human3.6M dataset
- Downsampled by a factor of 5

- Detection
- Learning rate 0.001
- Loss function: Cross-Entropy

Regression
- Learning rate 0.0001
- Loss function: Mean Square Error

Our method: Experimental setup and data preparation

Data Preparation:

- Random window selection
- Uniform distribution
- Covering more than one quarter of the subject region
- Spanned over the four quarters

Random Window Selection:

Results: Objective evaluation

Compared to:

1. **VNect:** Mehta, Dushyant, et al. "Vnect: Real-time 3d human pose estimation with a single rgb camera." ACM Transactions on Graphics (TOG) 36.4 (2017): 44.

2. **InWild:** Zhou, Xingyi, et al. "Towards 3d human pose estimation in the wild: a weakly-supervised approach." IEEE International Conference on Computer Vision. 2017.

Results: Objective evaluation

Method	Direction	Discussion	Eating	Average
Vnect	286.64	329.20	350.67	338.01
InWild	300.00	329.96	338.91	332.48
Ours	**143.5**	**180.25**	**144.72**	**173.6**

mean-per-joint-error of **present** joints

$$L(y_{gt}, y_{est}) = \frac{1}{N}\sum_{j=1}^{N} ||C_j^{y_{gt}} - C_j^{y_{est}}||_2;$$

y_{gt}: ground truth joints′ position matrix
y_{est}: estimated joints' position matrix
N: number of the joints
$C_j^{y_{gt}}$: the vector of the j^{th} column of the matrix y

Results: Objective evaluation

Method	Direction	Discussion	Eating	Average
Vnect	370.57	387.86	403.85	396.44
InWild	392.1	394.96	405.00	400.50
Ours	**156.02**	**190.71**	**157.71**	**184.94**

mean-per-joint-error of **full** body recovery

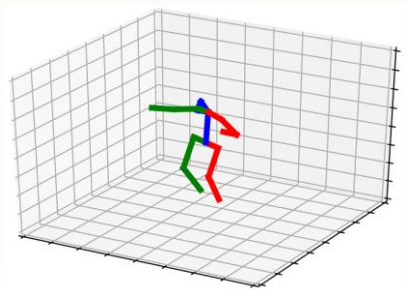
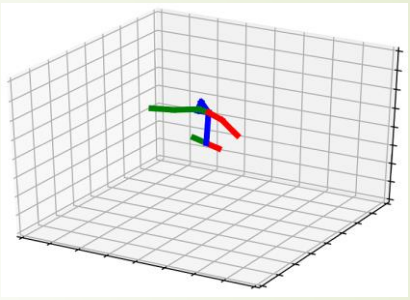
Results: Objective evaluation

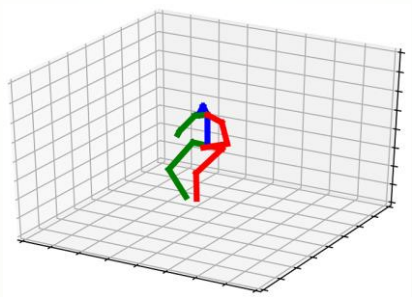
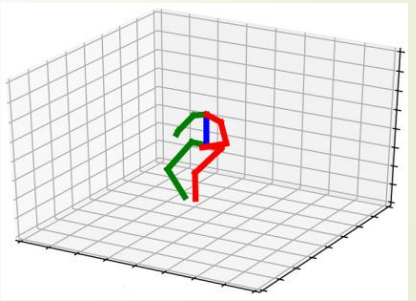
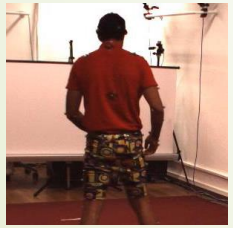
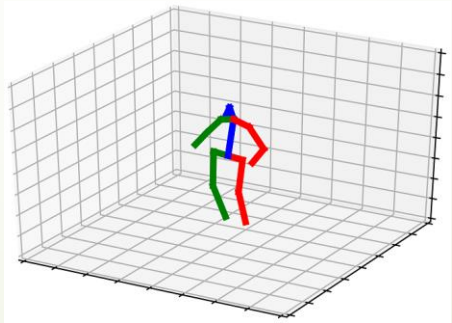
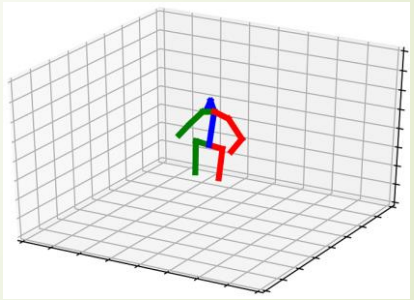
Joint	Pelvis	Left Ankle	Right Shoulder	Average
Accuracy (%)	92.63	86.70	90.41	88.00

performance of the **detection** stage based on binary accuracy

Results: Subjective evaluation

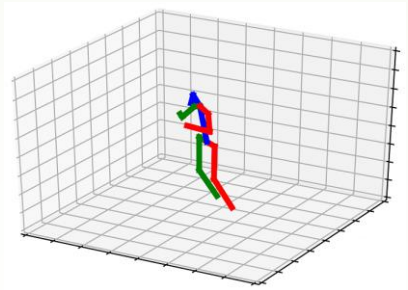
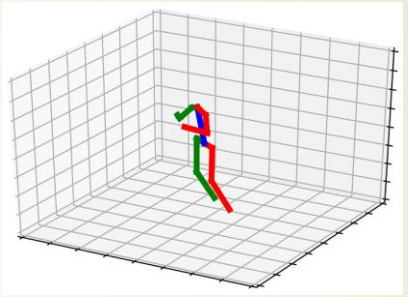
Subjective results under partial body presence:

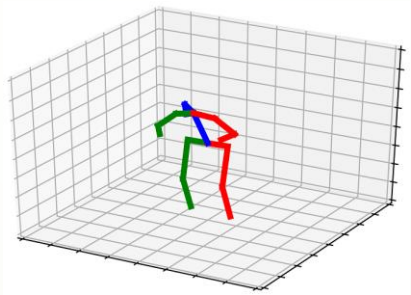
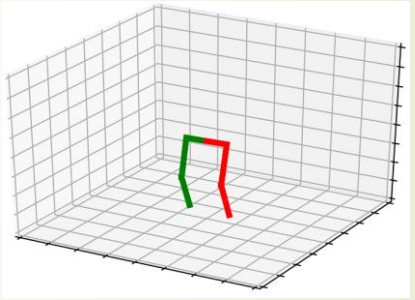
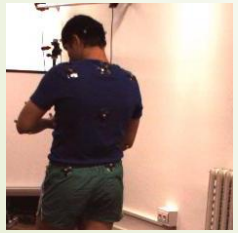
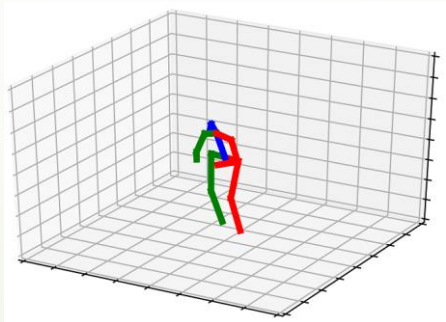
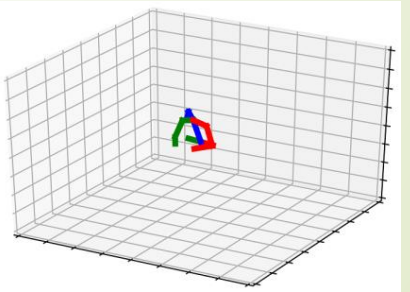




Results: Subjective evaluation

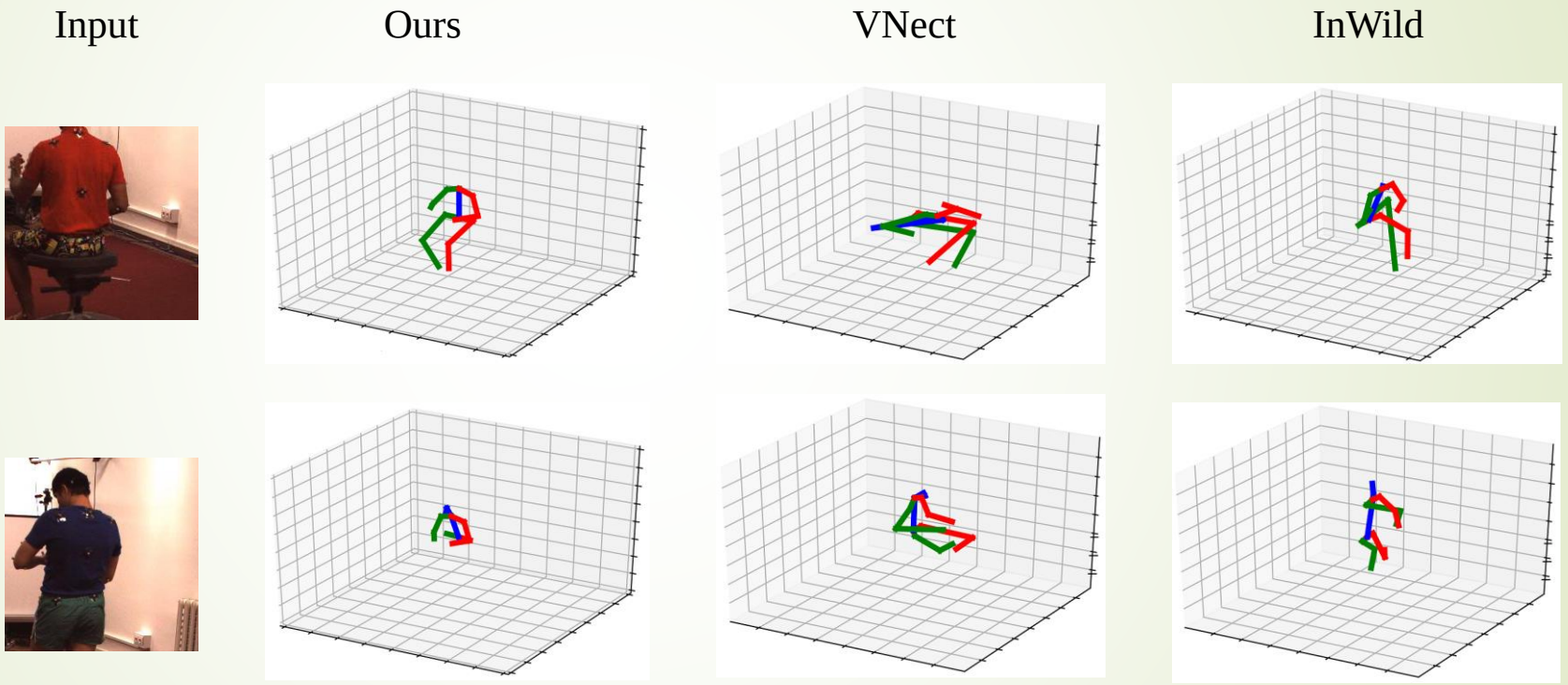
Subjective results under partial body presence:

Results: Subjective evaluation

Our method compared to VNect and InWild under partial body presence:



Conclusion

- ✓ A deep learning based method to handle 3D human pose estimation
- ✓ Handling partial presence in the input 2D image
- ✓ A CNN based detection network to classify the presence
- ✓ A deep CNN to regress the human pose from images containing partial body
- ✓ Empirical evaluations yield promising results on Human3.6M dataset.

Thank you for your time and attention.