

Reducing Footskate in Human Motion Reconstruction with Ground Contact Constraints

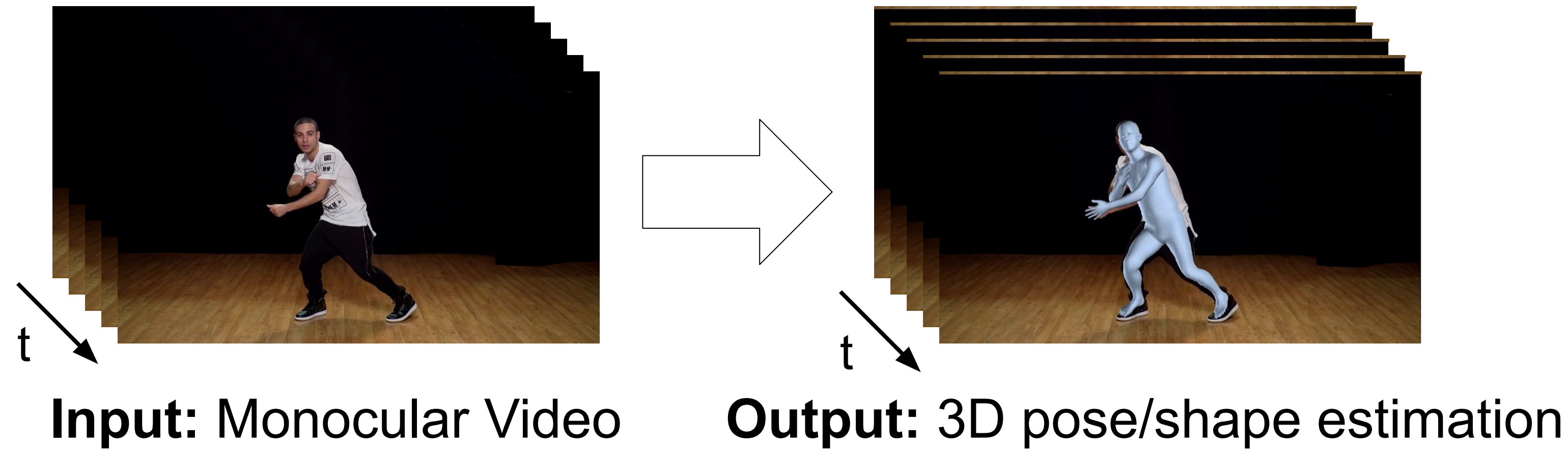
Code available at: http://bit.ly/fs_reducer

Fork me on GitHub



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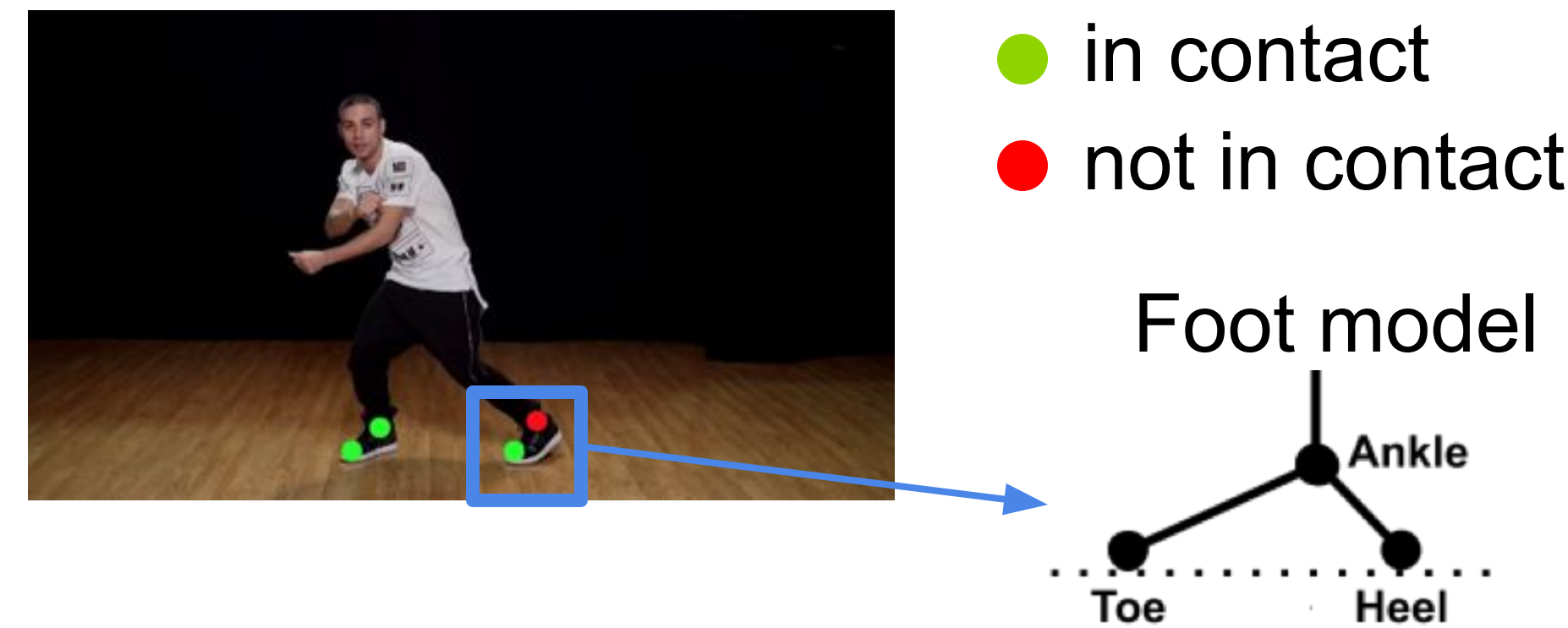
Human Motion Reconstruction



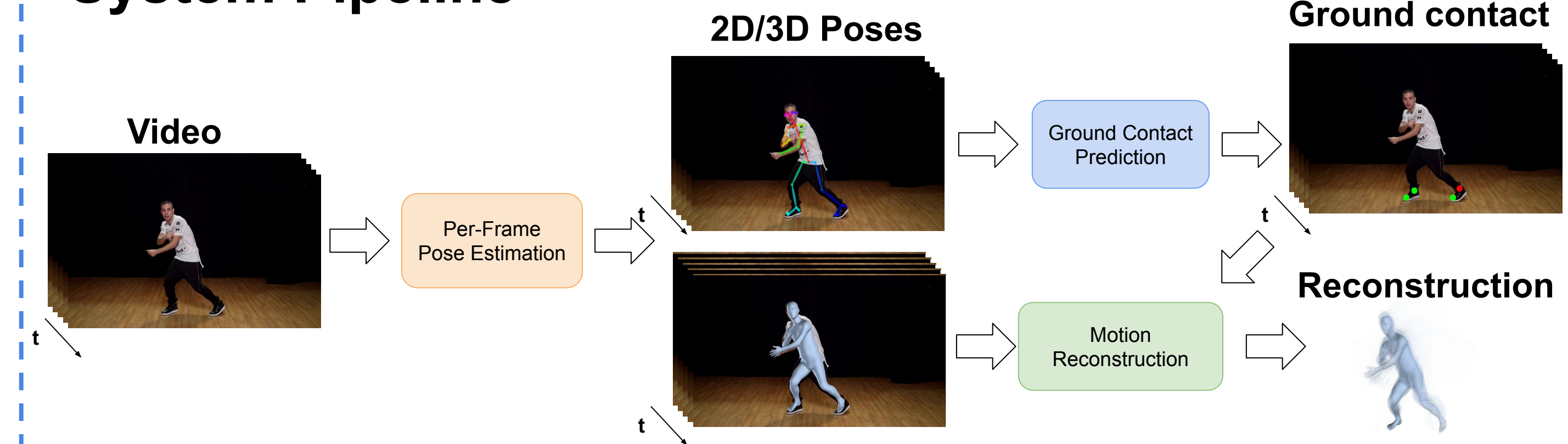
Reducing Footskate with Ground Contact Constraints

Core Idea

- Toes or heels in contact with ground → zero velocity



System Pipeline



Applications



Character animation



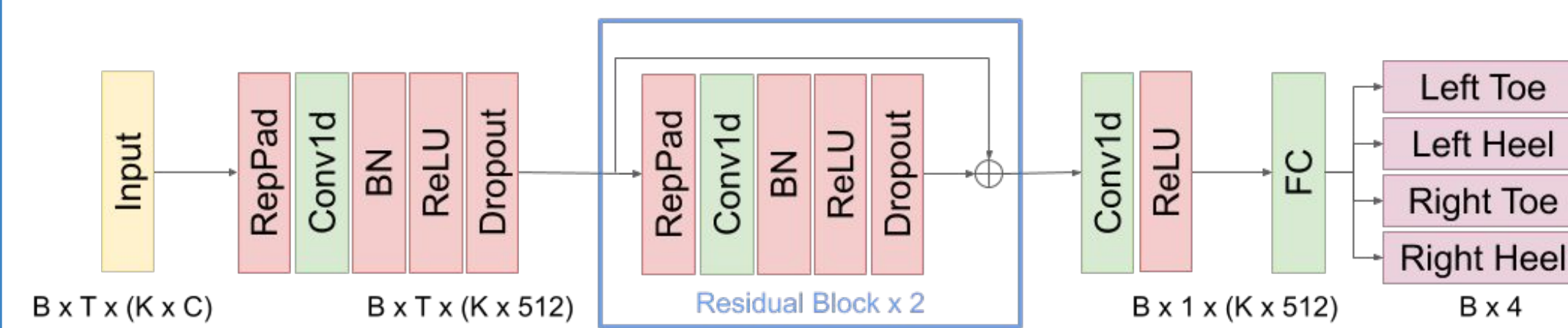
Virtual reality



Imitation learning

Step 1: Ground Contact Prediction

Model: Temporal Convolutional Network



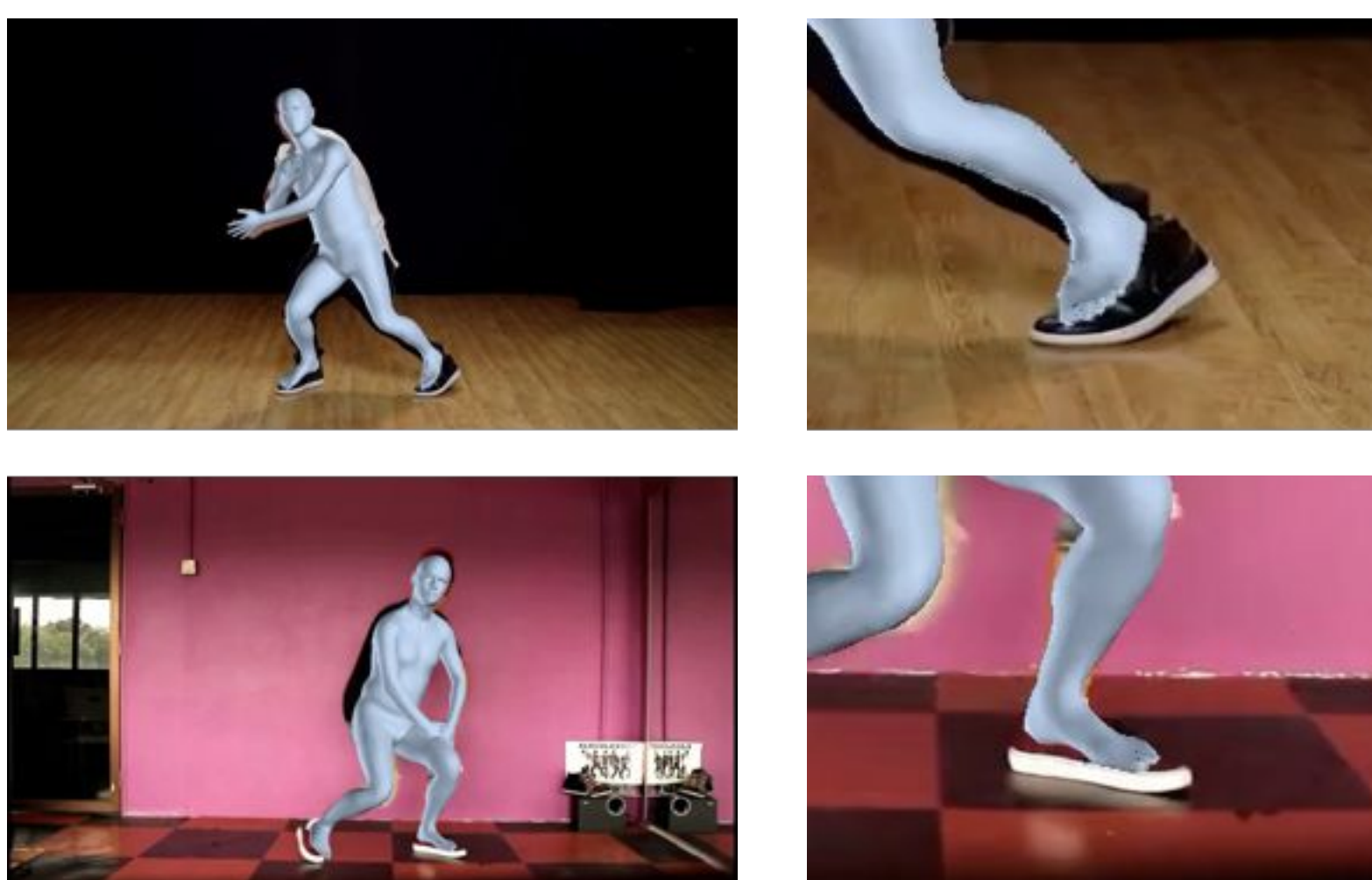
Main results

	Left Toe	Left Heel	Right Toe	Right Heel	mean AP
Keypoint (w/o training)	0.9418	0.8314	0.9437	0.7876	0.8761
Flow (w/o training)	0.9169	0.8003	0.9426	0.7881	0.8620
Flow	0.9670	0.8559	0.9422	0.8284	0.8984
Keypoint	0.9755	0.8960	0.9662	0.8789	0.9292
Keypoint + Detection score	0.9686	0.8783	0.9588	0.8762	0.9205
Keypoint + Flow	0.9725	0.8846	0.9634	0.8700	0.9226

Design choice validation



Problem: Footskate



- Per-frame estimation causes serious jittering (HMR [Kanazawa et al. 2017])
- Temporal smoothing reduces jittering (SFV [Peng et al. 2018])
- Foot slippage (footskate) artifacts remain

Step 2: Motion Reconstruction

Zero-Velocity Constraint

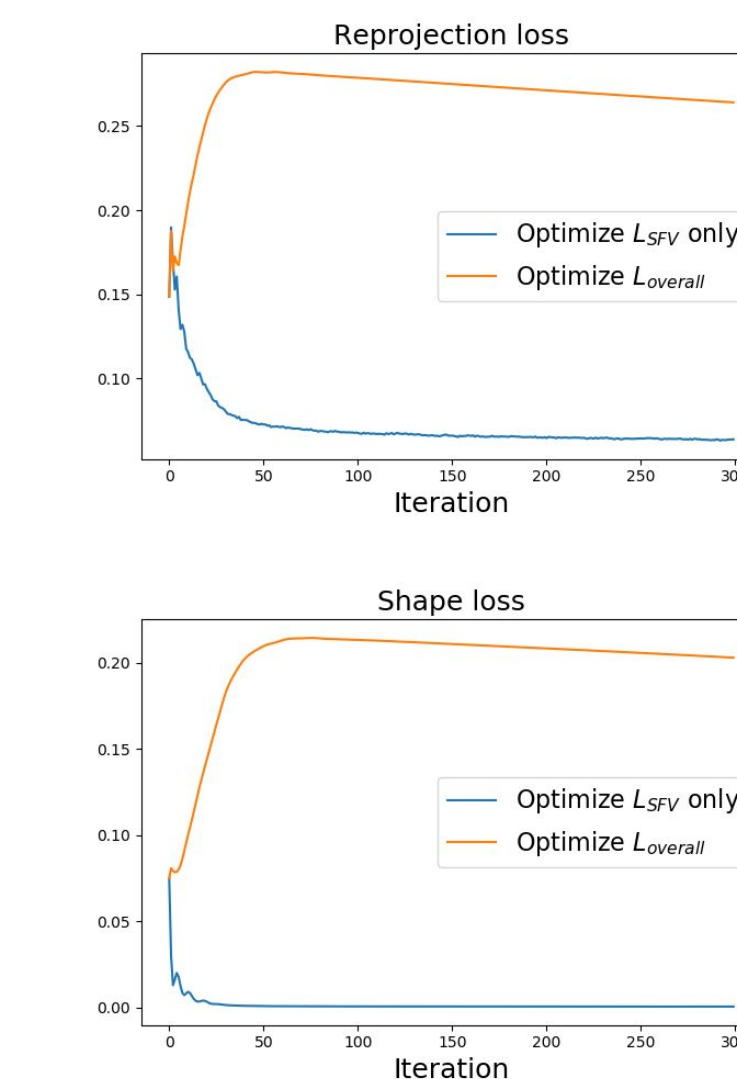
- Joint in two consecutive frames are in contact with the ground → zero velocity

$$L_{Zv} = \sum_{t=2}^T \sum_{k \in S_{foot}} \hat{y}_k^{t-1} \hat{y}_k^t \left\| x_k^{t-1} - x_k^t \right\|_2^2$$

Ground contact prediction Global coordinates

Two-Stage Optimization

- **First stage:** HMR + temporal smoothing (SFV) to get a good initialization
- **Second stage:** Jointly optimizing zero-velocity and temporal consistency
- **Why?** Direct optimization causes conflicts



Result Improvement

	HMR	SFV	Ours
WalkDog	75.05	72.68	72.26
Walking	64.82	66.63	65.61
WalkTogether	73.29	72.21	71.27
Average	71.05	70.42	69.63