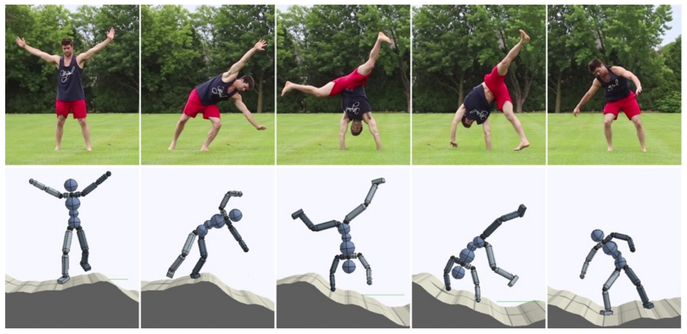
SFV: Reinforcement Learning of Physical Skills from Videos

Xue Bin Peng Angjoo Kanazawa Jitendra Malik Pieter Abbeel Sergey Levine

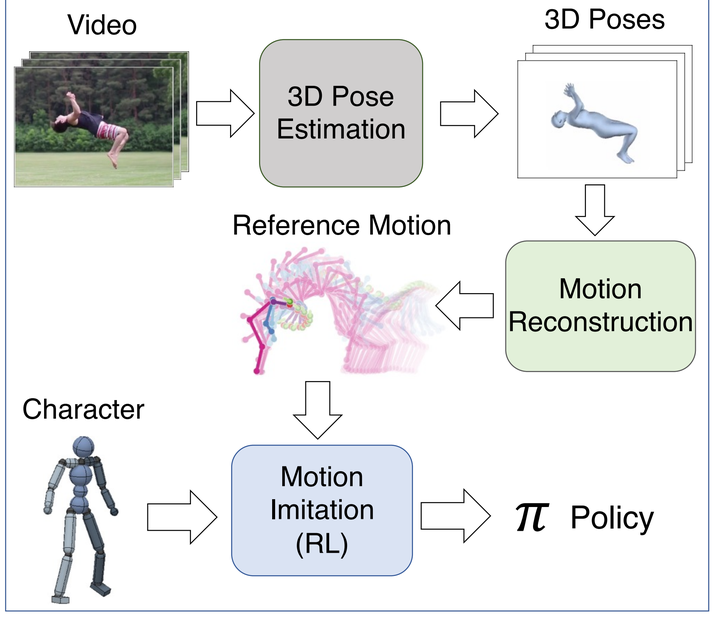
SIGGRAPH Asia 2018

Motivation

- Motion capture: Most common source of motion data for motion imitation
- But mocap is quite a hassle, often requiring heavy instrumentation.
- There are lots of videos on the Internet (300hr/min uploaded to YouTube)
- Can we enable physically simulated characters to learn **skills from videos** (SFV)?

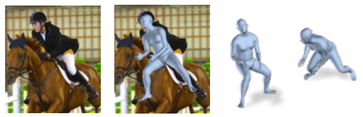


Approach



Motion Reconstruction

Predict the actor's 3D pose in each frame via a vision-based 3D pose estimator [1]



Human Mesh Recovery (HMR) [1] recovers the 3D mesh and pose of the person as the 3D rotation of 23 joints from a single image

But per-frame prediction results in a jittery trajectory + noisy output on challenging images.

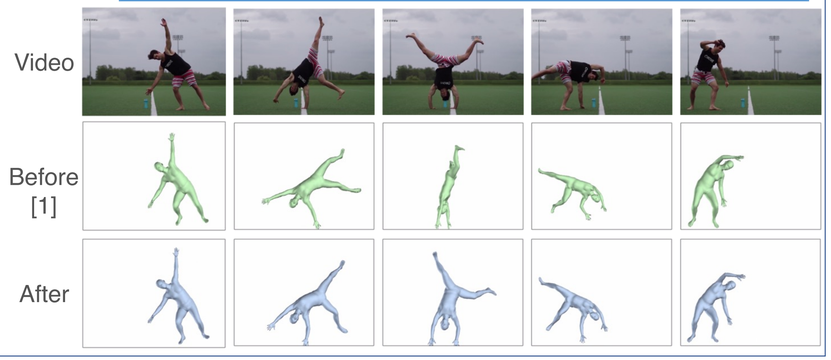
➔ Recover a temporally consistent pose via optimization

Main objective:

$$\min_{\hat{Q}} \; w_p l_p(\hat{Q}) + w_{sm} l_{sm}(\hat{Q})$$

$||$ – $||^2$ Stay close to original

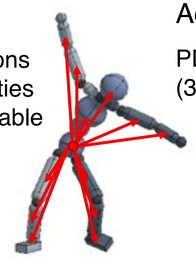
$||$ – $||^2$ Smooth motion



Motion Imitation

State:

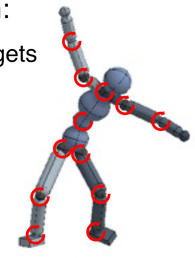
- Link positions
- Link velocities
- Phase variable (197D)



As in [2]

Action:

PD targets (36D)



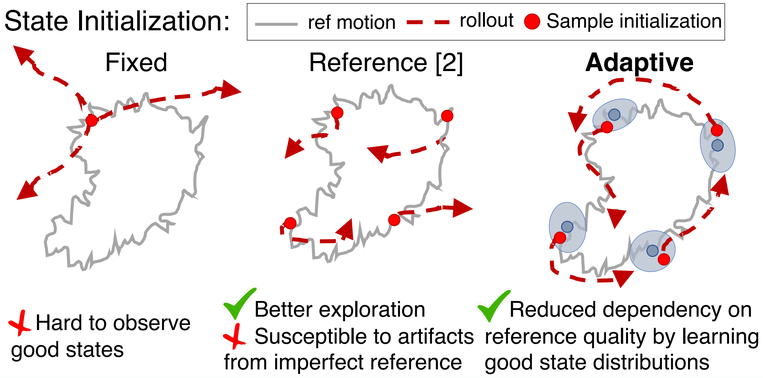
$$\pi(a|s) = \mathcal{N}(\mu(s), \Sigma)$$

Reward:

Per-frame difference of pose between the reference and the simulated character

$$r_t = \exp\left(-\| \quad - \quad \|^2\right)$$

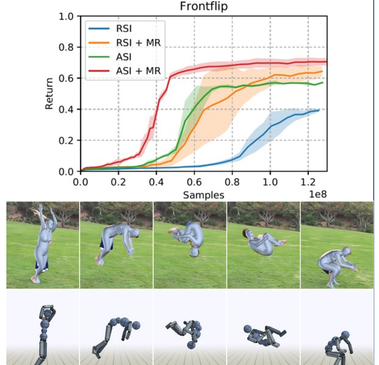
State Initialization:



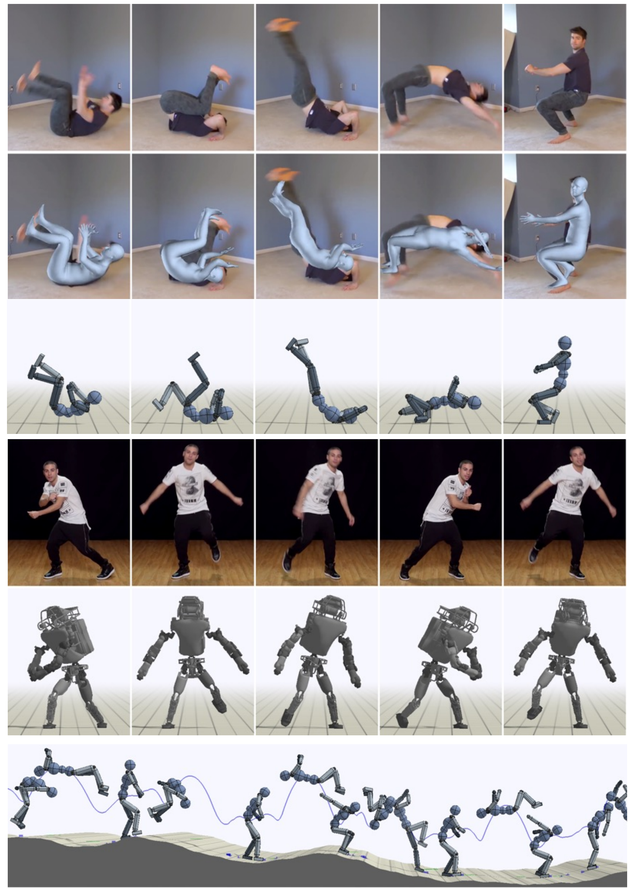
✗ Hard to observe good states

✓ Better exploration
✗ Susceptible to artifacts from imperfect reference

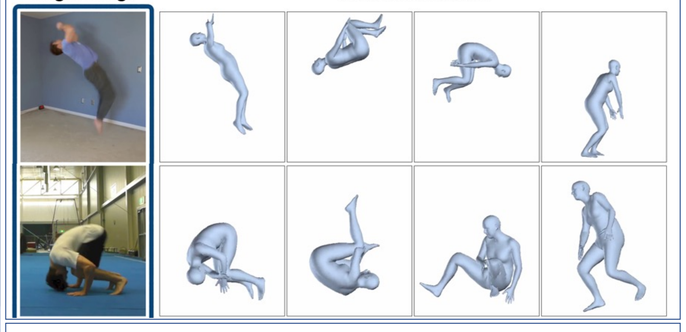
✓ Reduced dependency on reference quality by learning good state distributions



Results



Physics based Motion Prediction



References

[1] Angjoo Kanazawa, Michael J. Black, David W. Jacobs, Jitendra Malik, "End-to-end Recovery of Human Shape and Pose", *CVPR 2018.*

[2] Xue Bin Peng, Pieter Abbeel, Sergey Levine, Michiel van de Panne, "DeepMimic: Example-Guided Deep Reinforcement Learning of Physics-Based Character Skills", SIGGRAPH 2018