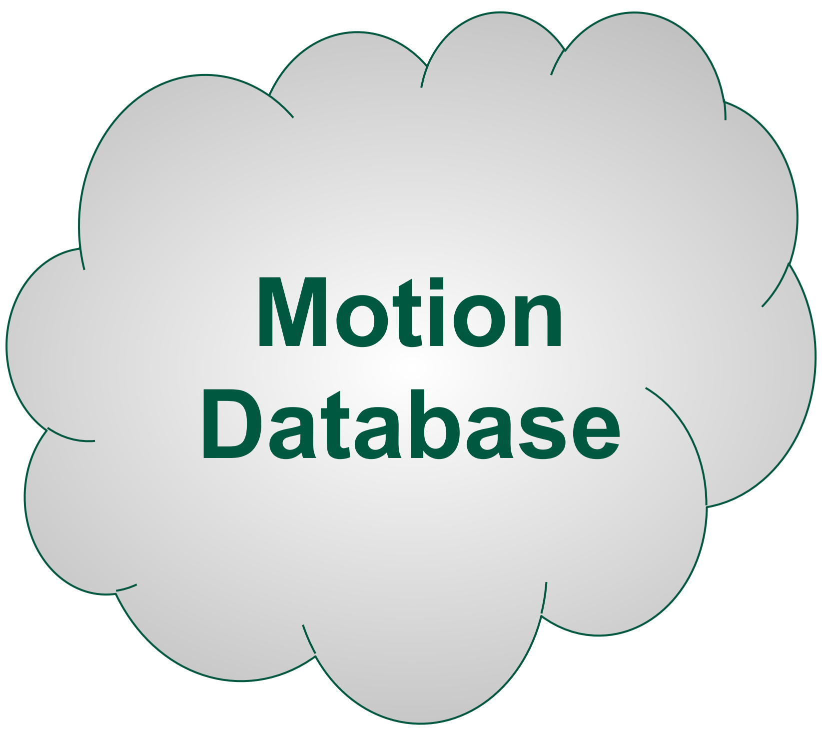
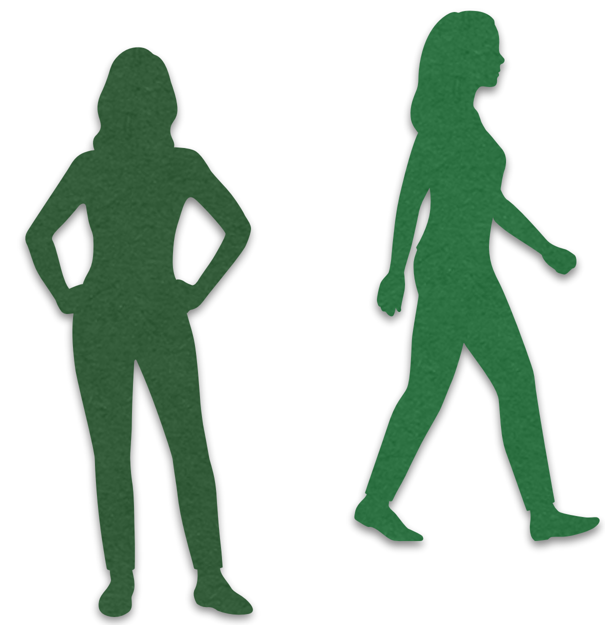
딥러닝으로 드래곤 길들이기

이제희 서울대학교 컴퓨터공학부

Motion Capture

Data-Driven Animation

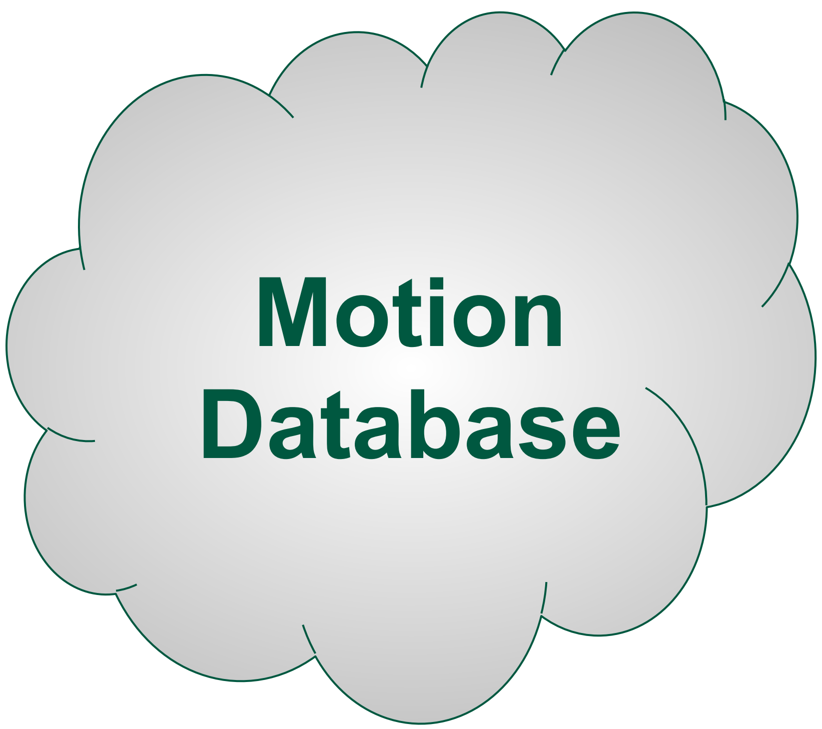


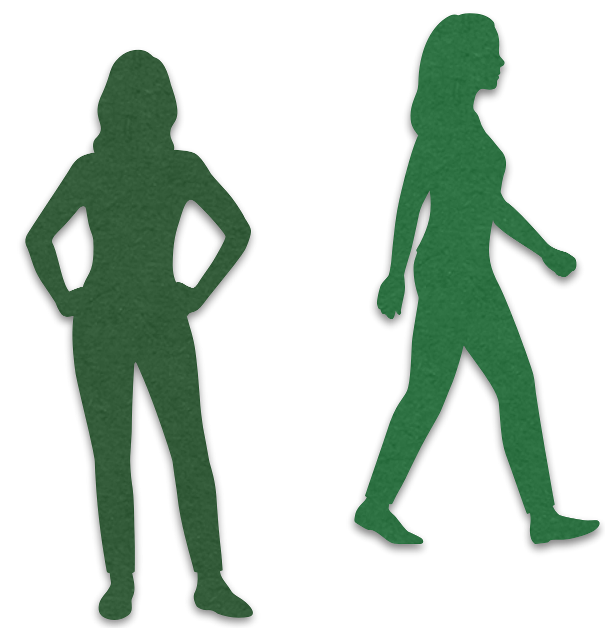


Data-Driven Animation

Degree of User Intervention

Unsupervised
Minimally-supervised
Supervised





Data Size

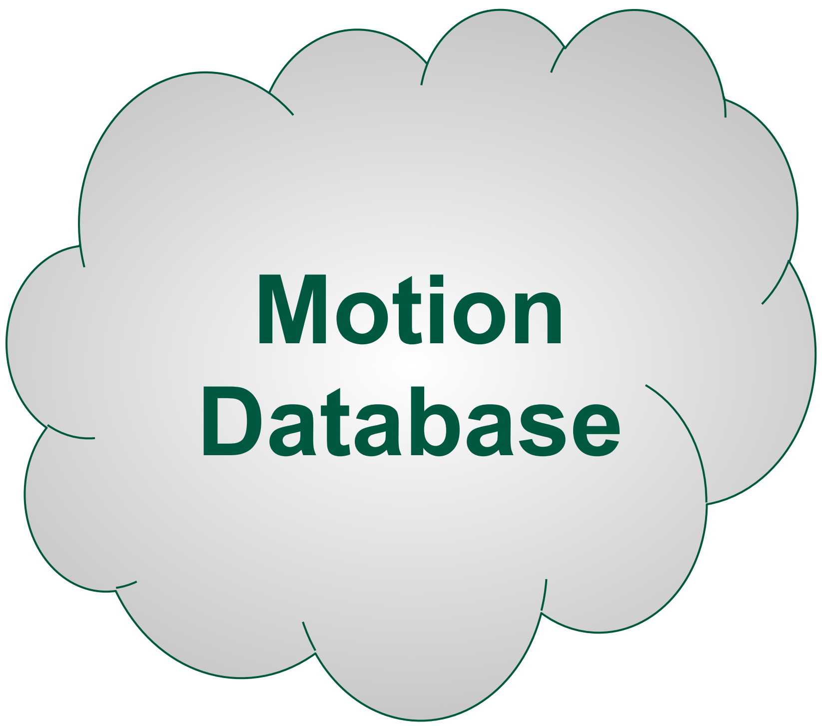
small to very large

Model Complexity

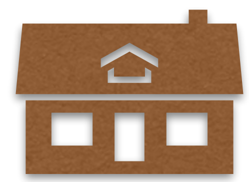
Sticks and joints
3D animated character
Musculoskeleton

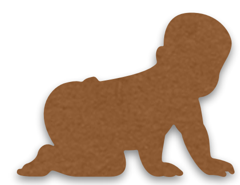
Data-Driven Animation

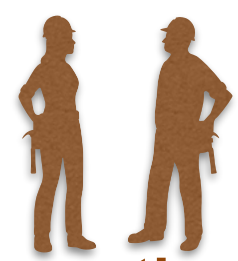
Degree of User Intervention
Unsupervised
Minimally-supervised
Supervised

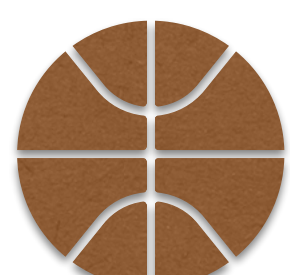


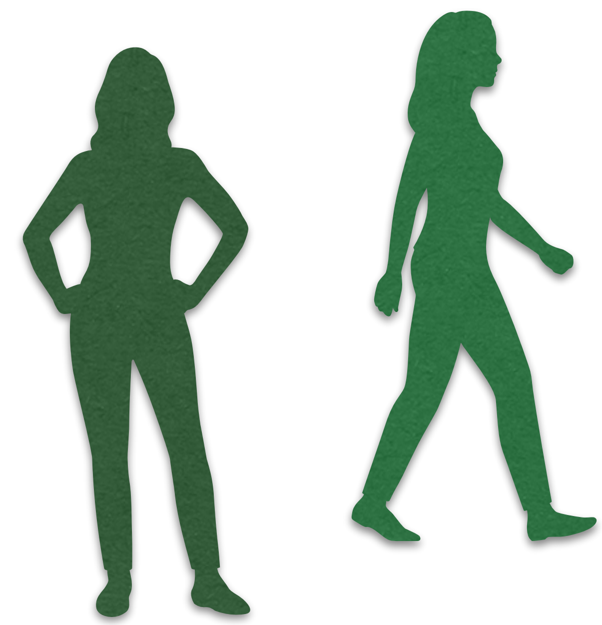
Data Size
small to very large


Environment


Body Types


Interaction


Syntax and Semantics



Model Complexity
Sticks and joints
3D animated character
Musculoskeleton

Interactive Character Animation by Learning Multi-Objective Control

Kyungho Lee, Seyoung Lee and Jehee Lee
(ACM Transactions on Graphics 2018, SIGGRAPH Asia 2018)

Why Deep Learning?

Fast at runtime

Specialized chips will be available to all platforms soon

Compact in memory

We don’t have to keep motion data
Everything goes into layers of networks

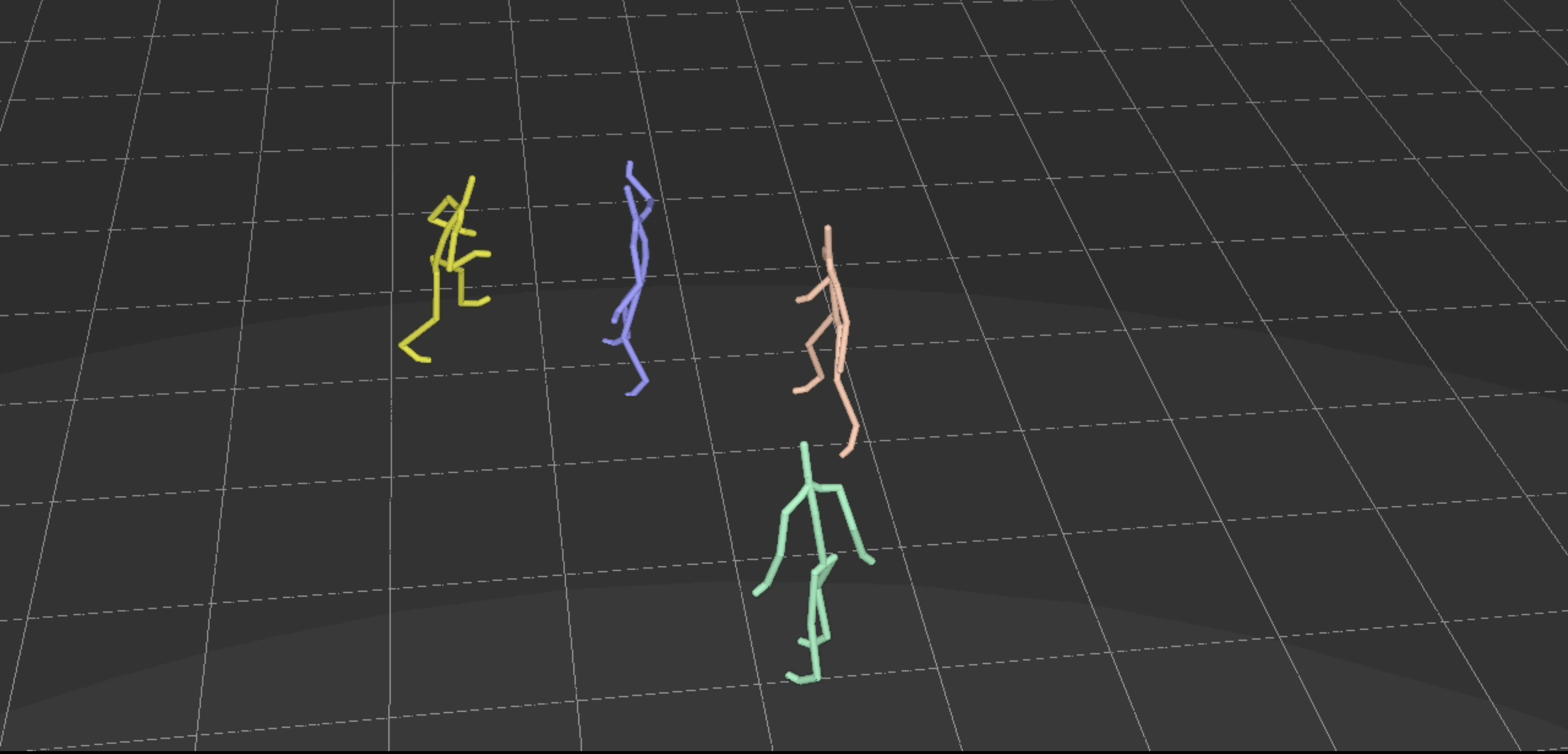
Easy to build

Learning process is largely automated

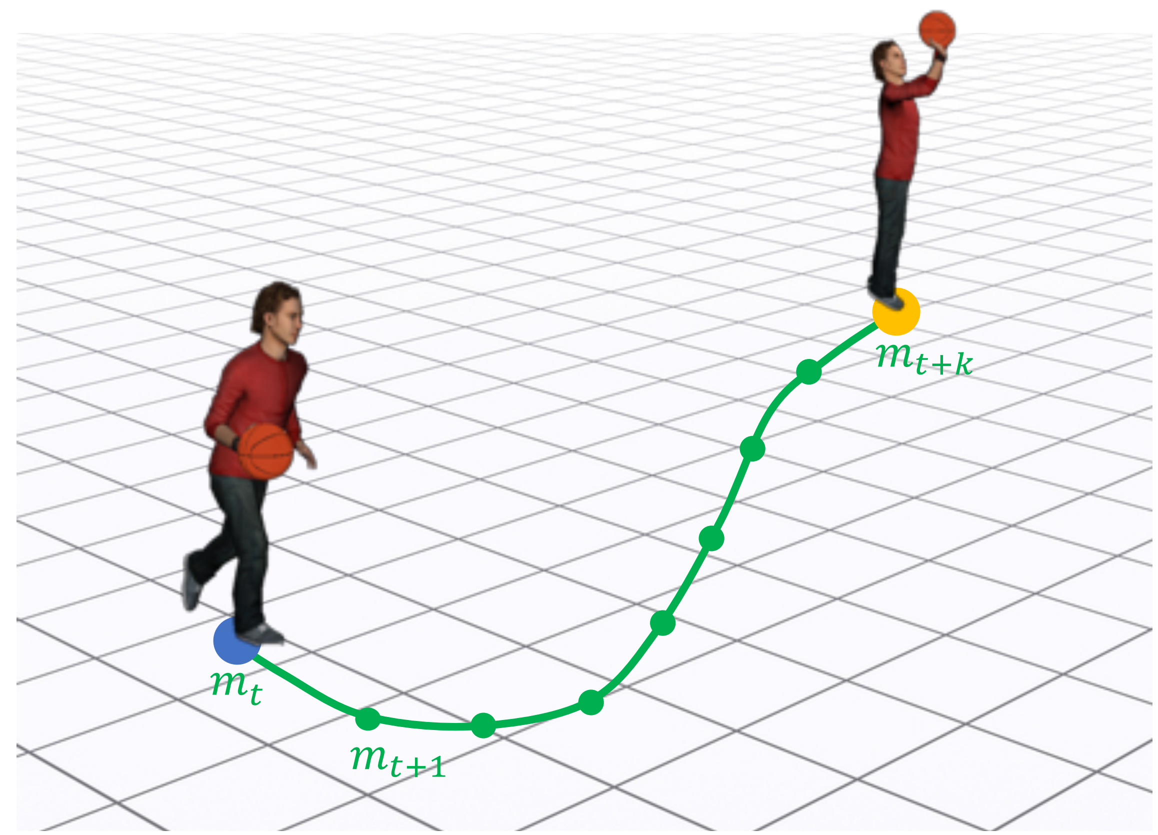
Interactive control

We still want to have direct control over the character’s motion

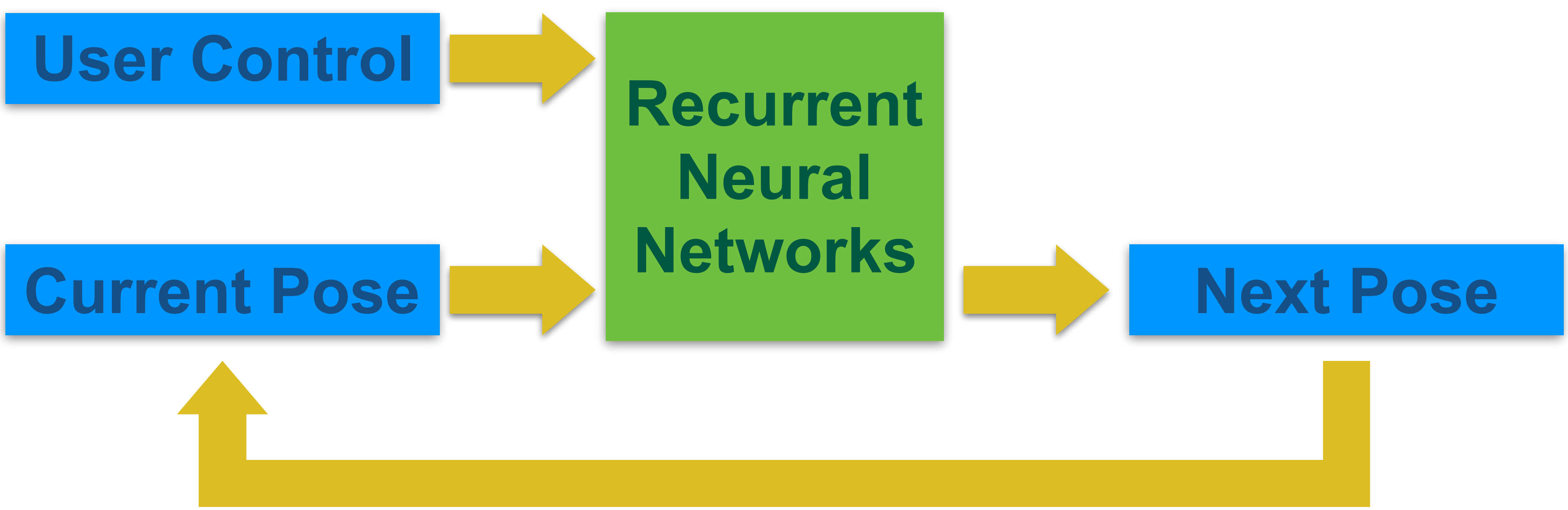
Motion Capture Data



RNN for Interactive Character Control



Target position,
direction,
velocity, …



Issues in Motion Learning

Multiple actions in the data set

Dribble, shoot, pass, catch, pivot, run, …

Size of motion data

We can never have enough data for deep learning

Segmentation and labeling

labor-intensive and time consuming

Multi-Objective Control

Learn Multiple actions simultaneously

Each action may have a different set of control parameters

Automatic data augmentation

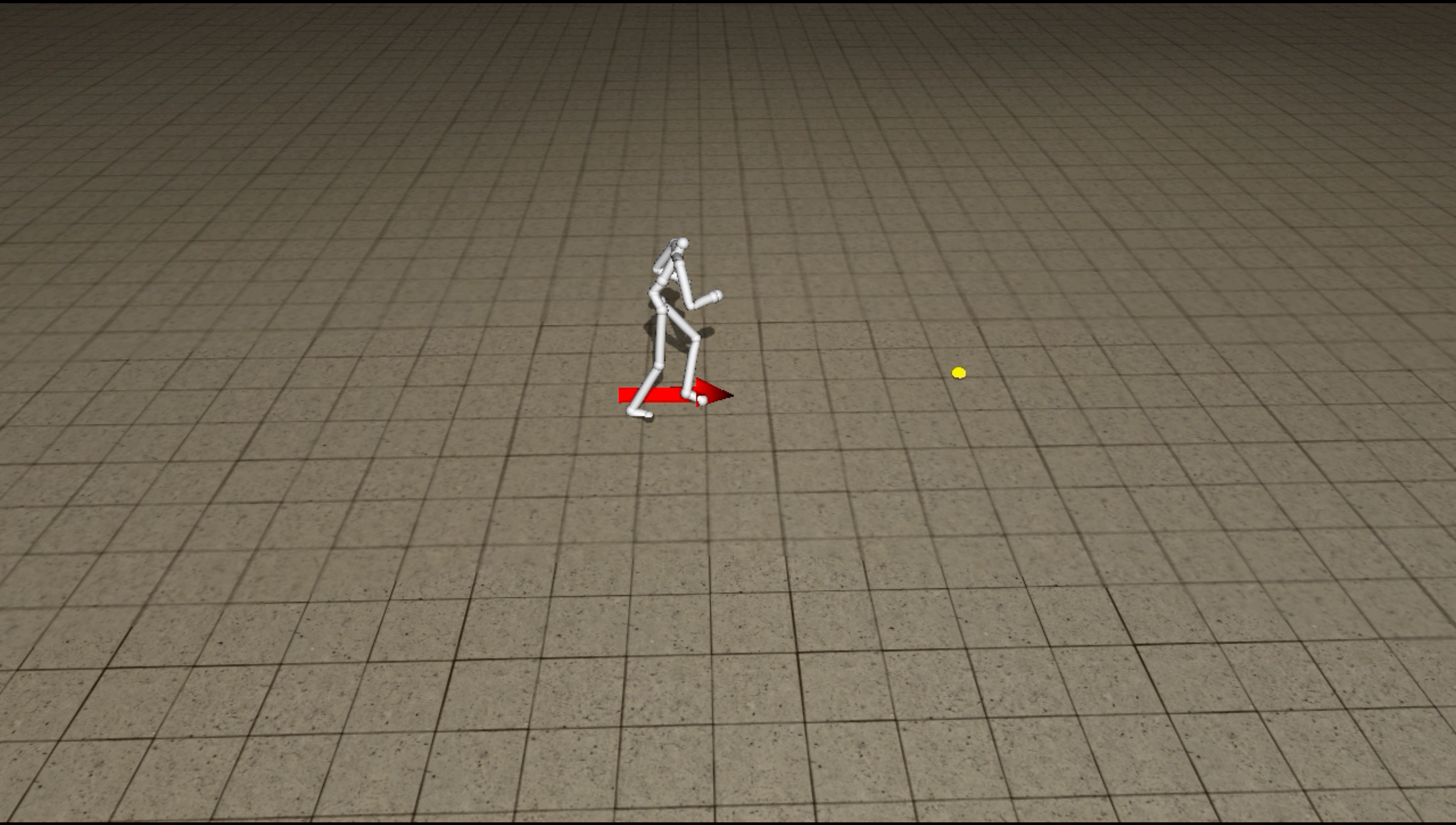
Enhance variabilities in combinatorial and spatiotemporal domains

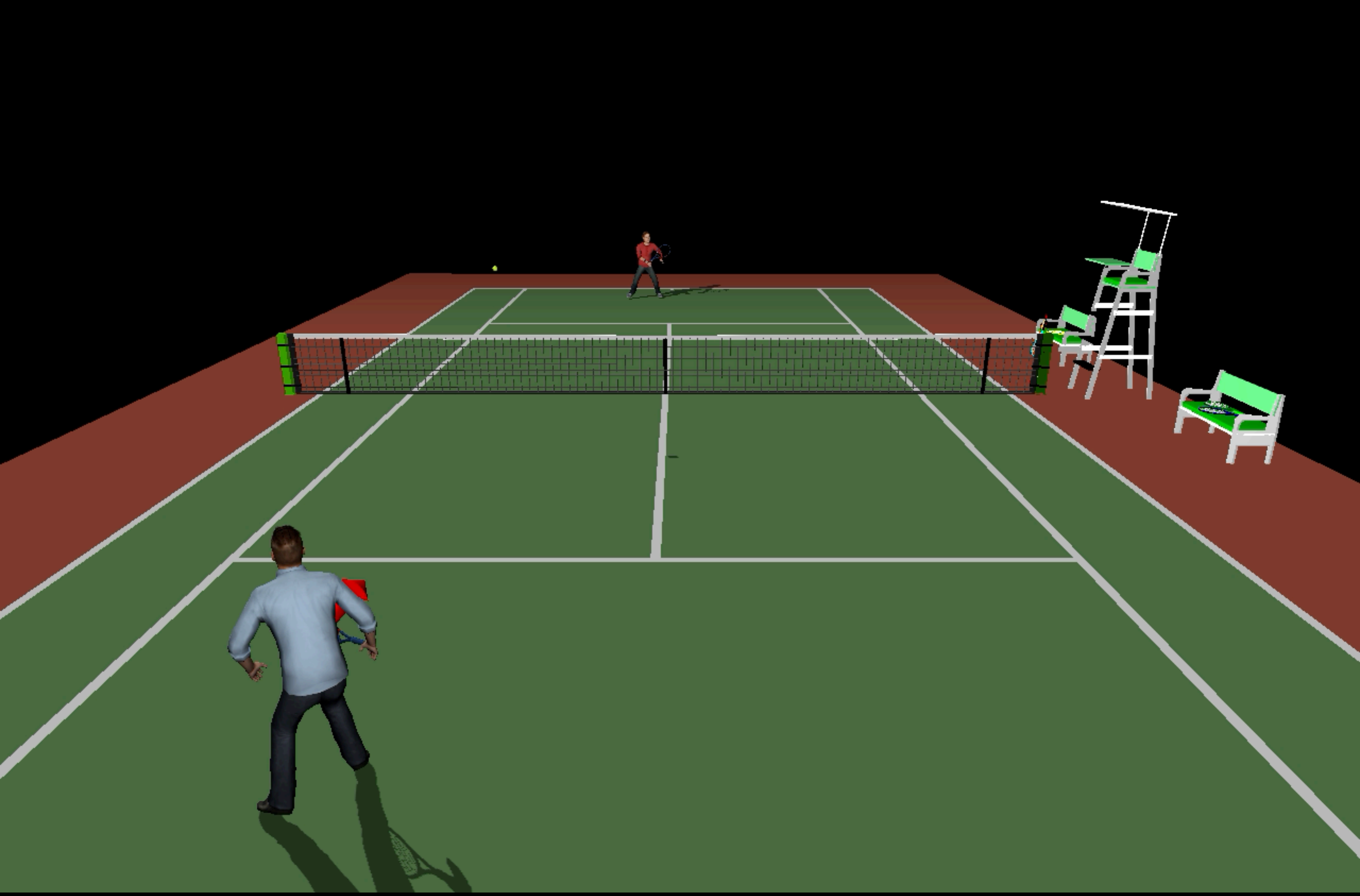
From very small (10 to 20 sec) to medium (20 min)

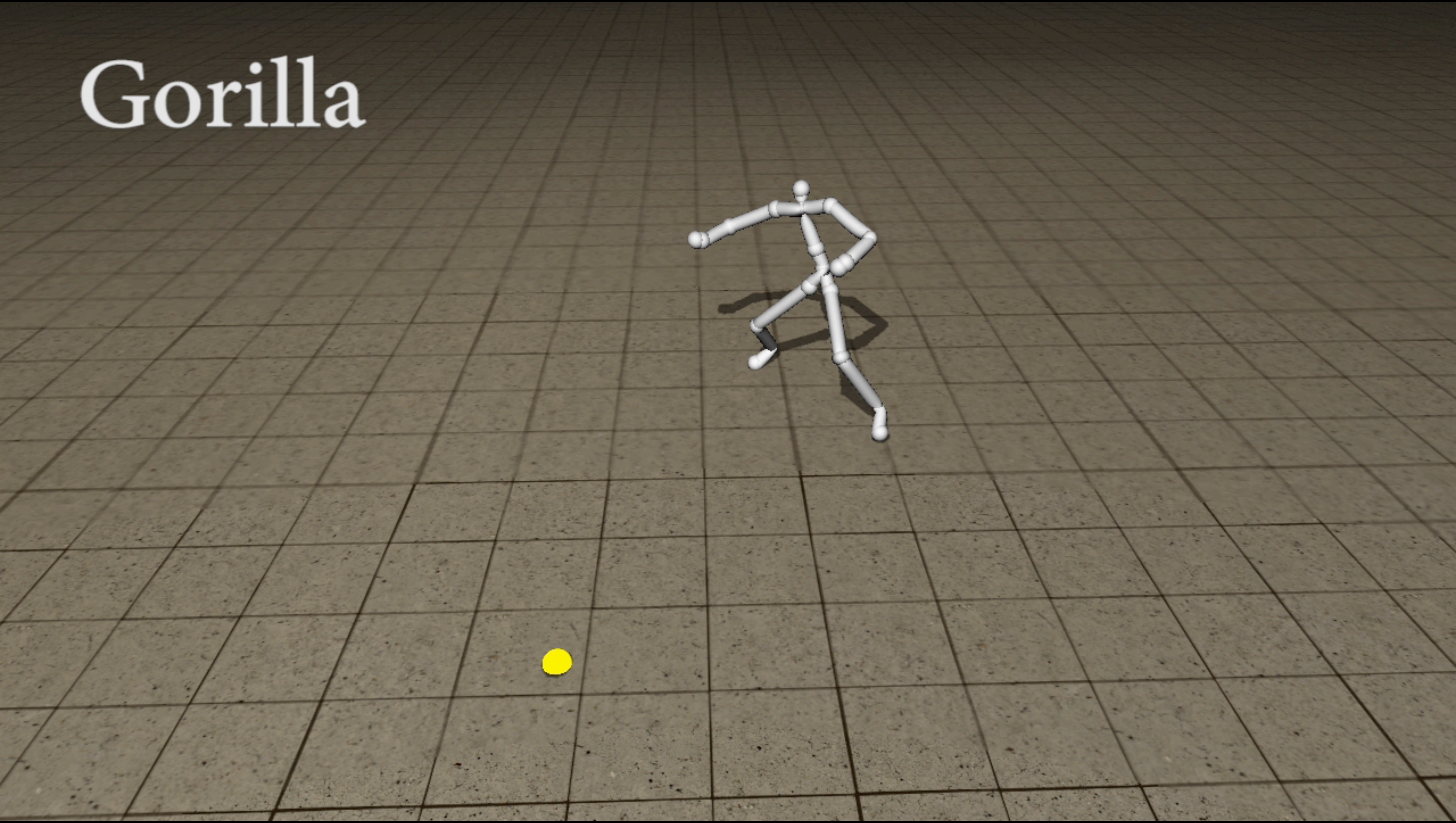
Minimal user intervention

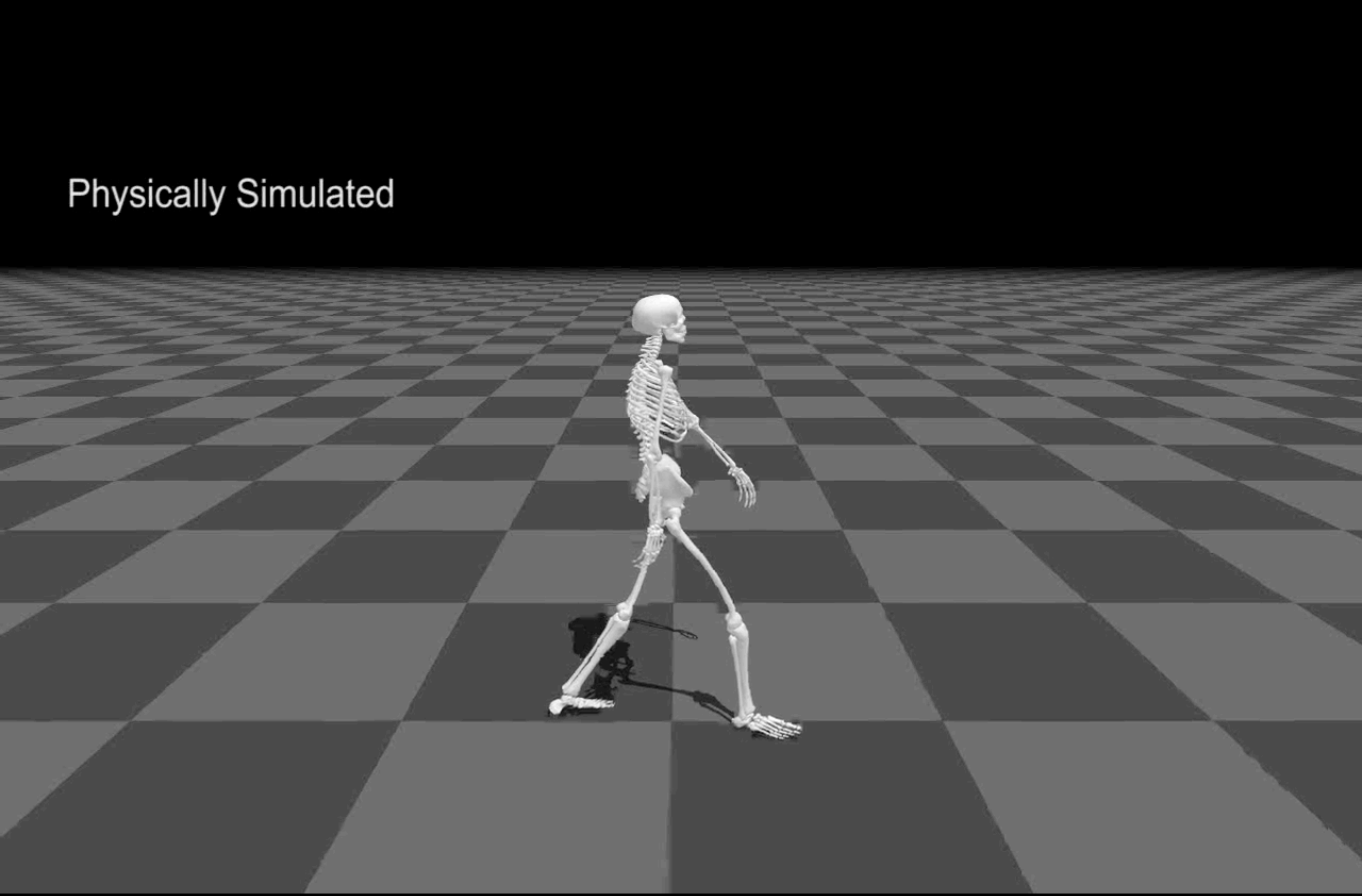
No segmentation, minimal labeling

Need more work to design syntactic and semantic rules

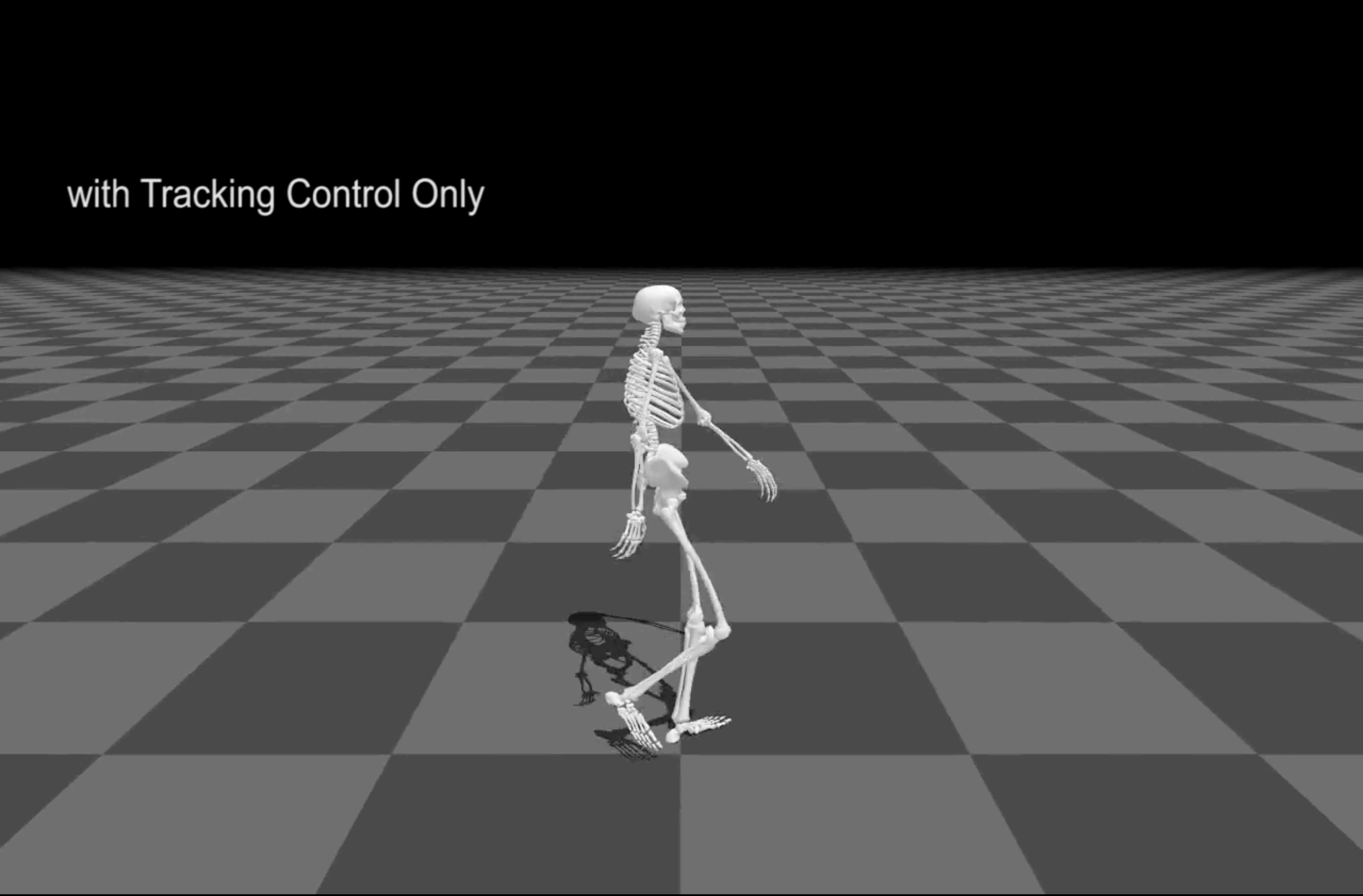




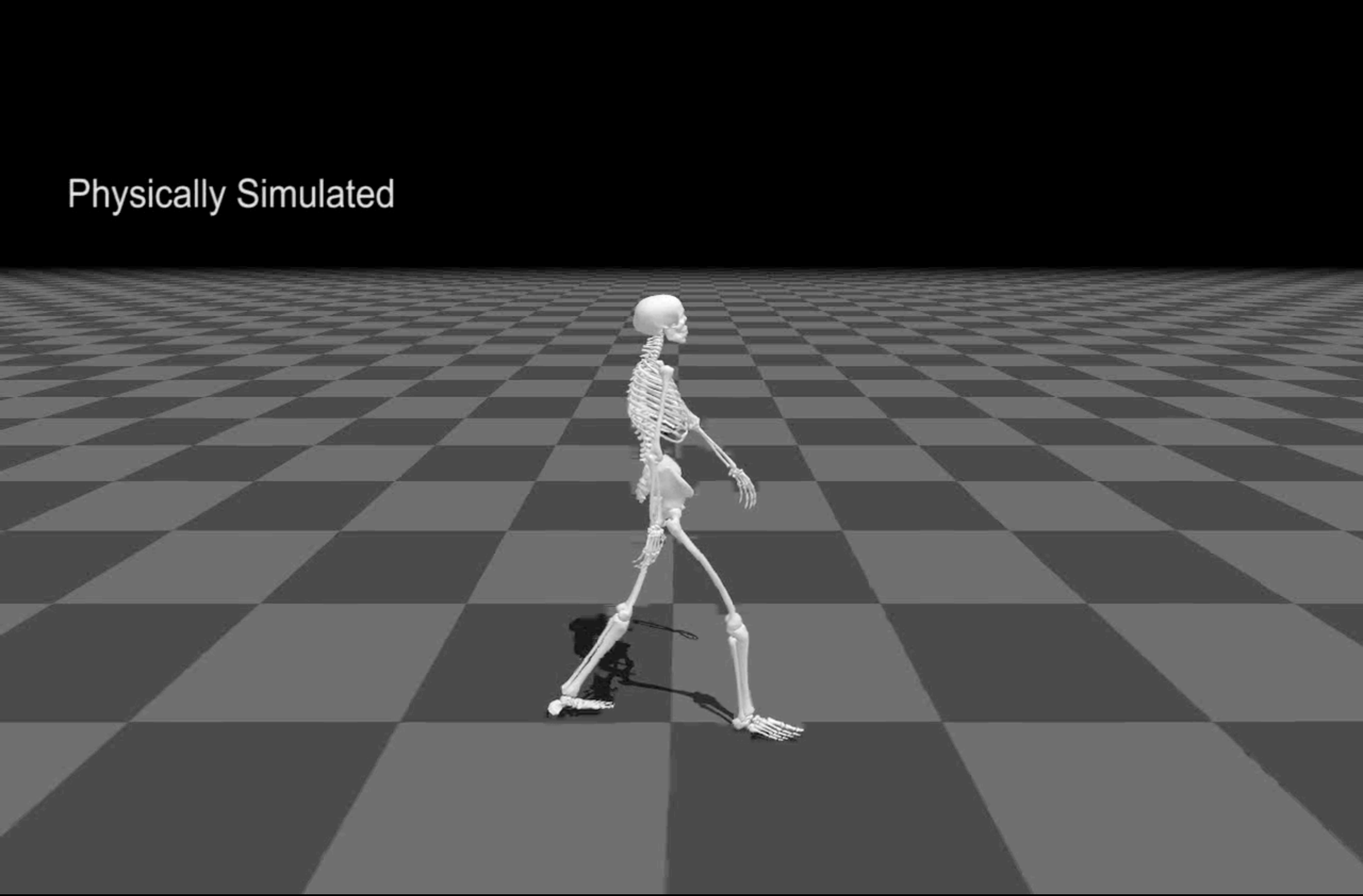

Gorilla



[SIGGRAPH 2010] Lee et al, Data-driven biped control

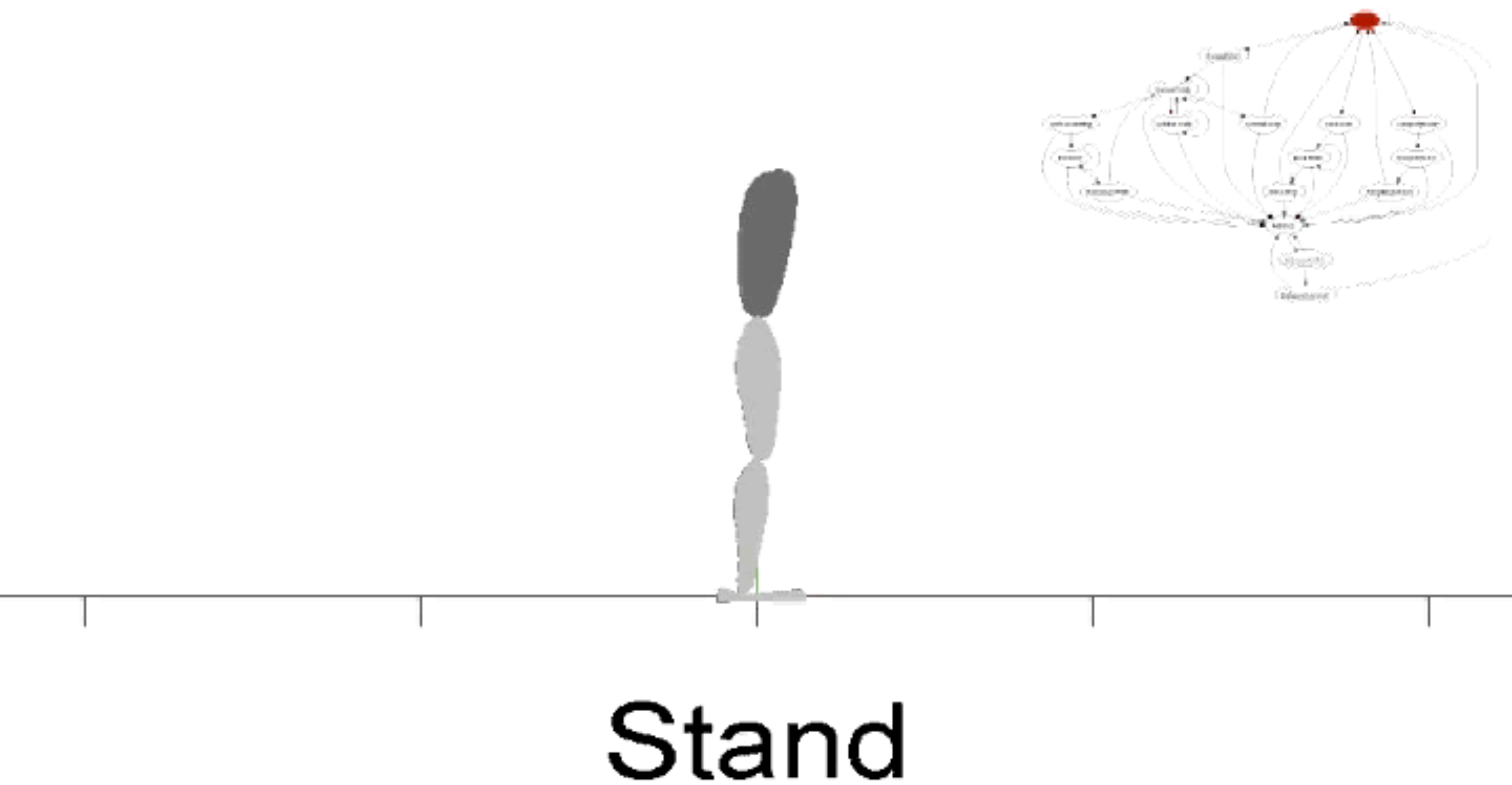


[SIGGRAPH 2010] Lee et al, Data-driven biped control

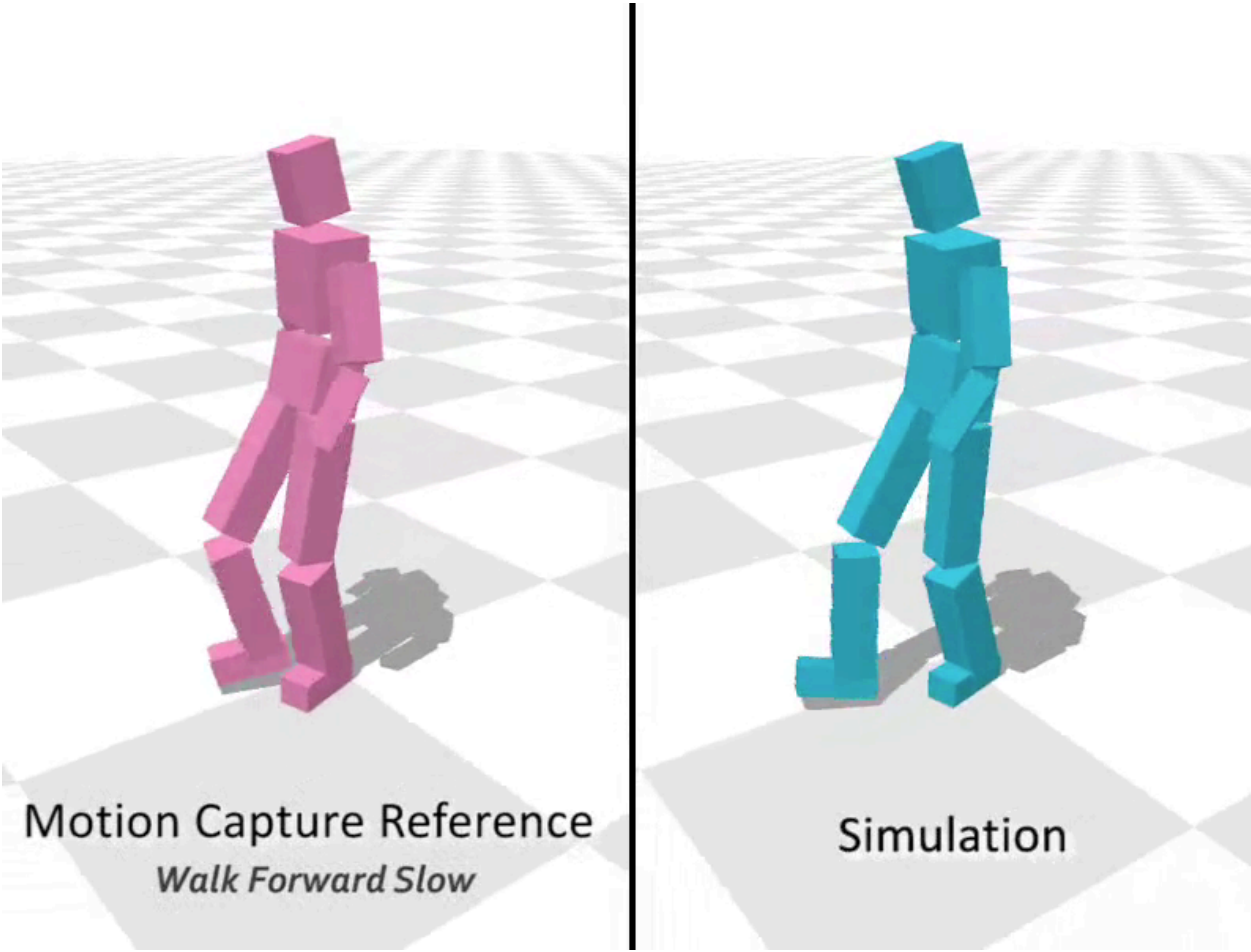


[SIGGRAPH 2010] Lee et al, Data-driven biped control

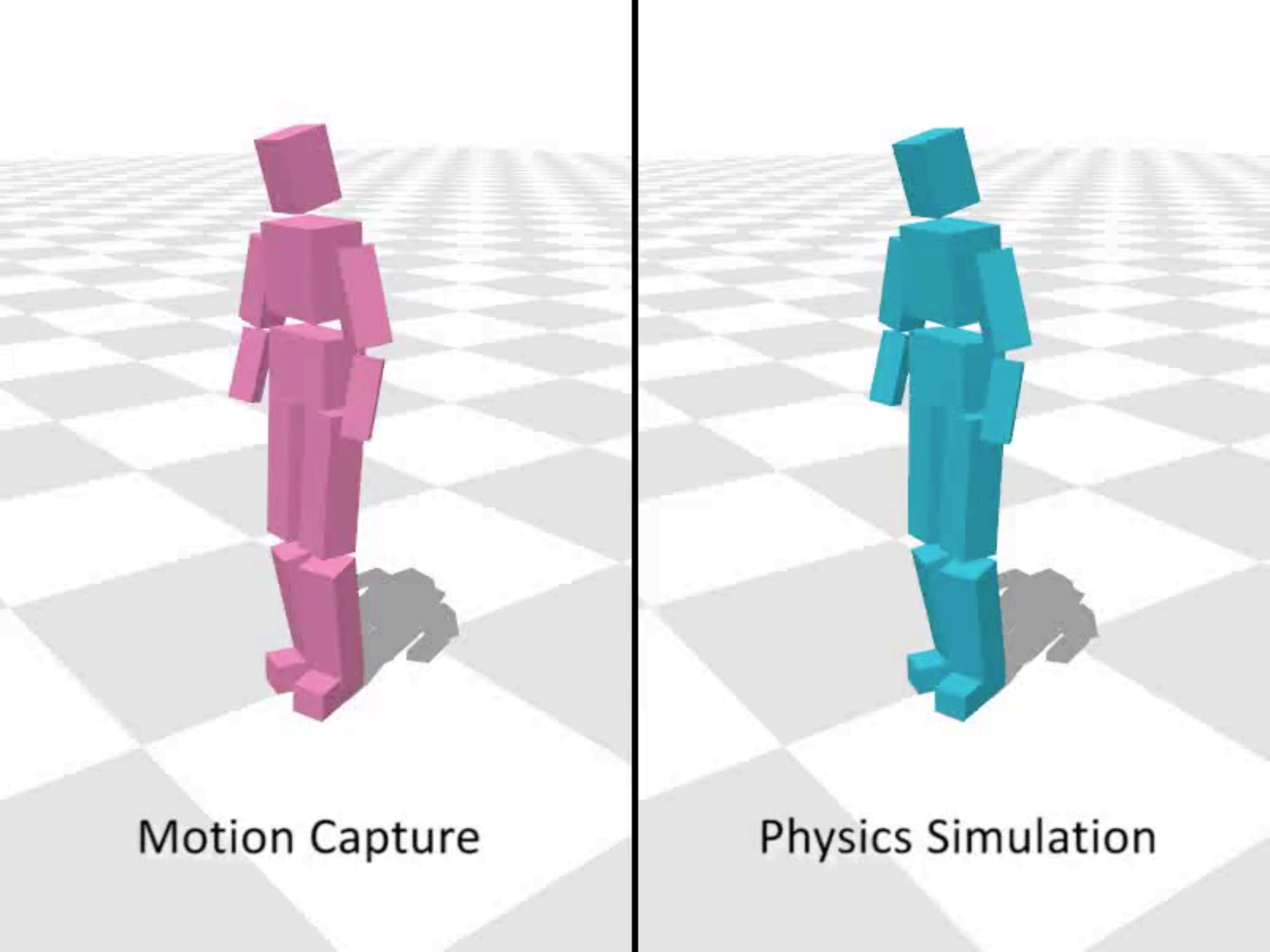
Hubo 2013

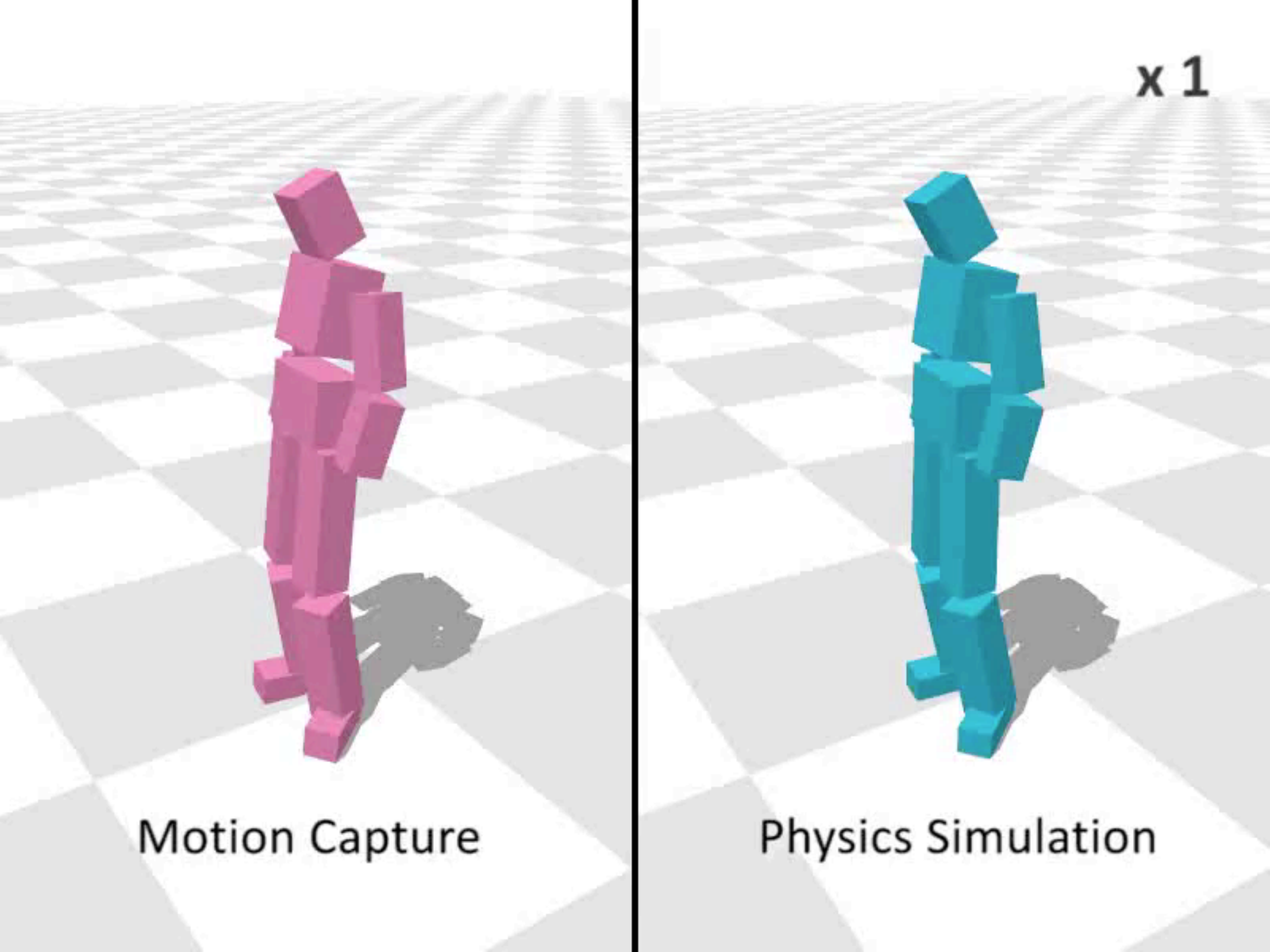


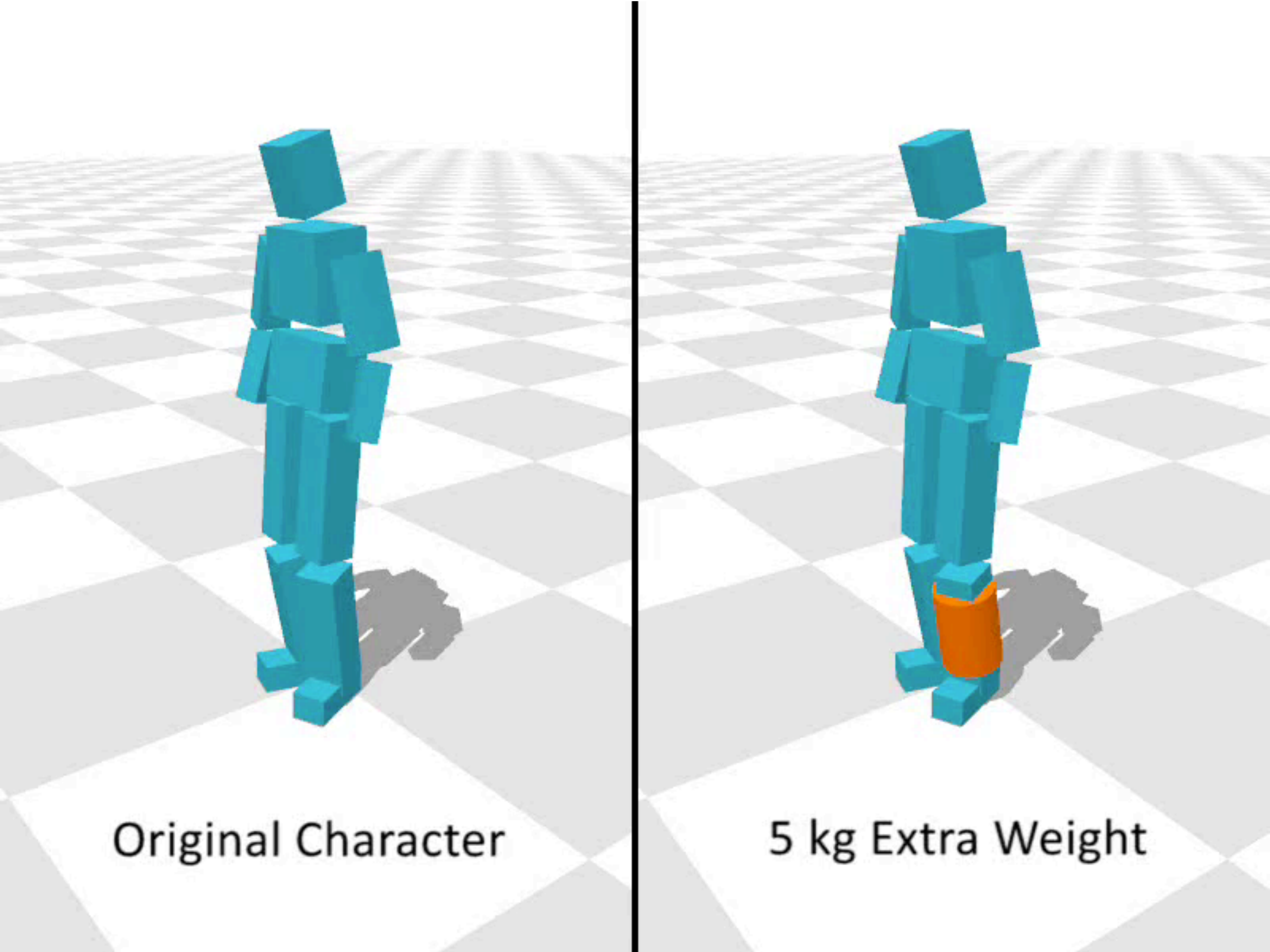
[SIGGRAPH 2007]
Sok et al, Simulating Biped Behaviors from Human Motion Data

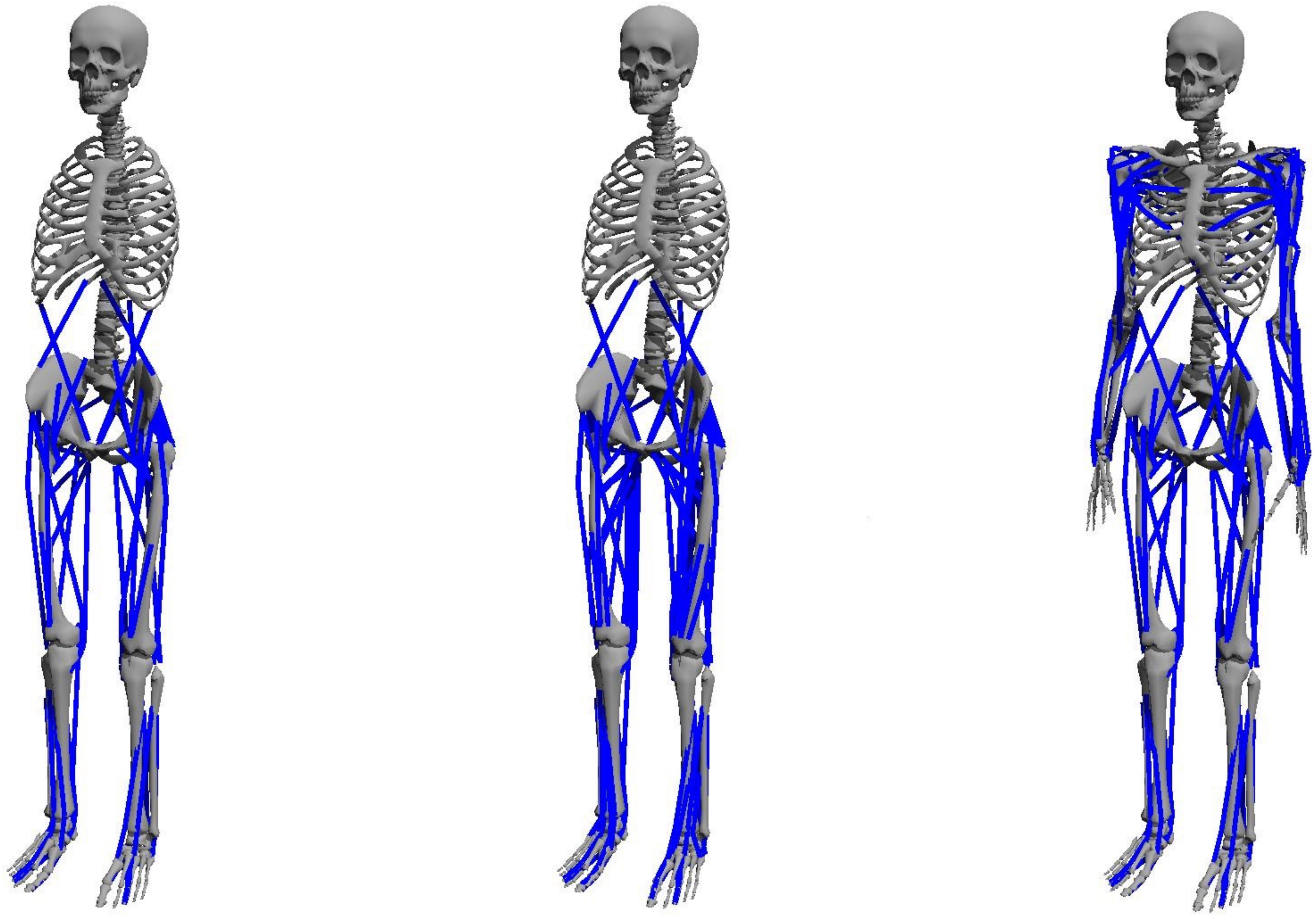


[SIGGRAPH 2010] Lee et al, Data-driven biped control


Motion Capture
Physics Simulation


x 1
Motion Capture
Physics Simulation


Original Character
5 kg Extra Weight

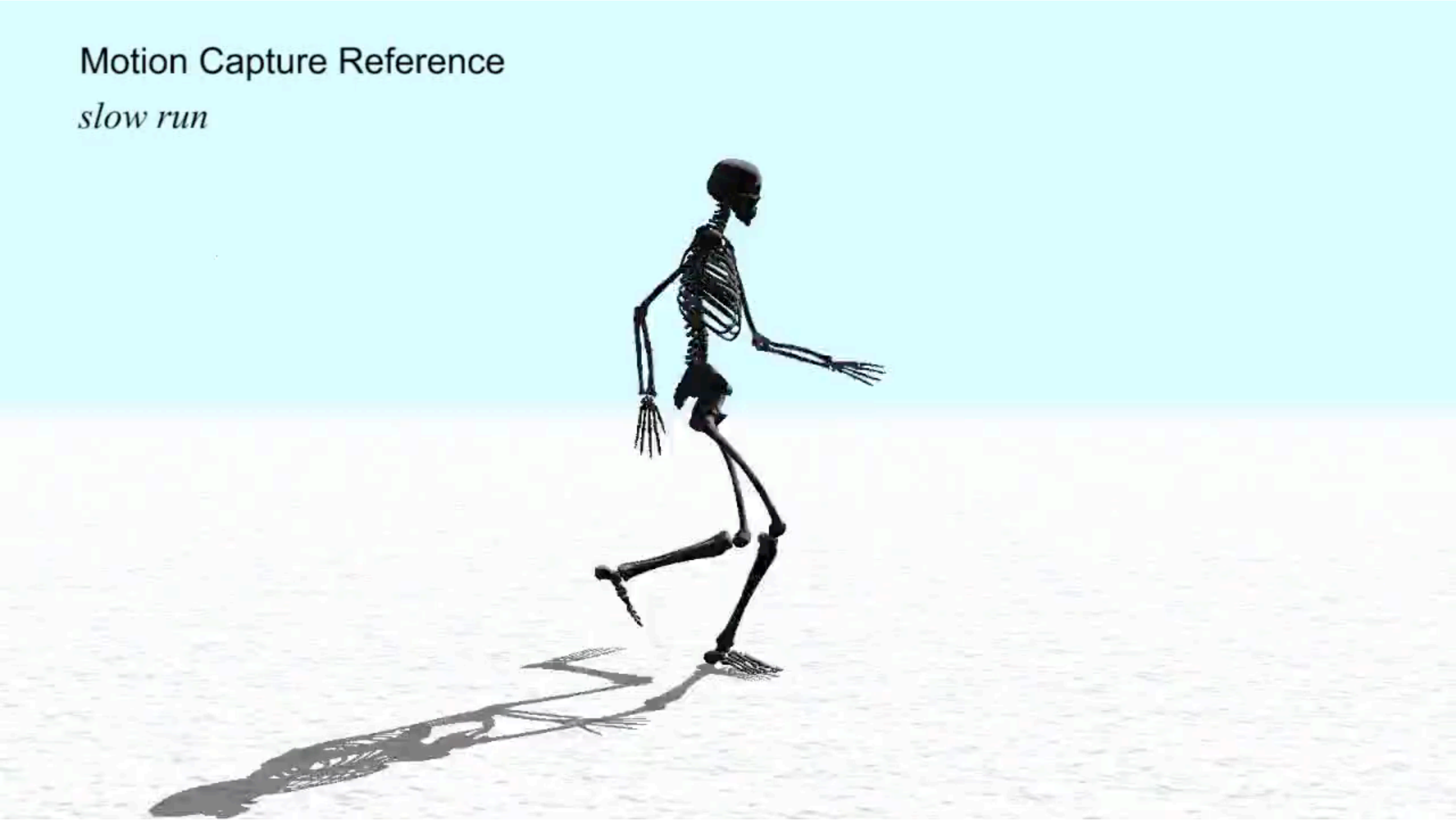


Gait2562 (25 DOFs, 62 muscles)

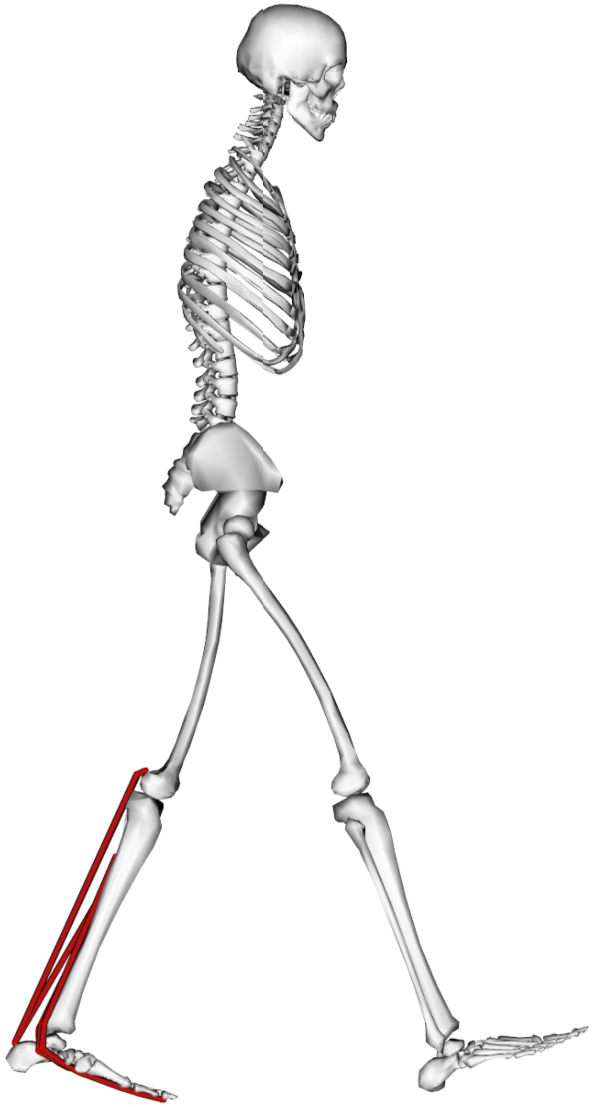
Gait2592 (25 DOFs, 92 muscles)

Fullbody (39 DOFs, 120 muscles)

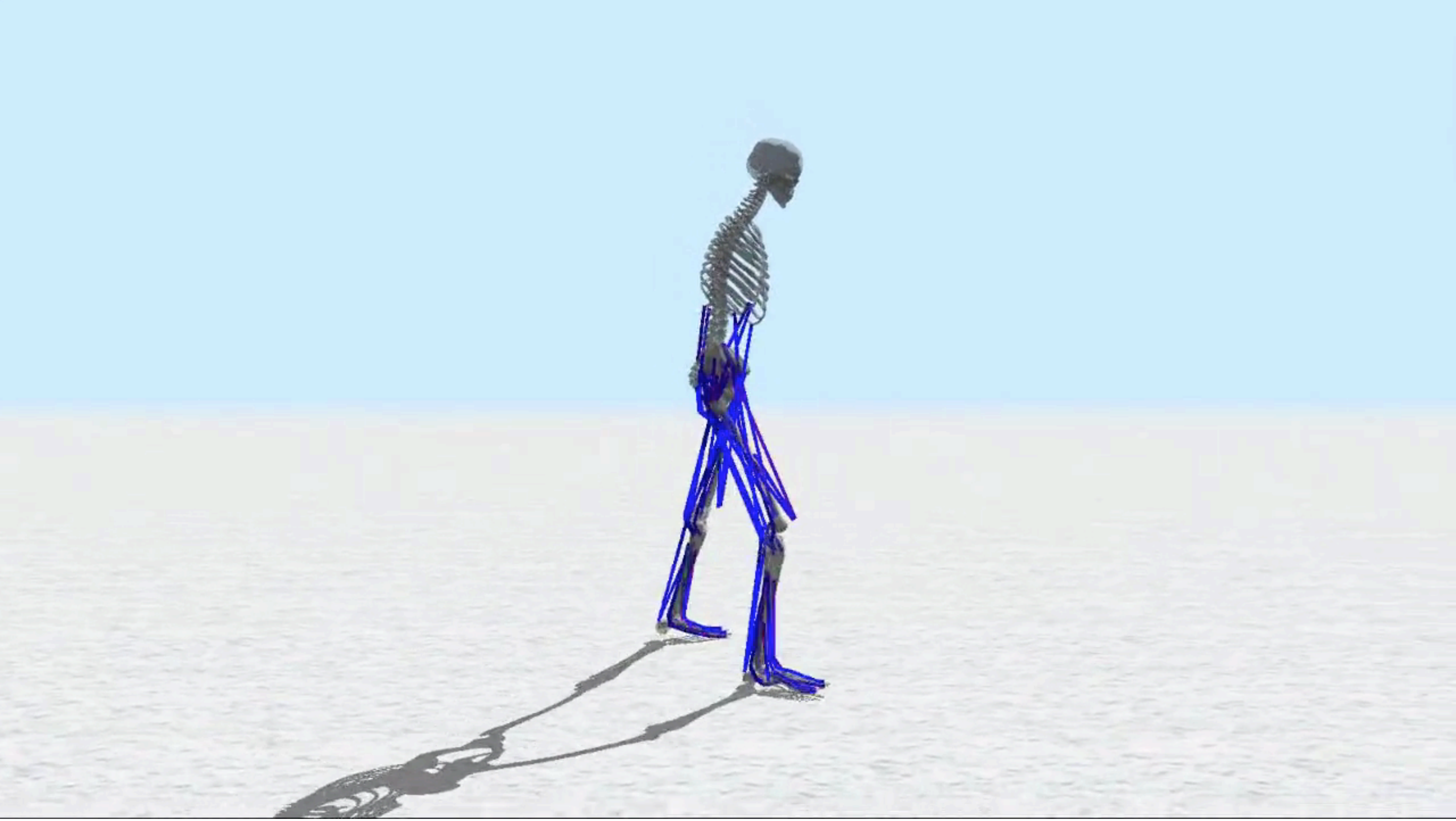
[SIGGRAPH Asia 2014] Lee et al, Many-Muscle Humanoids

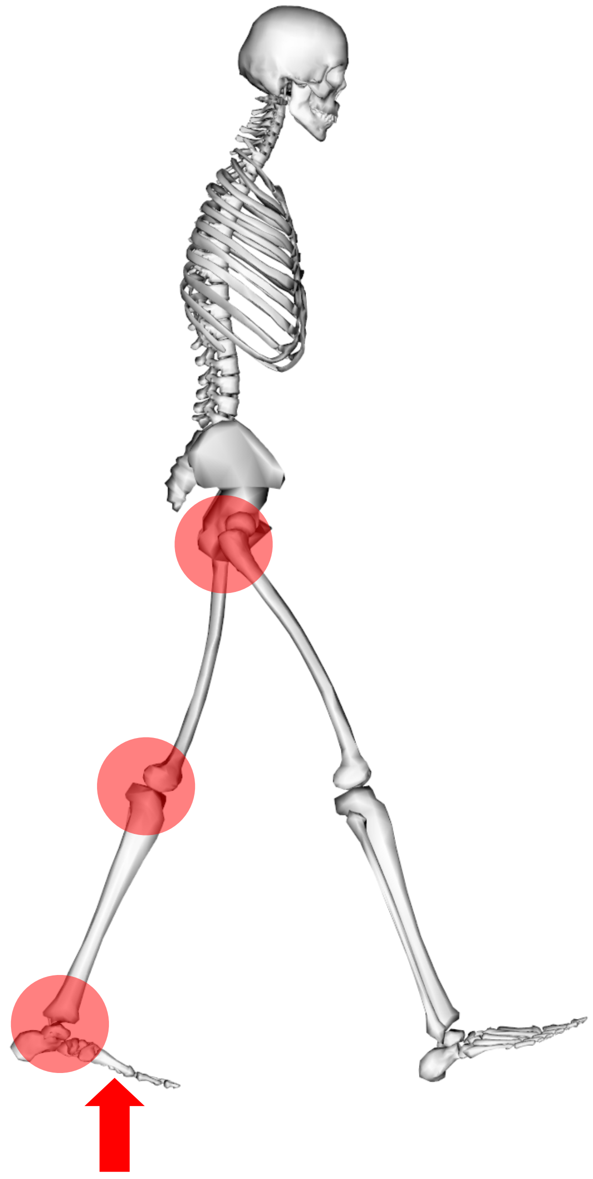


[SIGGRAPH Asia 2014] Lee et al, Many-Muscle Humanoids

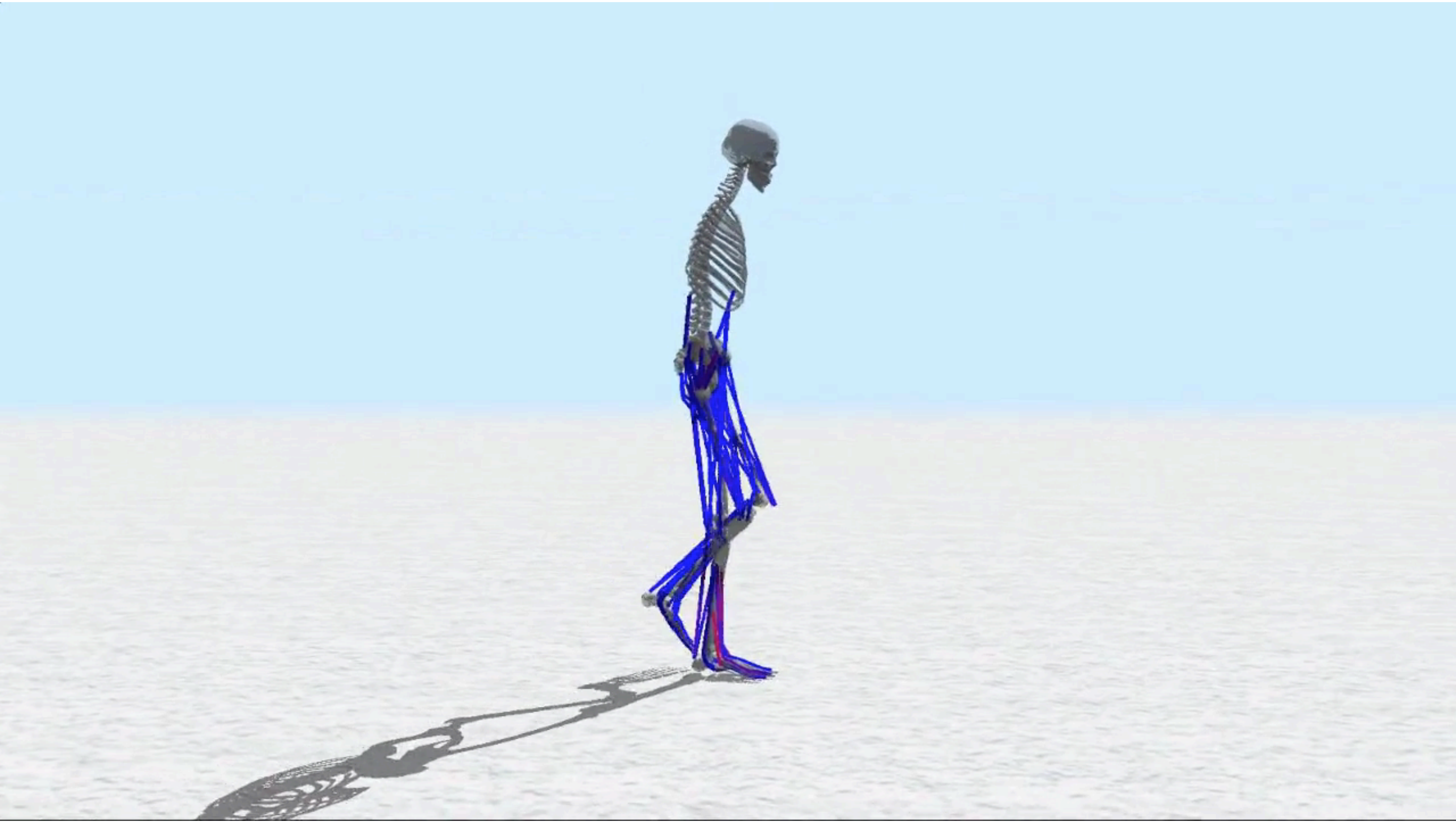


종아리 근육이 약화되면, ...

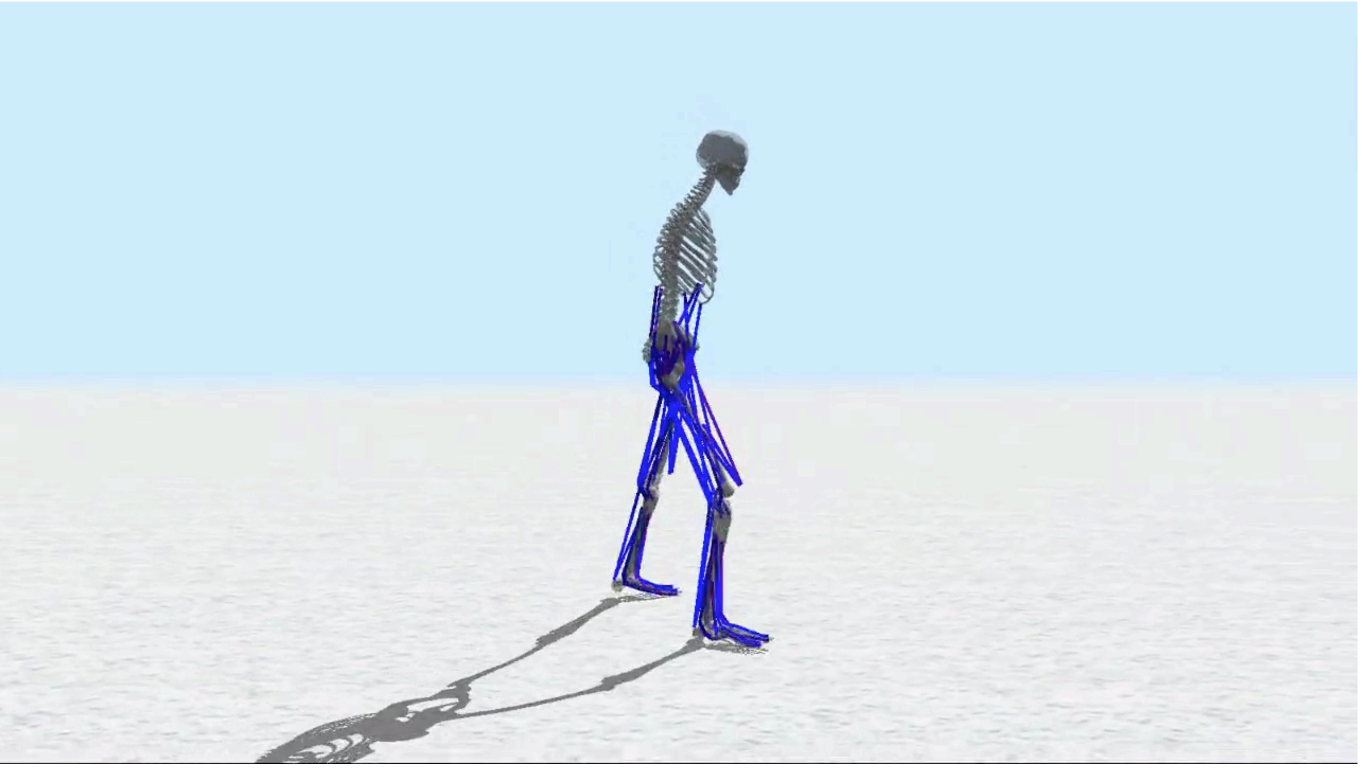




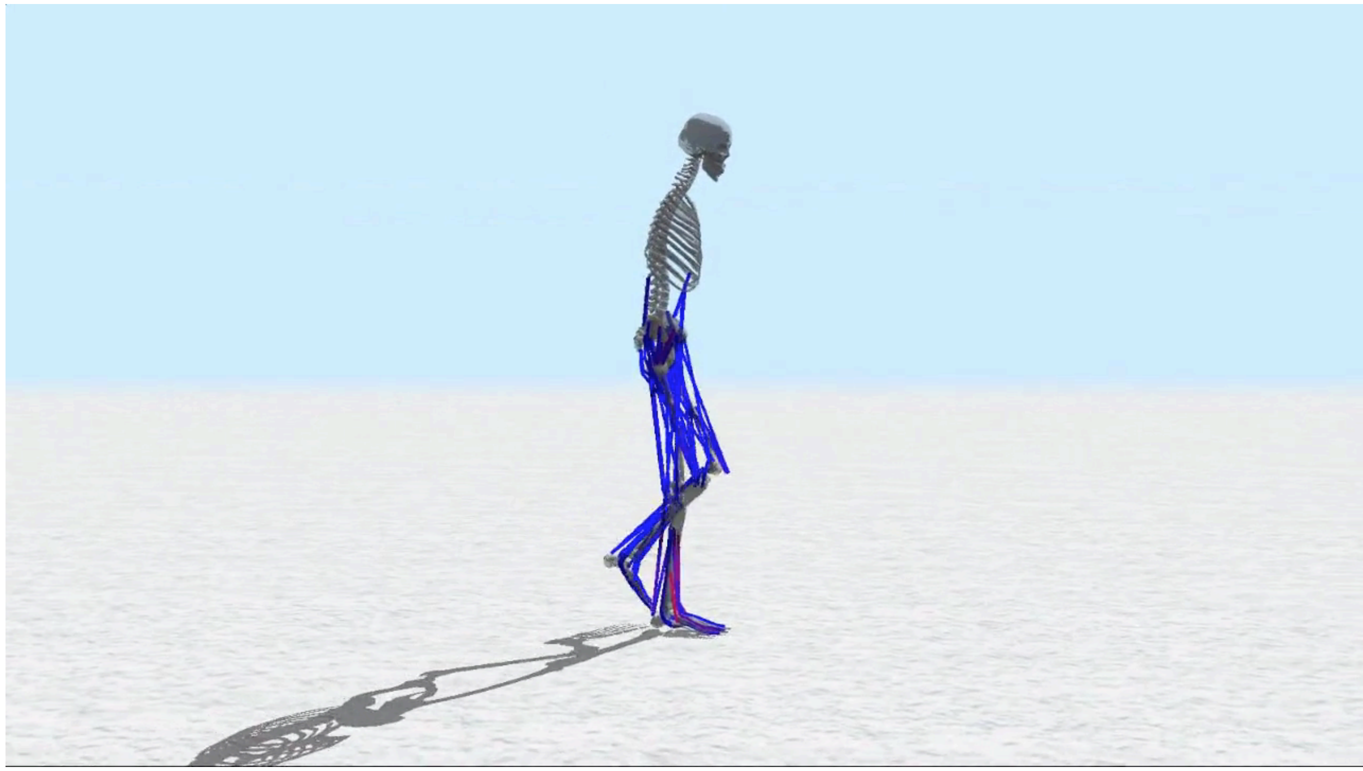
관절에 통증이 있으면, ...



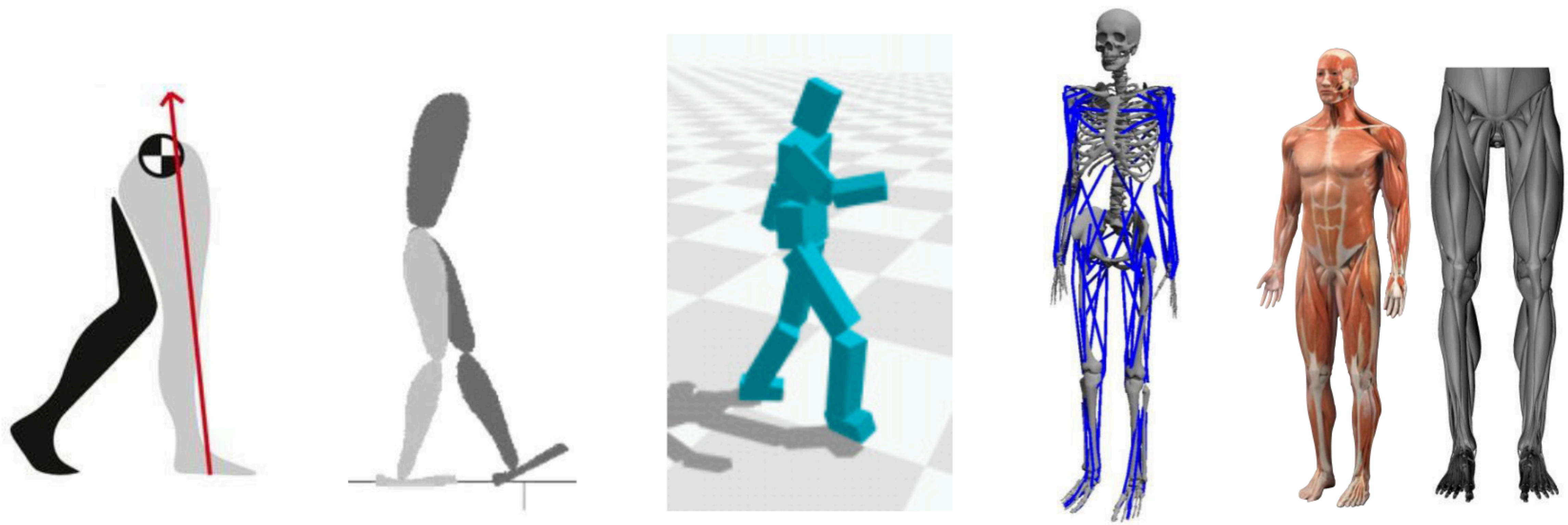
Painful Left Ankle Plantar Flexor



Painful Joints on Left Leg



보행 시뮬레이션을 위한 딥러닝



1980년대 – 2000년대	2007년	2010년	2014년	2017년 이후
단순화된 모델	Fullbody dynamics	Fullbody dynamics	근골격구조	근골격+피부
Inverted pendulum	Motor/torque control	Motor/torque control	선형 Hill type	Volumetric FEM
로봇의 걸음걸이	사람과 같은 걸음걸이	다양한 동작	생체역학적 동작	해부학적 정밀도
DOF < 5	DOF < 10	DOF < 100	DOF < 1000	DOF > 10000

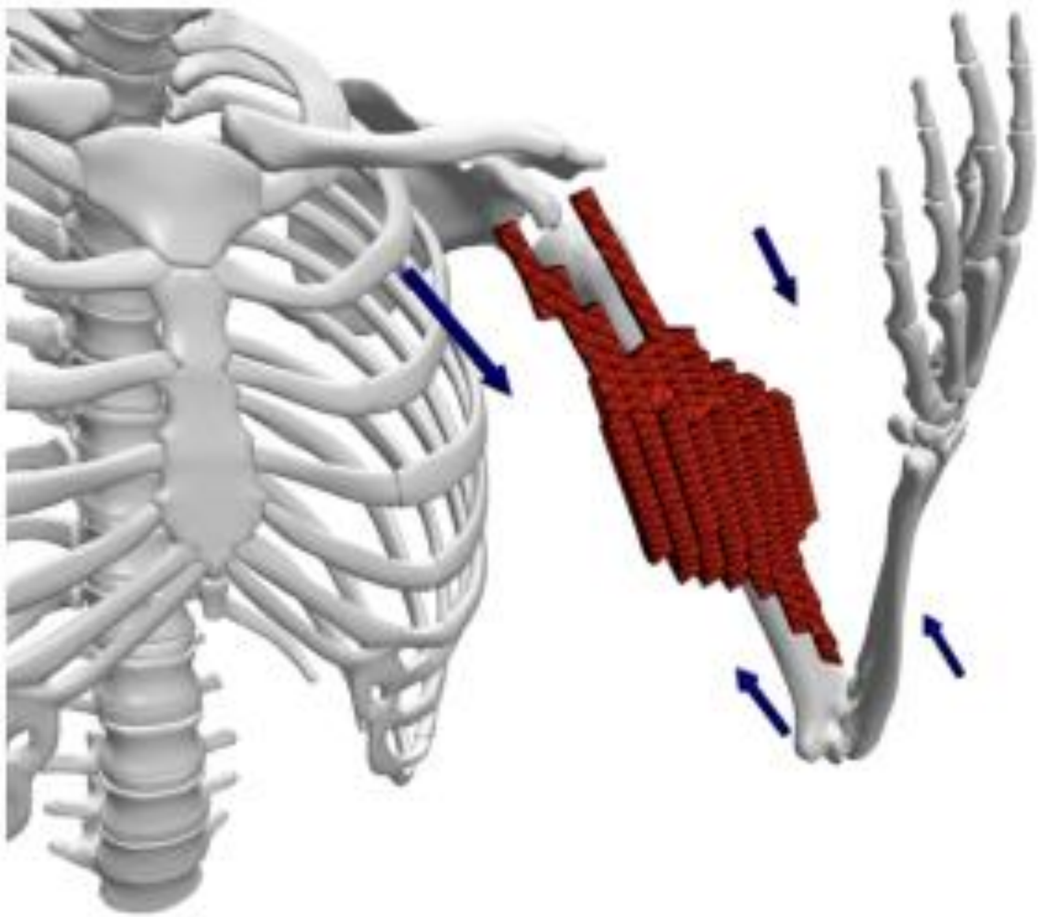
Closed-form solution

Feedback control, Optimization, Data-driven

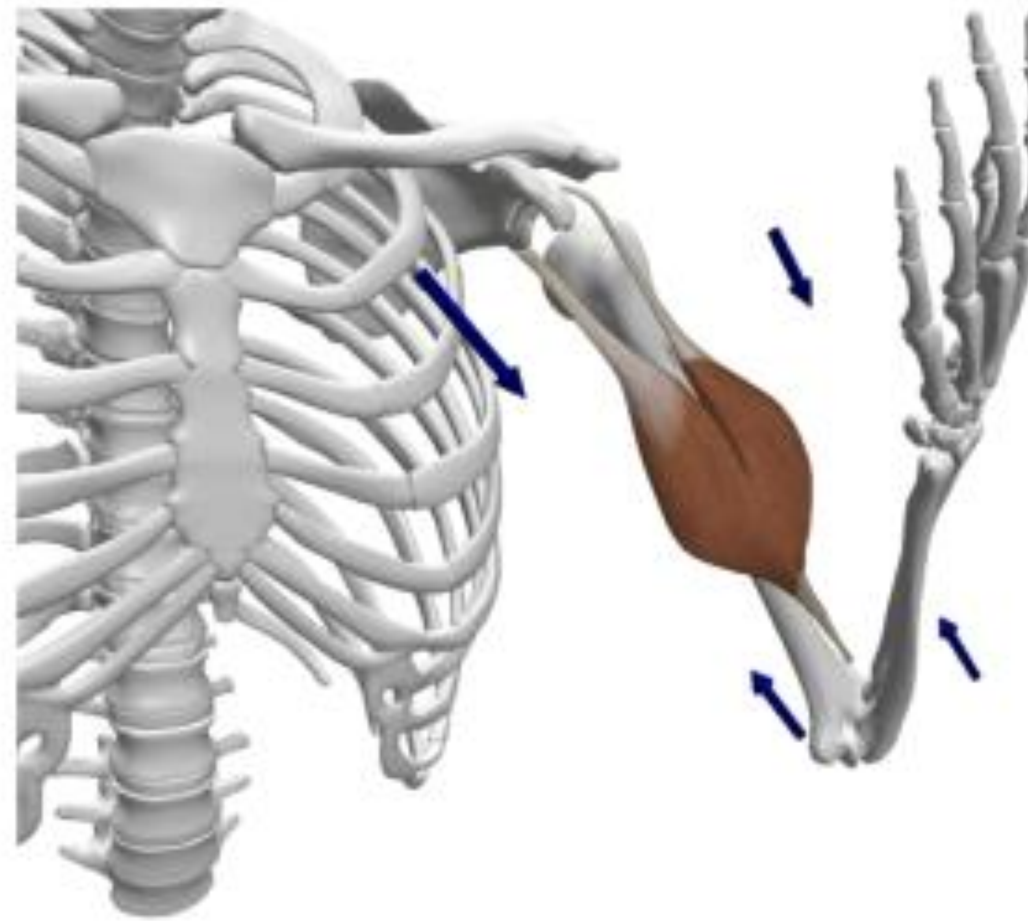
Direct policy learning
Local regression

Reinforcement learning
Deep neural network
End-to-end learning

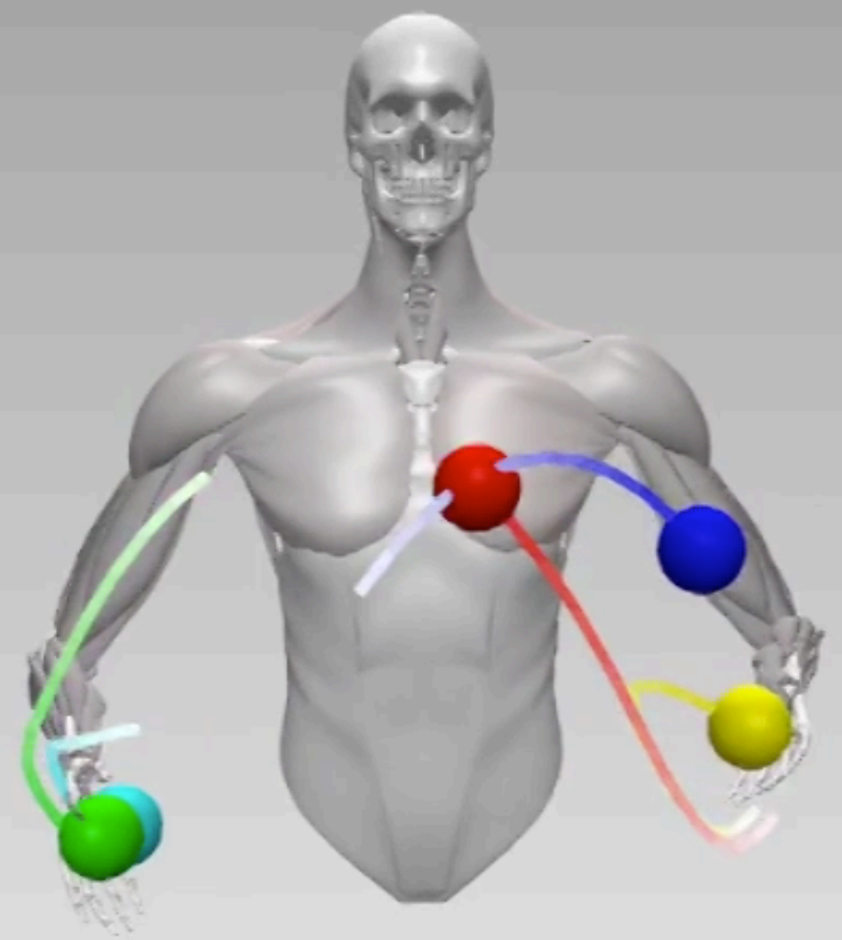
근골격신경 모델링

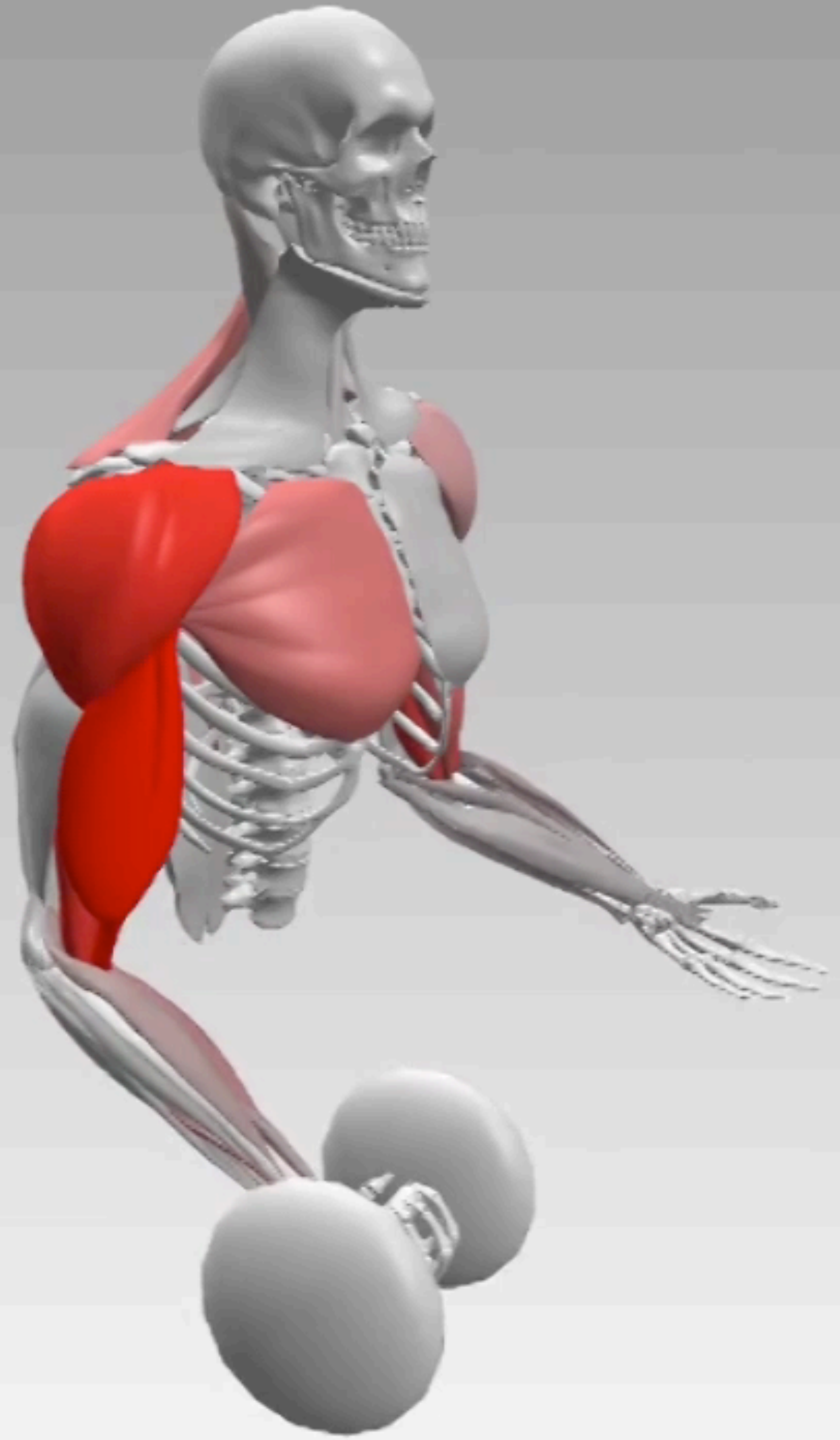


FEM simulation



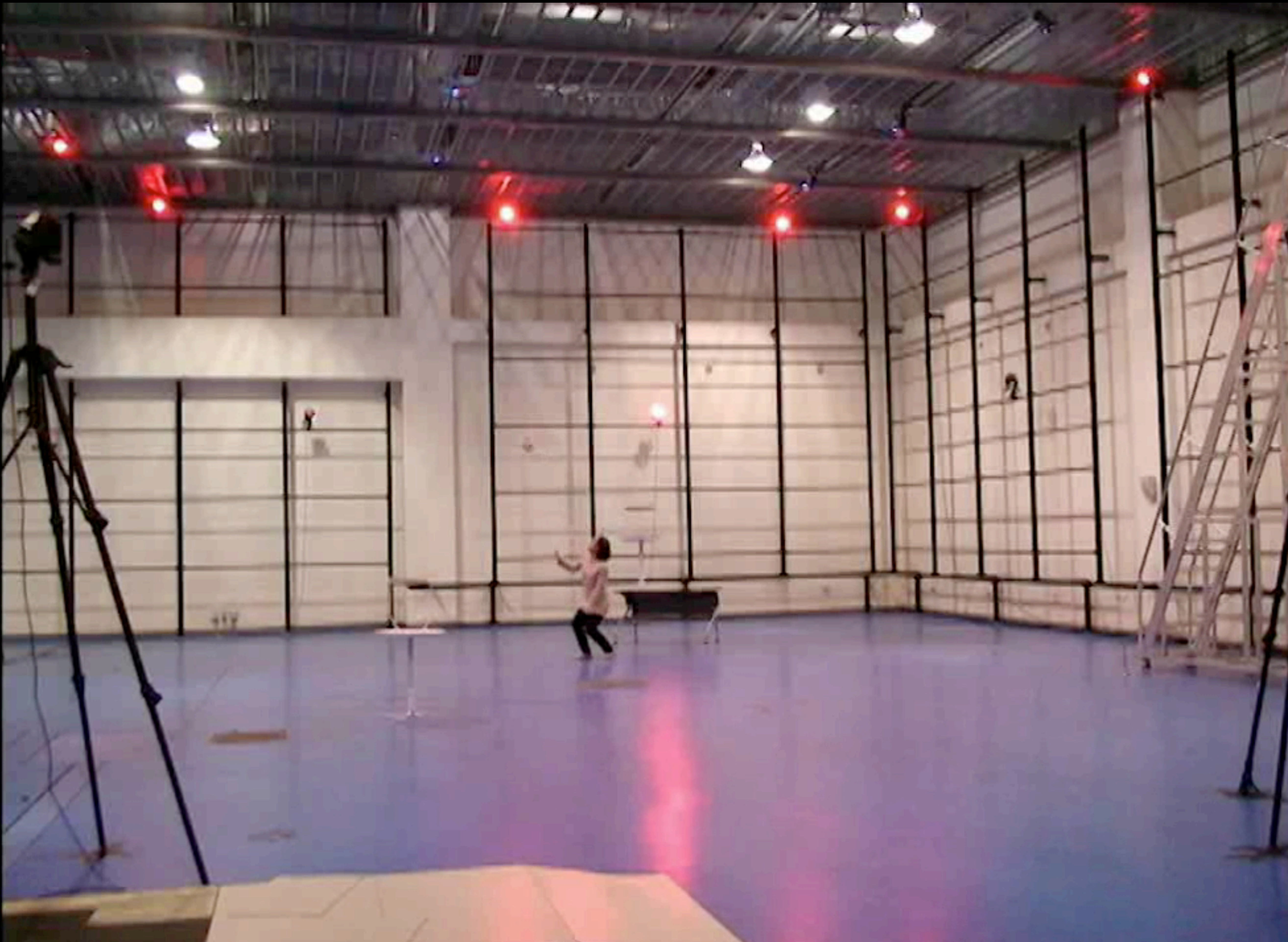
Muscle contraction

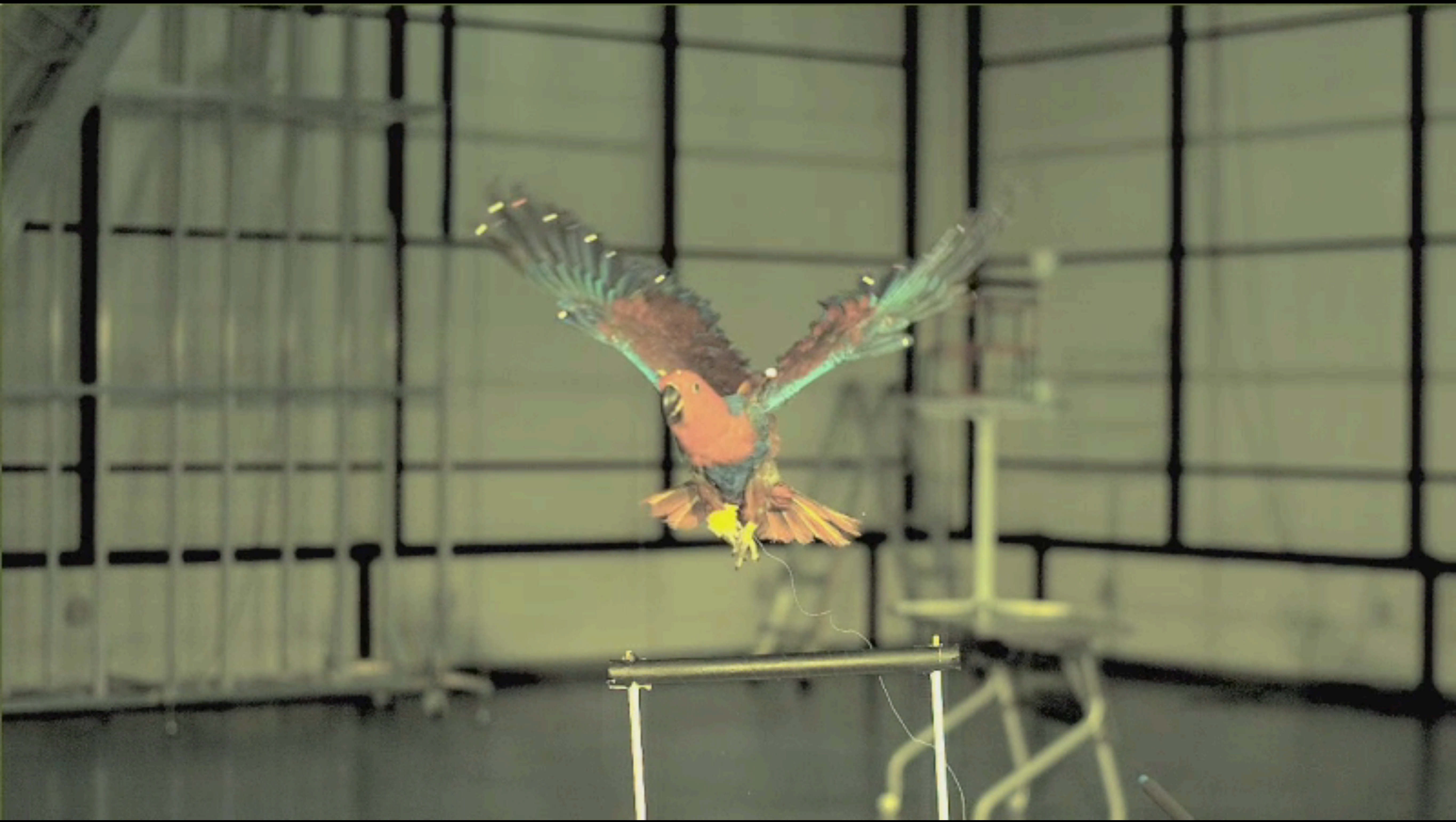


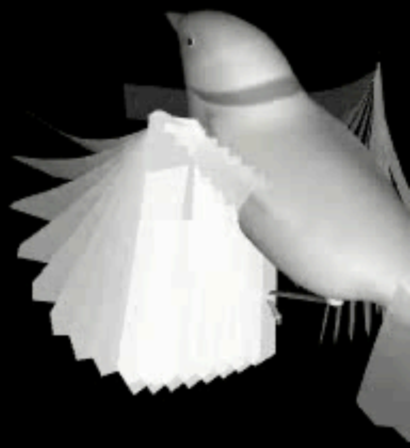


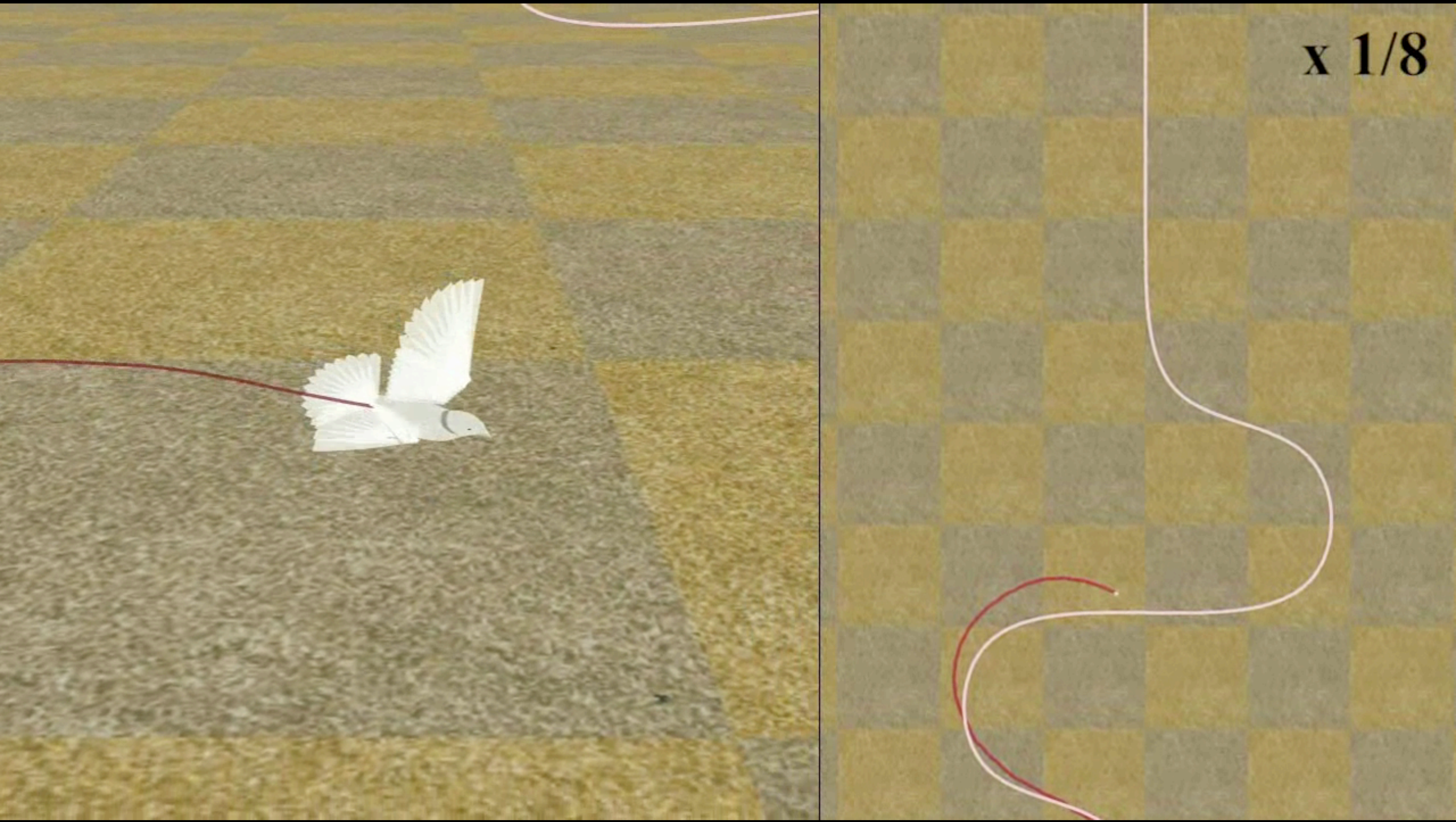
Data-driven Control of Flapping Flight

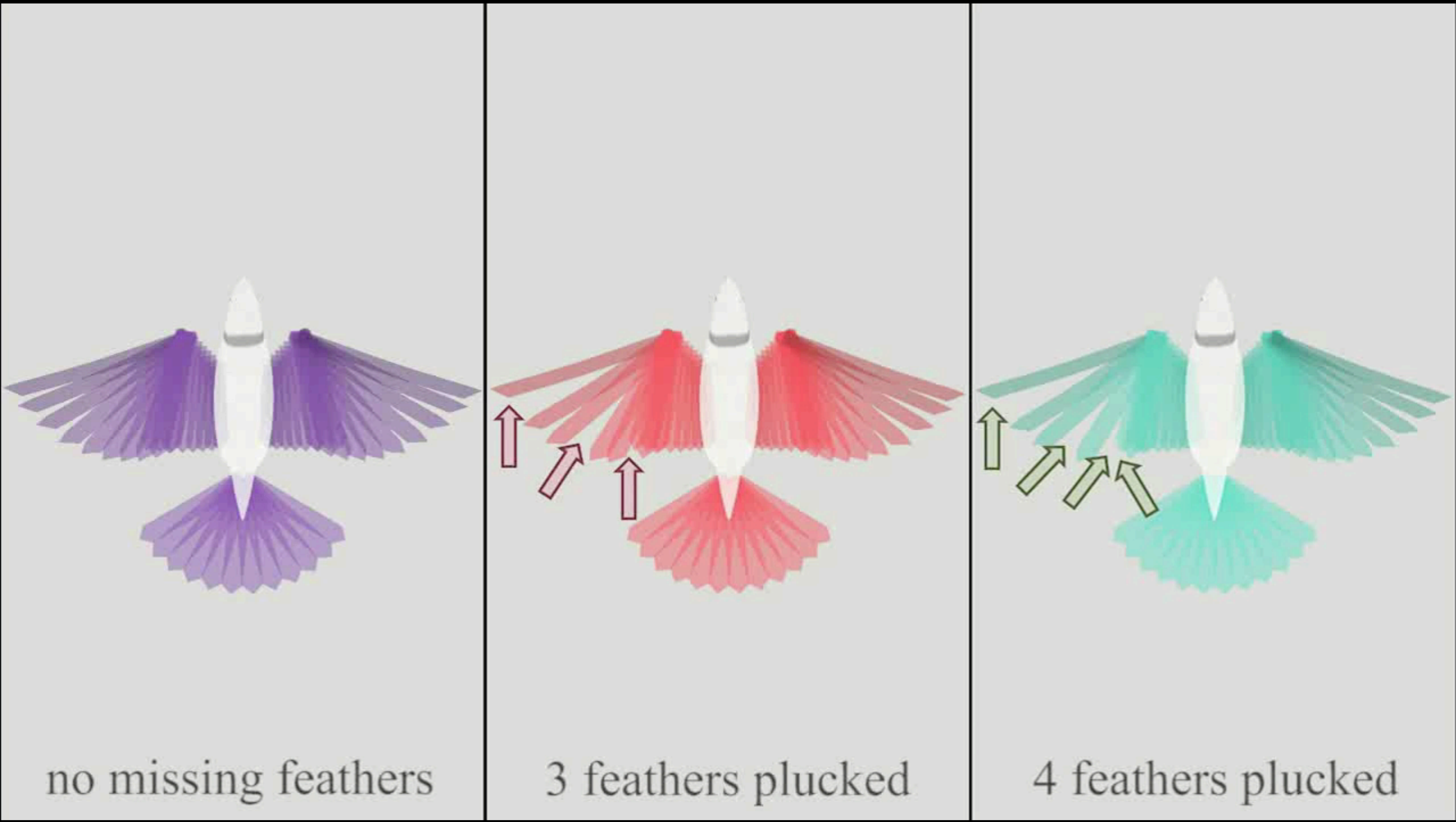
Collaboration with Eunjung Ju, Jungdam Won,
Byungkuk Choi, Junyong Noh, Min Gyu Choi
(ACM Transactions on Graphics 2013, presented at SIGGRAPH 2014)

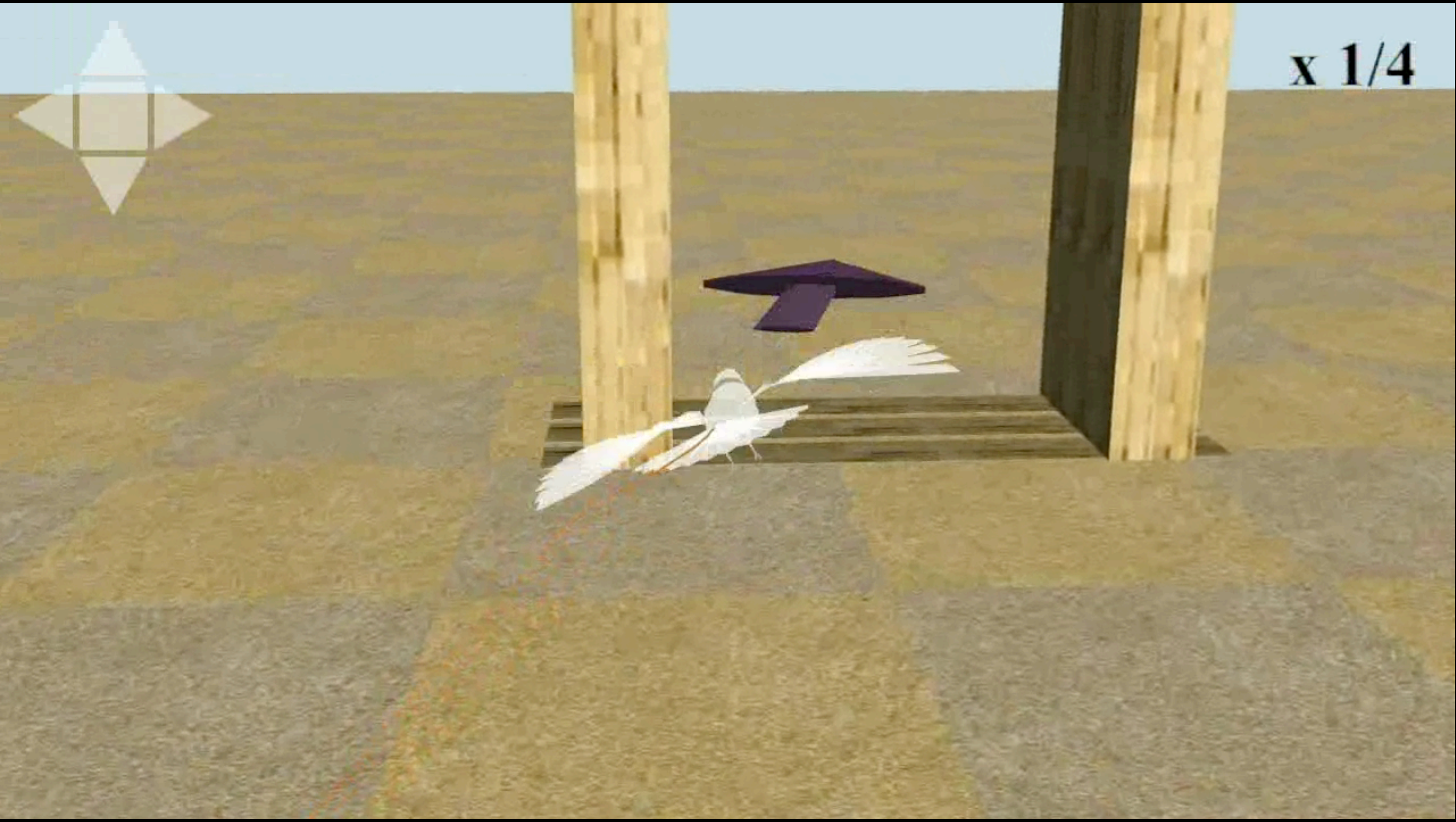




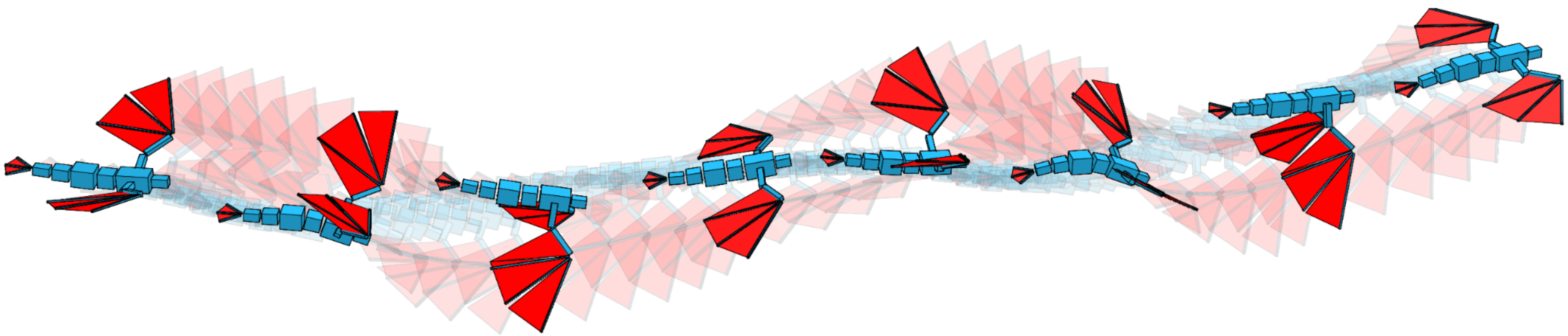



x 1/8


no missing feathers
3 feathers plucked
4 feathers plucked


x 1/4

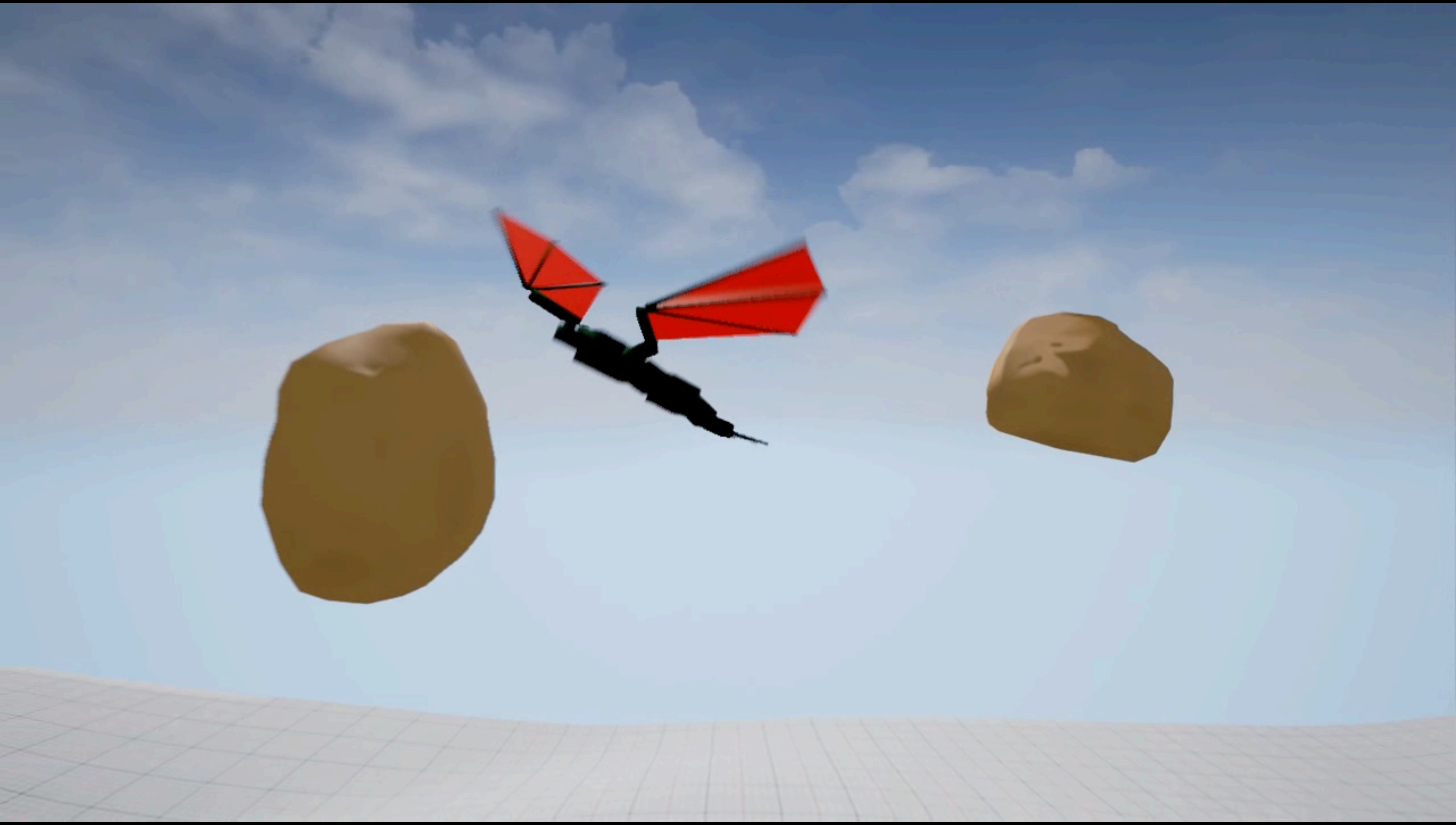
How To Train Your Dragon:
Example-Guided Control of Flapping Flight

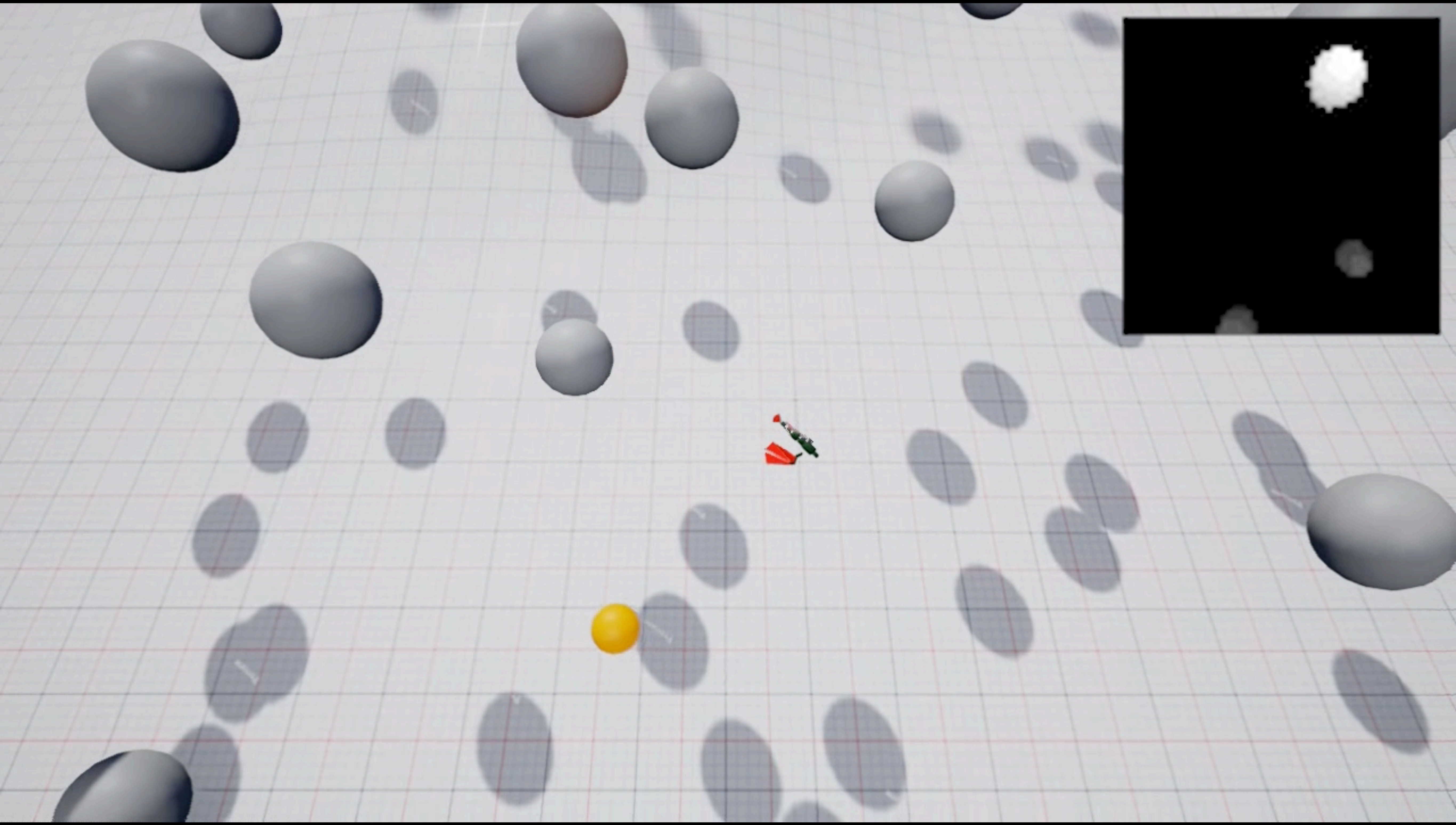


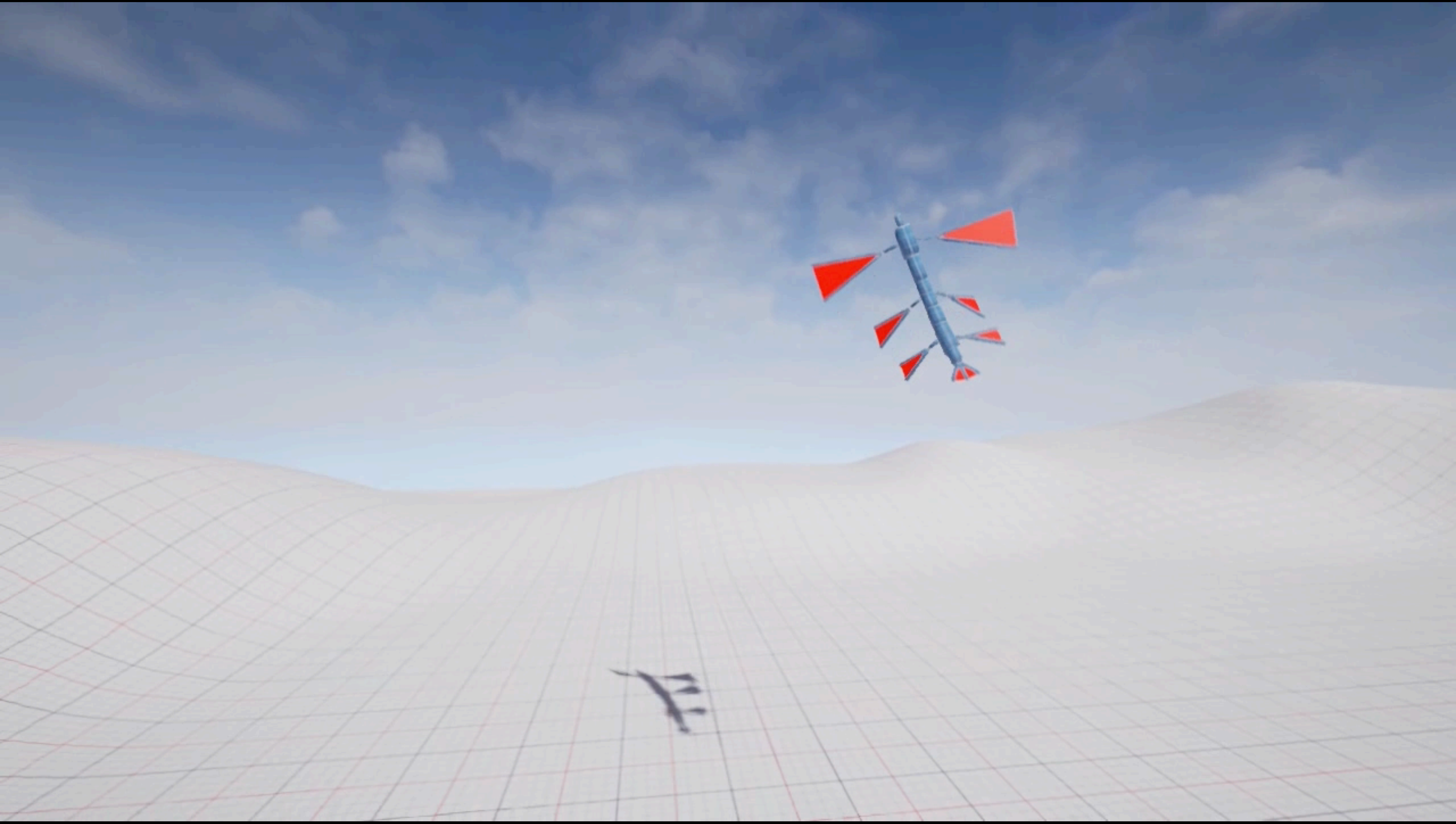
Jungdam Won   Jongho Park   Kwanyu Kim   Jehee Lee

Seoul National University

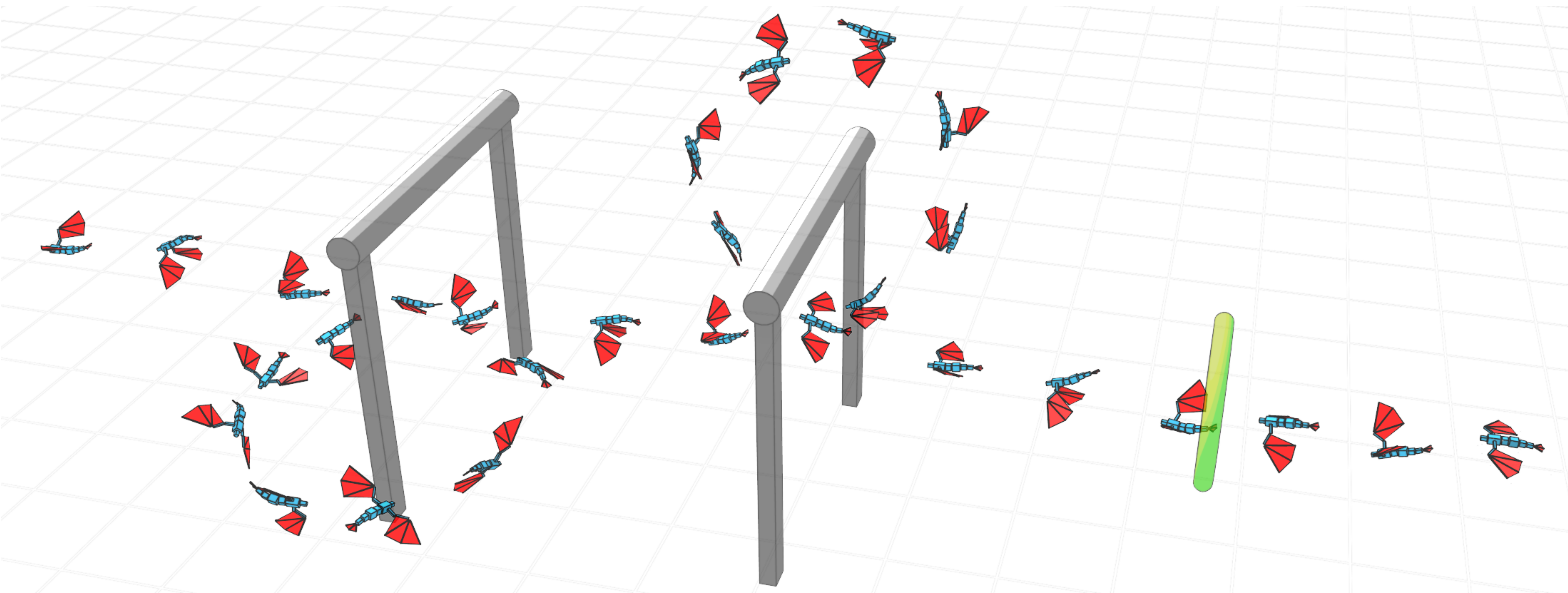
[SIGGRAPH Asia 2017]







Aerobatic Control of Flying Creatures via Self-Regulated Learning



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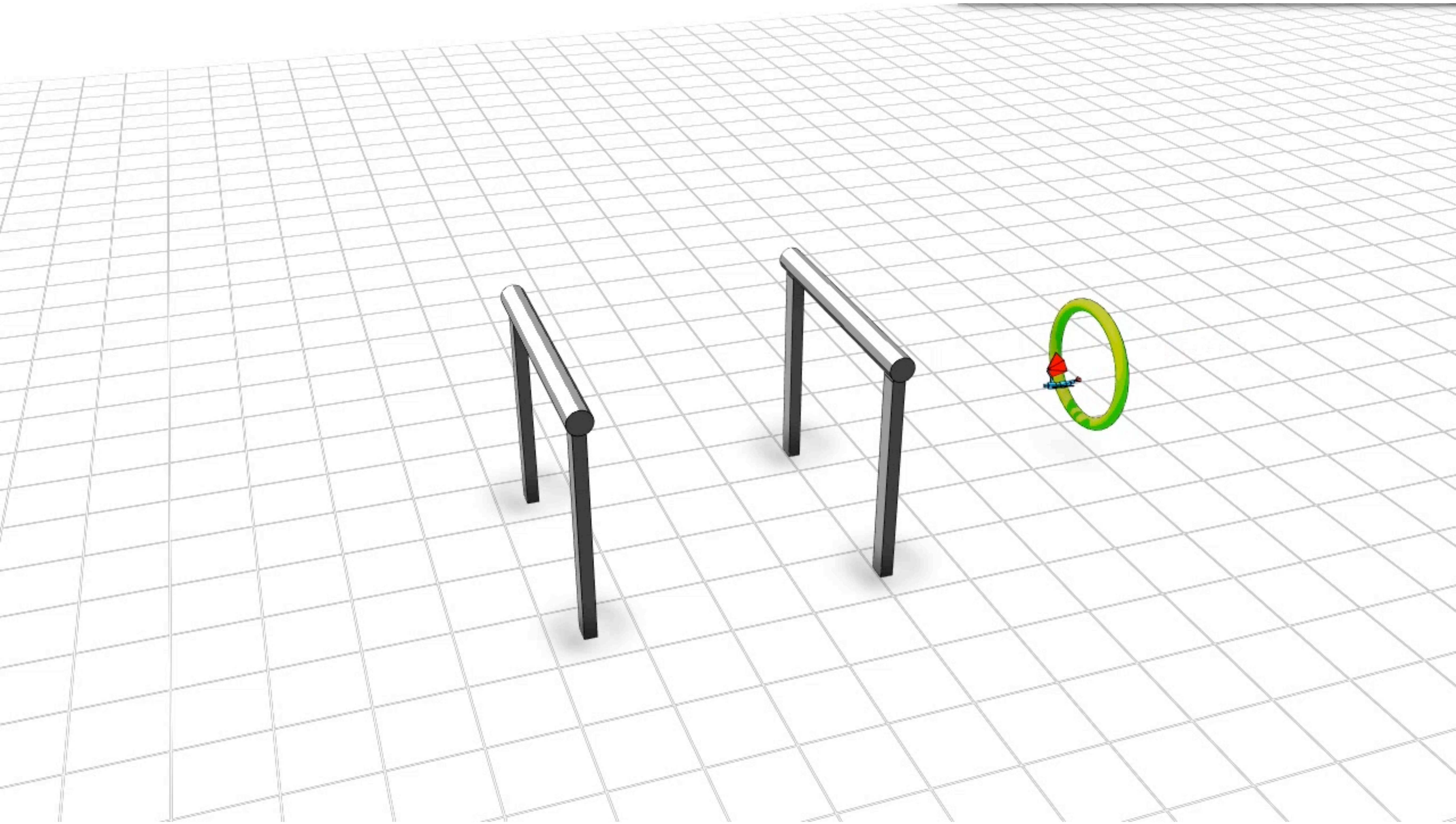
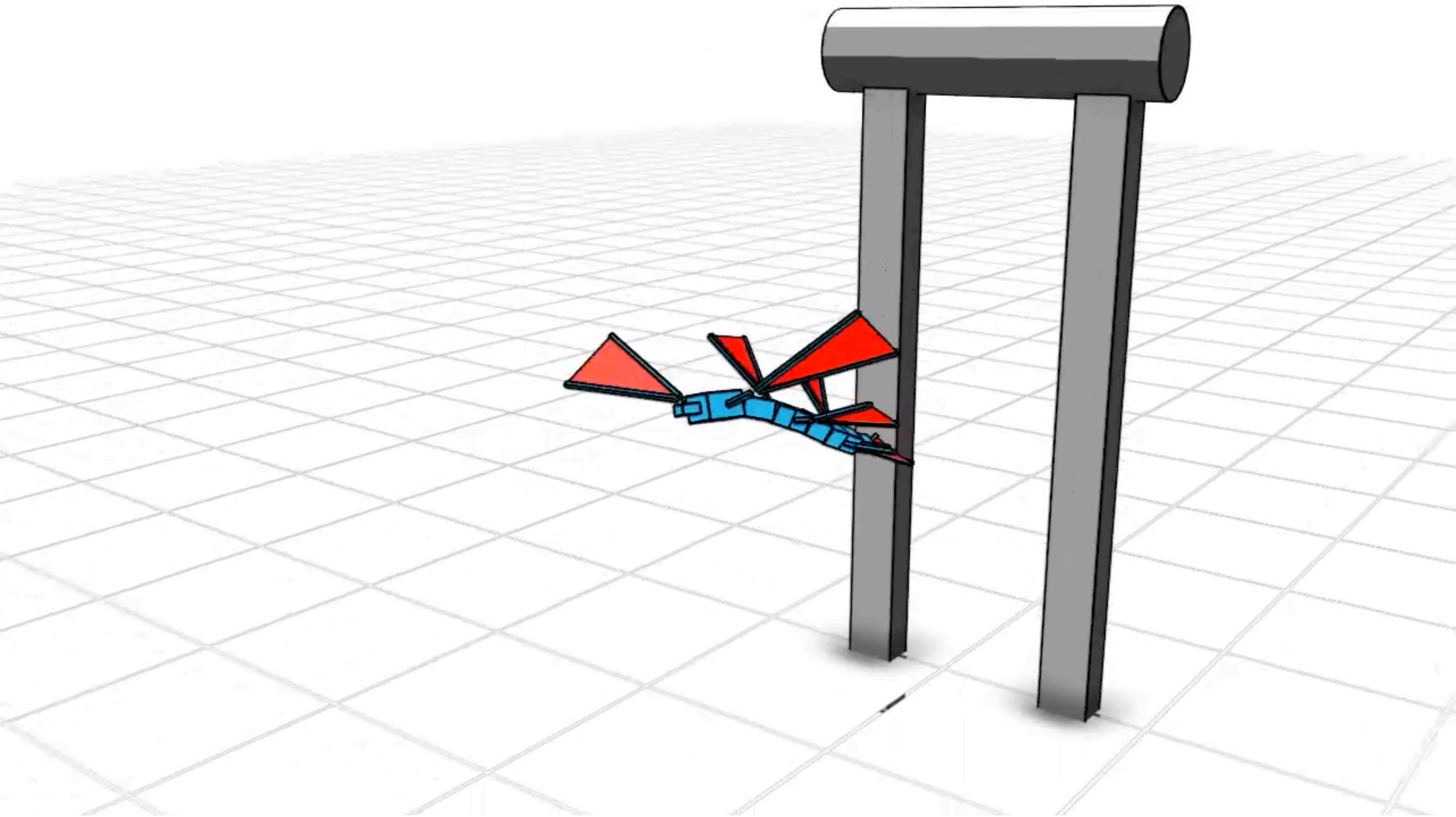
[SIGGRAPH Asia 2018]





The papers and videos are available at

SNU Movement Research Lab at http://mrl.snu.ac.kr

Collaborators

Jungdam Won, Kyungho Lee, Seunghwan Lee, Ri Yu, Jungnam Park, Seyoung Lee, Yoonsang Lee, Munseok Park, Jongho Park, Kwanyu Kim, Eunjung Ju, Manmyung Kim, Kwangwon Sok, and many others