Learning Speed-Adaptive Walking Agent Using Imitation Learning with Physics-Informed Simulation

Yi-Hung Chiu*[1], Ung Hee Lee*[2], Changseob Song[1], Manaen Hu[1], and Inseung Kang[1] *Member, IEEE*

* Equally contributed

[1] The Department of Mechanical Engineering, Carnegie Mellon University, Pittsburgh PA 15213, USA

[2] The Department of Mechanical Engineering and the Department of Robotics, University of Michigan, Ann Arbor, MI 48109 USA.

MetaMobility

Introduction

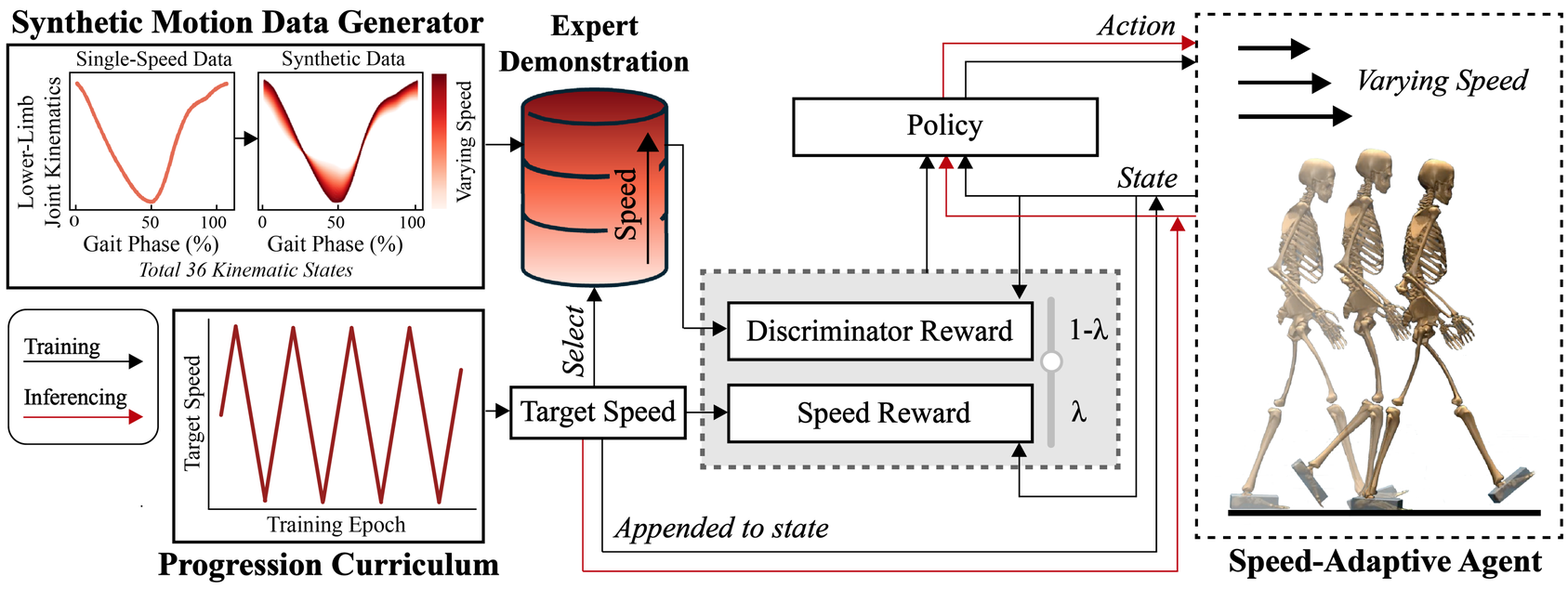
- Millions face mobility challenges affecting health and daily life.
- Digital twins offer an efficient way to simulate human gait for research and rehab.
- Challenges remain in sim-to-real transfer and adaptability to diverse walking speeds

Objective: Develop a skeletal humanoid agent that adapts to various walking speeds with biomechanically realistic motion

Method

Simulation Environment

- LocoMuJoCo used for high-DOF skeletal modeling & ML integration.
- Adult-sized skeletal model with direct joint torque control.

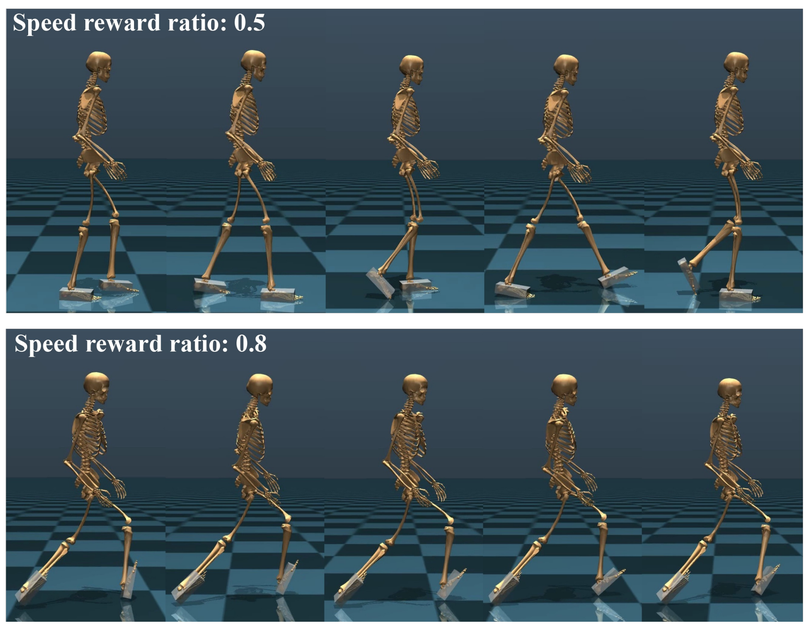


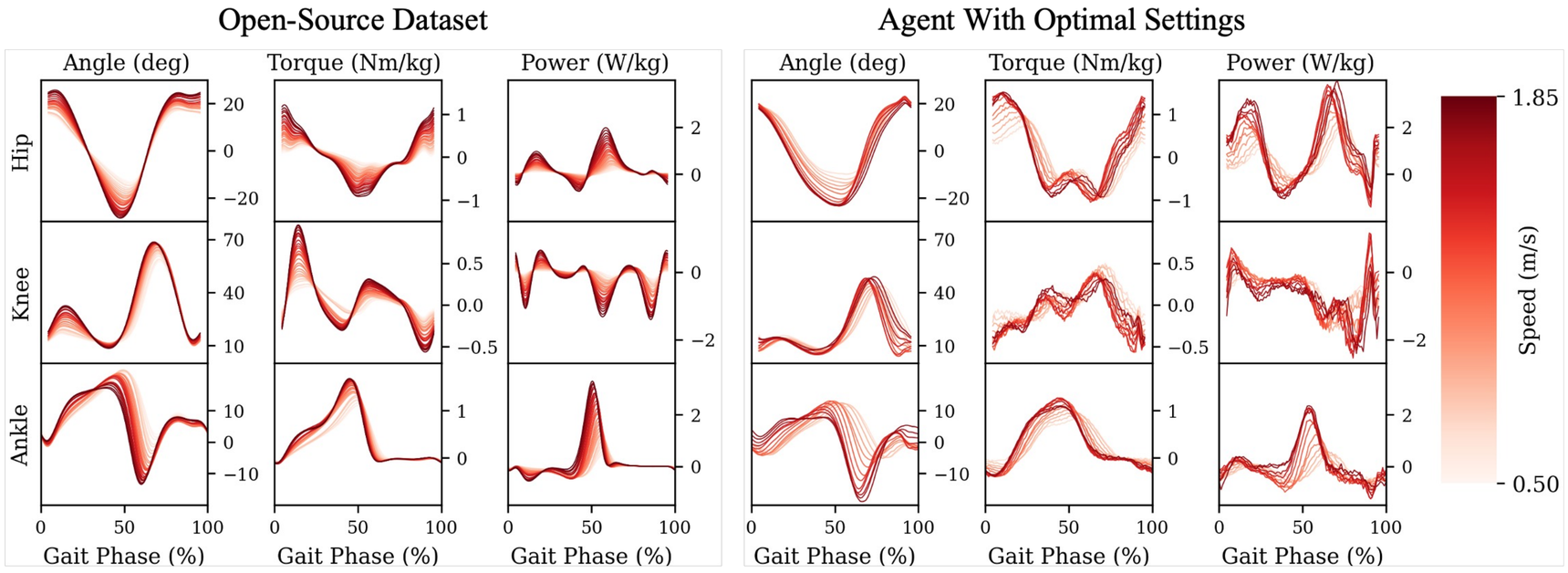
Imitation Learning Framework

- Synthetic Motion Generator: Derived from open-source biomechanics data (22 subjects). Linear model fits gait data across walking speeds (0.5–1.85 m/s).
- Variational Adversarial Imitation Learning using discriminator reward & speed reward
- Used Trust Region Policy Optimization & Curriculum Learning

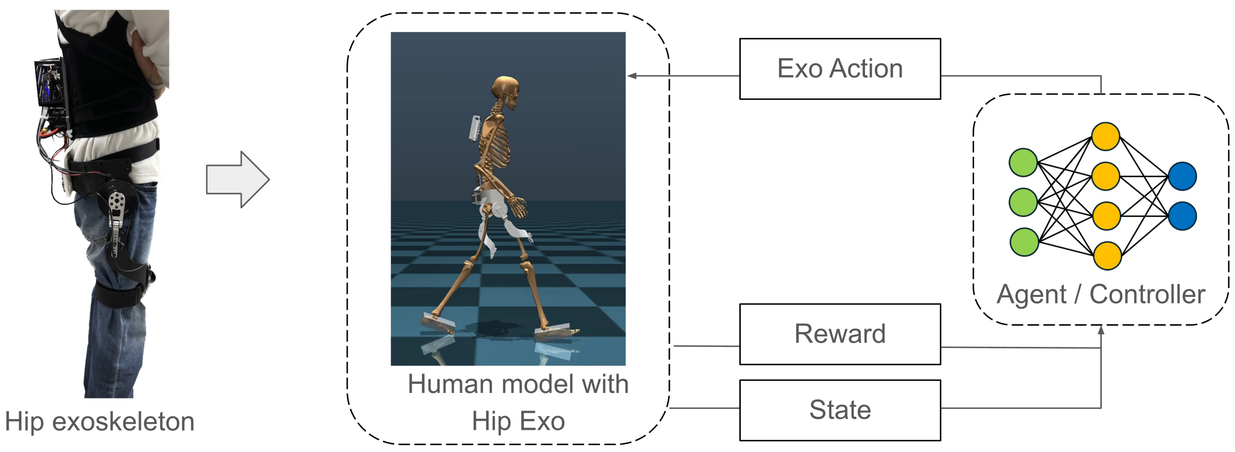
Results

- Able to train a policy resulted in biomechanically plausible speed-adaptive gait.





Discussion & Future work



- Apply framework to real-world exoskeletons.
- Extend to more complex tasks: stairs, sit-to-stand.

Code & Paper

PROJECT WEBPAGE

Paper

CODE

References

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Contact: unghee@umich.edu, inseung@cmu.edu

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