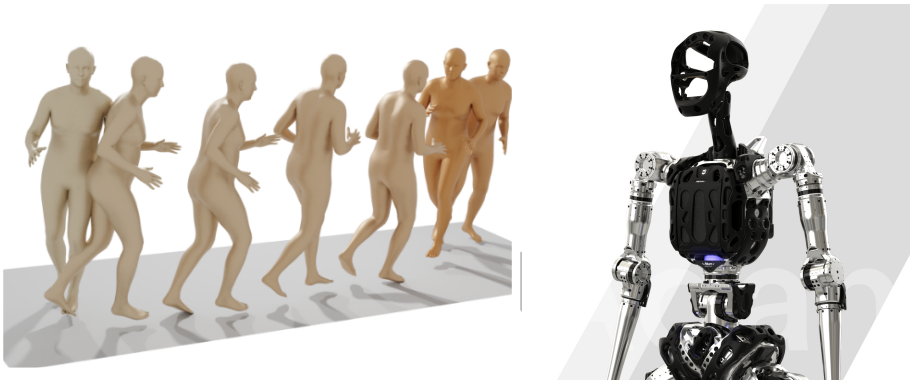
ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

CRL
Computational
Robotics Lab

Master Thesis

Motion Imitation and Control for Humanoid Robot using Diffusion



Introduction

To achieve effective and natural interaction, humanoid robots may need to closely imitate human motion, which encompasses walking, object manipulation, and environmental interactions. Motion capture data [1], which captures human motion with high precision, serves as an excellent resource for training robotic systems to replicate human movements. Diffusion models [2] are a class of generative models designed to handle multi-modal distributions, making them highly suitable for complex motion generation tasks. Recent state-of-the-art methods use diffusion to produce human like motions for character animation [3] or to imitate human expert data for controlling robotic arms [4].

The goal of this project is to explore diffusion approaches for imitating motion data from humans to obtain control policies for humanoid robots.

Task Description

The student will:

- Conduct a thorough literature review. Particularly, study prior work on RL, motion imitation, Diffusion [5, 3, 4].
- Leverage physics-based simulators such as Isaac Gym[6] for training.
- Use motion capture data as reference for imitation.
- Possibly deploy trained policies on humanoid hardware platforms.
- Write a report and give an oral presentation at the end of the project.

Skills

- Very good programming skills in Python, and familiarity with Pytorch.
- Experience in Machine Learning and RL.
- Experience with physics-engines or motion capture data is plus.
- Willingness to work on cutting edge methods and algorithms.

Remarks

This thesis is overseen by Prof. Dr. Stelian Coros.

Contact

For further information or application for the thesis project, please contact Fatemeh Zargarbashi (fatemeh.zargarbashi@inf.ethz.ch) and submit a copy of your CV and your transcripts.

References

[1] C. M. University, "Cmu graphics lab motion capture database." http://mocap.cs.cmu.edu/.

[2] J. Ho, A. Jain, and P. Abbeel, "Denoising diffusion probabilistic models," *Advances in neural information processing systems*, vol. 33, pp. 6840–6851, 2020.

[3] G. Tevet, S. Raab, B. Gordon, Y. Shafir, D. Cohen-or, and A. H. Bermano, "Human motion diffusion model," in *The Eleventh International Conference on Learning Representations*, 2023.

[4] C. Chi, Z. Xu, S. Feng, E. Cousineau, Y. Du, B. Burchfiel, R. Tedrake, and S. Song, "Diffusion policy: Visuomotor policy learning via action diffusion," *The International Journal of Robotics Research*, p. 02783649241273668, 2023.

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[6] V. Makoviychuk, L. Wawrzyniak, Y. Guo, M. Lu, K. Storey, M. Macklin, D. Hoeller, N. Rudin, A. Allshire, A. Handa, *et al.*, "Isaac gym: High performance gpu-based physics simulation for robot learning," *arXiv preprint arXiv:2108.10470*, 2021.