ShapeVerse: Physics-based Characters with Varied Body Shapes

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PROBLEM

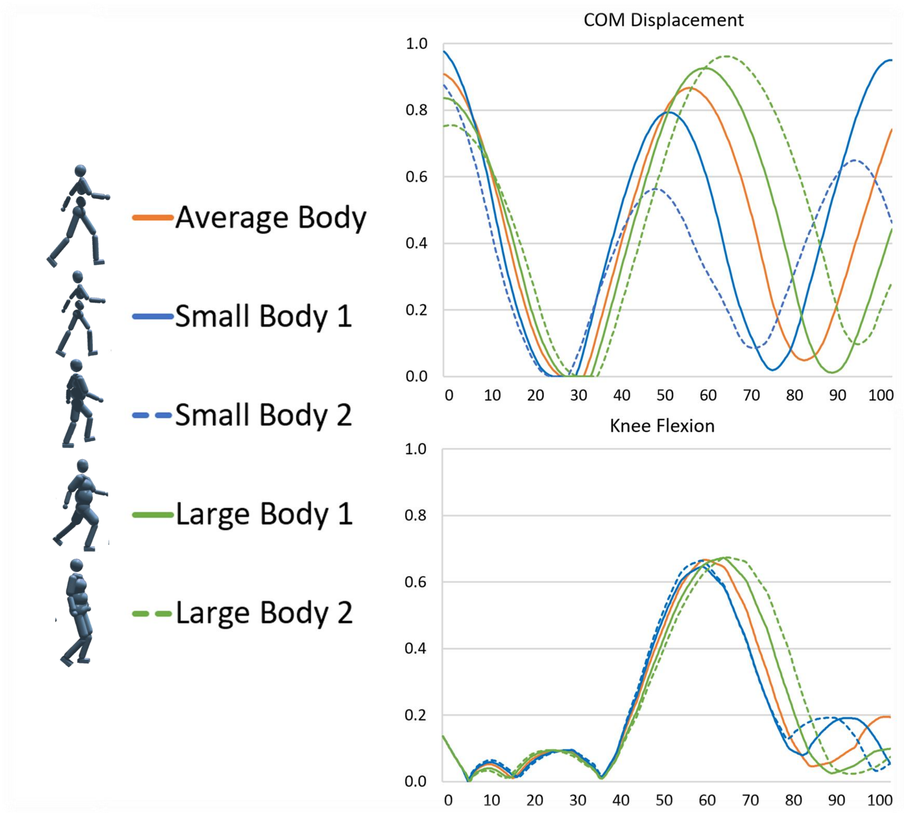
- Physics-based characters are not widely used although they create more **responsive and realistic motions.**
- Existing methods often lack diversity and do not account for the **effects of individual body shape parameters and mass** on character motion.
- **Redundant motion capture** of multiple actors of different body shape.

SUMMARY

- This work proposed a **deep reinforcement learning (DRL) based framework** to generate physics-based characters with varying body shapes.
- During the **training process**, the characters were trained to **imitate the reference motion** based on their specific body shape parameters.
- The proposed approach enabled the generation of a diverse range of animations.

RESULTS

- **Evaluation:**
  - Extracted beta parameters (β) using MoSH from a motion capture data. [5]
  - Compared the biological parameters from generated character motions with real human motion data.[6] [7]
  - The trained policy output a **distinct trajectory of the pelvis** for each character.
  - **Knee flexion** values suggested that additional mass in characters can **generate lower leg motion diversity**

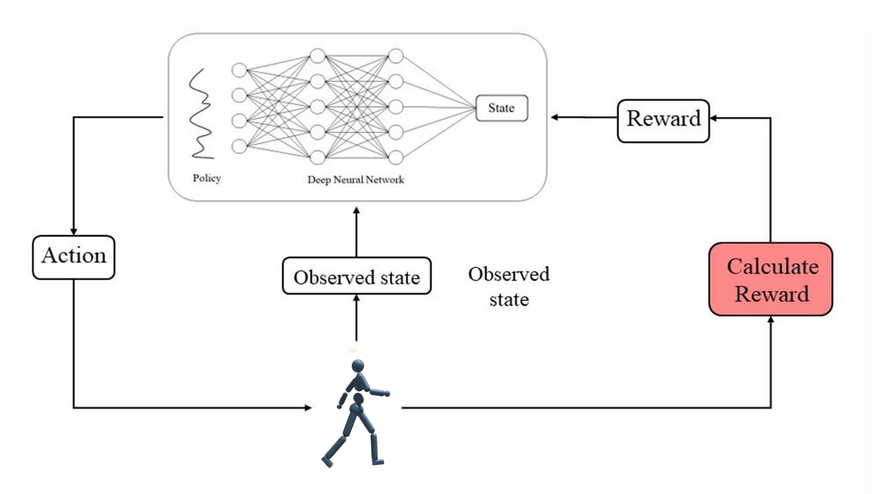


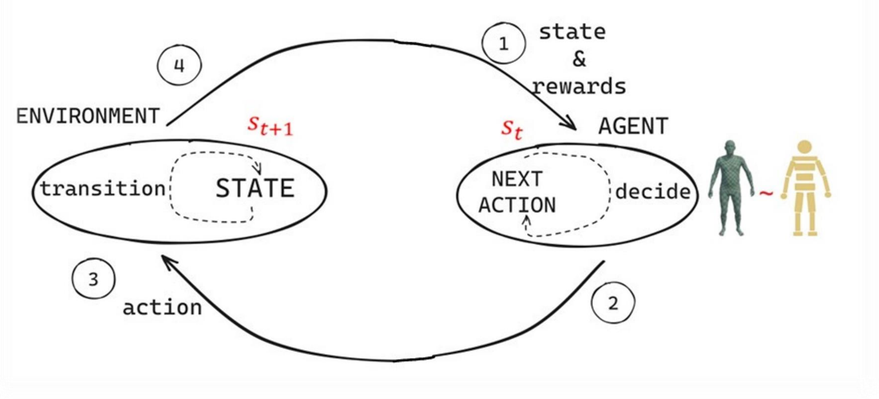
METHODOLOGY

- Proximal Policy Optimization (PPO) [1] was employed, a popular DRL algorithm.

- In **each training episode**,
  - Character was generated using the **SMPL body**[2] approximation.
  - Custom reward was calculated for each new character.

- **Reward System:**
  - The total reward was a combination of the imitation (Ri)[3] and Energy rewards (Re)[4].
  - **Total Reward** = $(1-\theta)$ Ri + (θ) Re
    $0 \leq \theta < 1$ (dependent on body parameters)





CONCLUSION

- Our work demonstrate the potential of imitation learning for human motion synthesis and the **role of body shape parameters** in generating **motion styles and patterns.**

- We show that certain parameters, especially **mass, play a crucial role in human movement**, and many variations in motion can be generated.

- In future work - the addition of physiological factors, such as **the center of mass of limbs**, can enhance the design of the reward system.

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