

GUANGDONG AND HONG KONG UNIVERSITIES

“1+1+1” Joint Research Collaboration Scheme

粵港高校「1+1+1」聯合資助計劃



Towards Vision-based Markerless Tracking and Force Analysis of Weightlifting-specific Technical Movements



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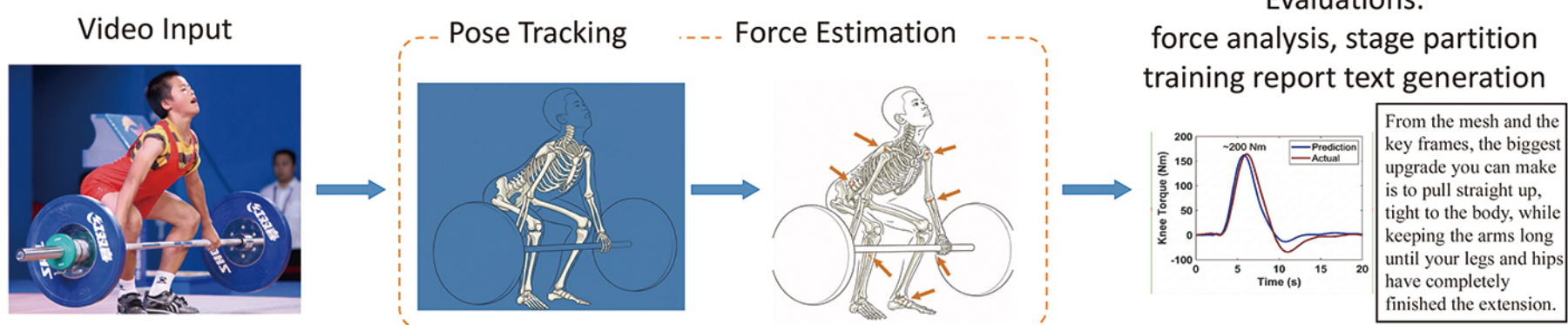
Background and Motivation

- Training objective: Long-term high-quality training for weightlifting skills for Olympic-level success
- Limitations of traditional training scheme: Subjective, delayed feedback, lack of detail
- Current marker-based motion tracking systems: expensive and non-popular
- Next generation visual based system: accurate and real-time force analysis with AI generate text guidance



Marker-based motion tracking system

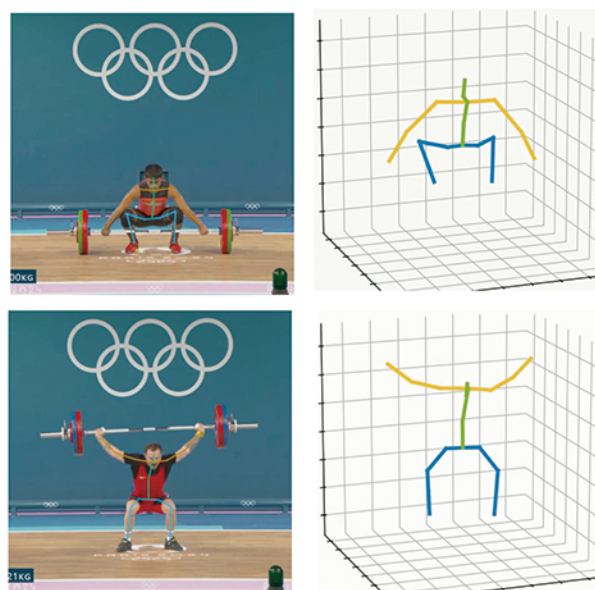
System Overview



Dataset Construction

Weightlifting Action Dataset

- 388 movement video clips
- Across different levels of competition
- Across different weight class and lifting ways
- Processed with **3D human pose tracking** annotation and weightlifting results
 - Midpoint of hands as the barbell trajectory
- Used for statistics of success/failed lifting and further guidance analysis



Analysis Method

Weightlifting Stage Partitioning

- Barbell trajectory analysis based on velocity and position

Text Guidance Generation

- Plan to collect corpus of coaching text from professional training record/textbooks
- Finetuning a VLM for AI based coaching text generation

Stages definitions

1. Start Stage: first frame where speed exceeds 10% of max speed
2. Peak Vertical Velocity: max upward vertical velocity
3. Max Height: max vertical position
4. Catch Position: first turning point after 3

[1] Action-HSMR: Sequence-based 3D Human Pose and Mesh Estimation with Temporal Consistency, ICASSP 2026.
 [2] STAR-Flow: Unified Spatio-Temporal Adaptive Residual Learning for Human Motion Reconstruction, ICME 2026.
 [3] Active Learning of 3D Gaussian Splatting with Consistent Region Partition and Robust Pose Estimation, ICLR 2026.

