Dual-Diffusion
for Binocular 3D Human Pose Estimation

NeurIPS 2024

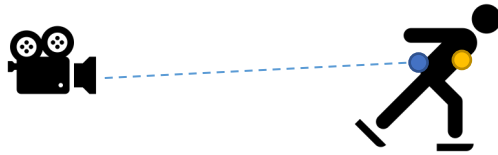Xiaoyue Wan, Zhuo Chen, Bingzhi Duan, Xu Zhao

Computer Vision Laboratory
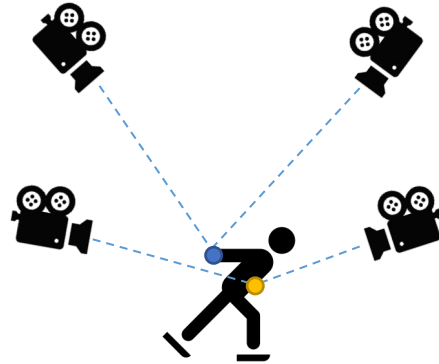Department of Automation
Shanghai Jiao Tong University

Background

- single-frame 3D human pose estimation
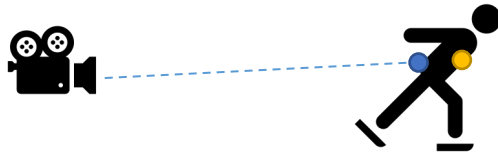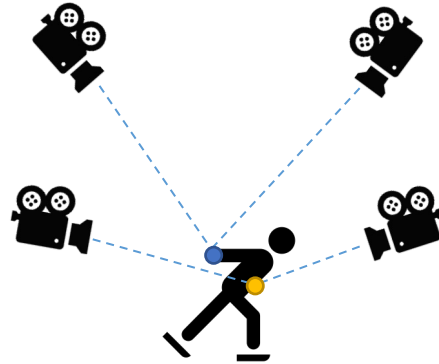
  - monucular

  - multiview

Background

- single-frame 3D human pose estimation

  - monucular

  - multiview

X depth ambiguity

X scene strictness
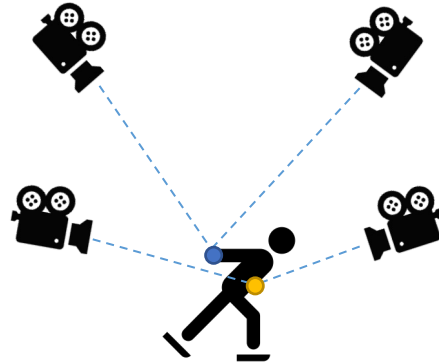
Background

- single-frame 3D human pose estimation

  - monucular

    X depth ambiguity
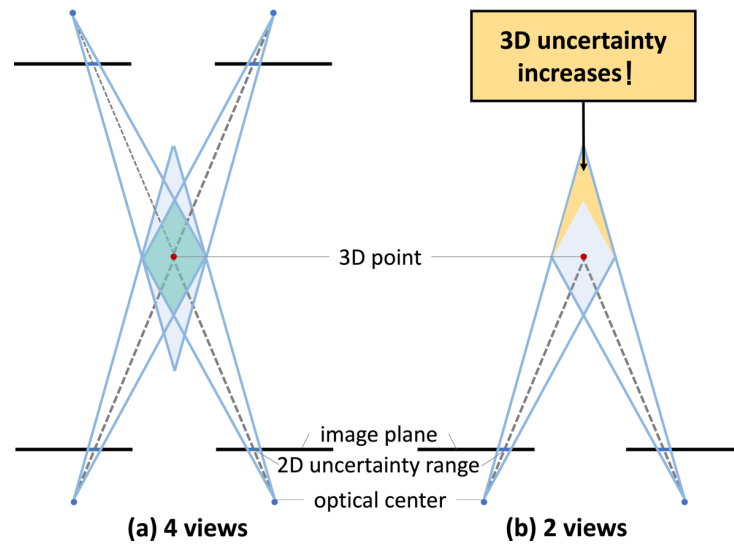
  - multiview

    X scene strictness

Binocular setup offers **both advantages** of them.

Research Problem 1
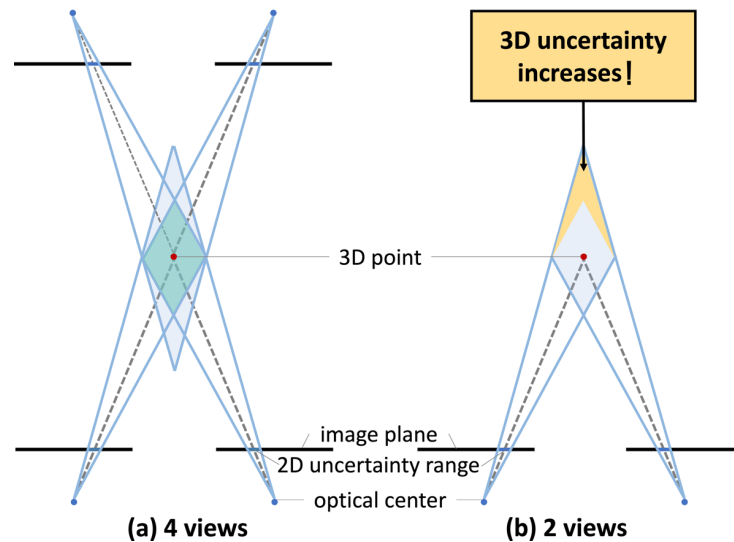
■ binocular 3D human pose estimation

● **uncertainty range** of 3D reconstruction increases

3D uncertainty increases!

3D point

image plane
2D uncertainty range
optical center

(a) 4 views   (b) 2 views

Research Problem 1

■ binocular 3D human pose estimation

● **uncertainty range** of 3D reconstruction increases

3D uncertainty
increases!

3D point

image plane
2D uncertainty range
optical center

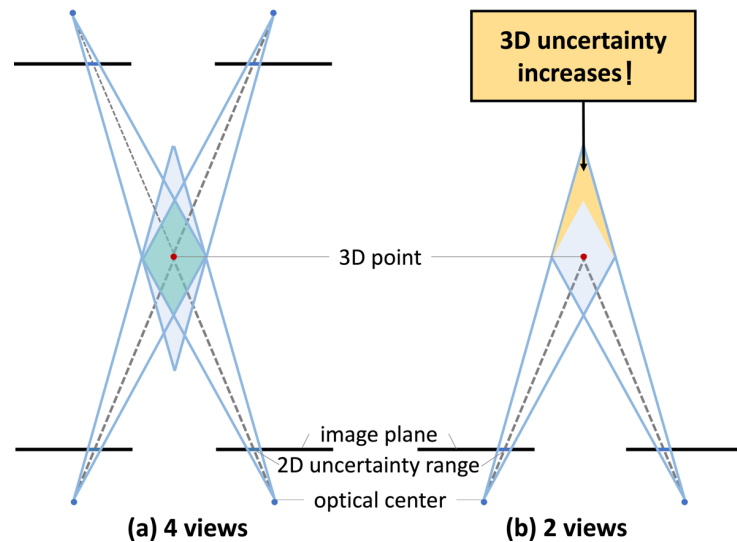(a) 4 views   (b) 2 views

⟶ diffusion models

Research Problem 1

■ binocular 3D human pose estimation

● **uncertainty range** of 3D reconstruction increases

→ diffusion models

Question: How can diffusion models be cleverly leveraged to reduce uncertainty?

Research Problem 1

■ revisit diffusion models in monocular 3D HPE

- start from **random noise**

- start from **initial 3D poses** with high uncertainty

Research Problem 1

■ revisit diffusion models in monocular 3D HPE

- start from **random noise**

X **time consumption**

- start from **initial 3D poses** with high undertainty

✅

Research Problem 1

■ revisit diffusion models in monocular 3D HPE

- start from **random noise**

  X **time consumption**

- start from **initial 3D poses** with high undertainty

  ✅

Question: How to model the **unknown distribution** of the initial 3D uncertainty?

Motivation 1

known	unknown
2D uncertainty ✅	
?	3D uncertainty ❓
geometry framework ✅	

Motivation 1

known   Unknown

2D uncertainty ✅
                          reconstruct
                                         3D uncertainty ❓
geometry framework ✅
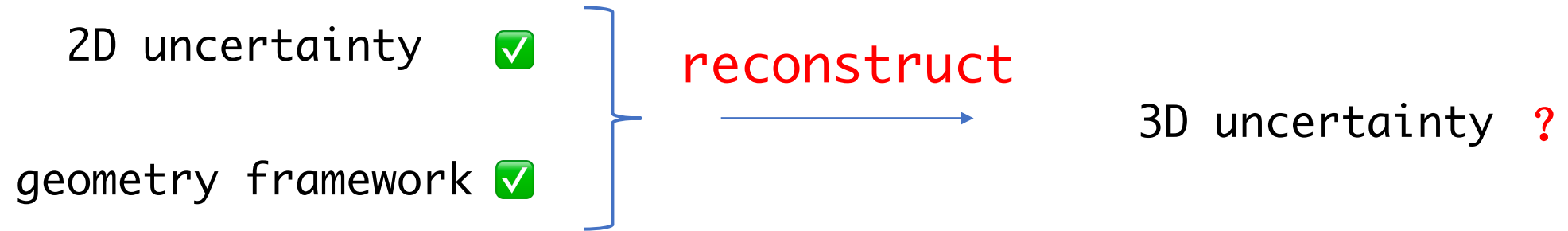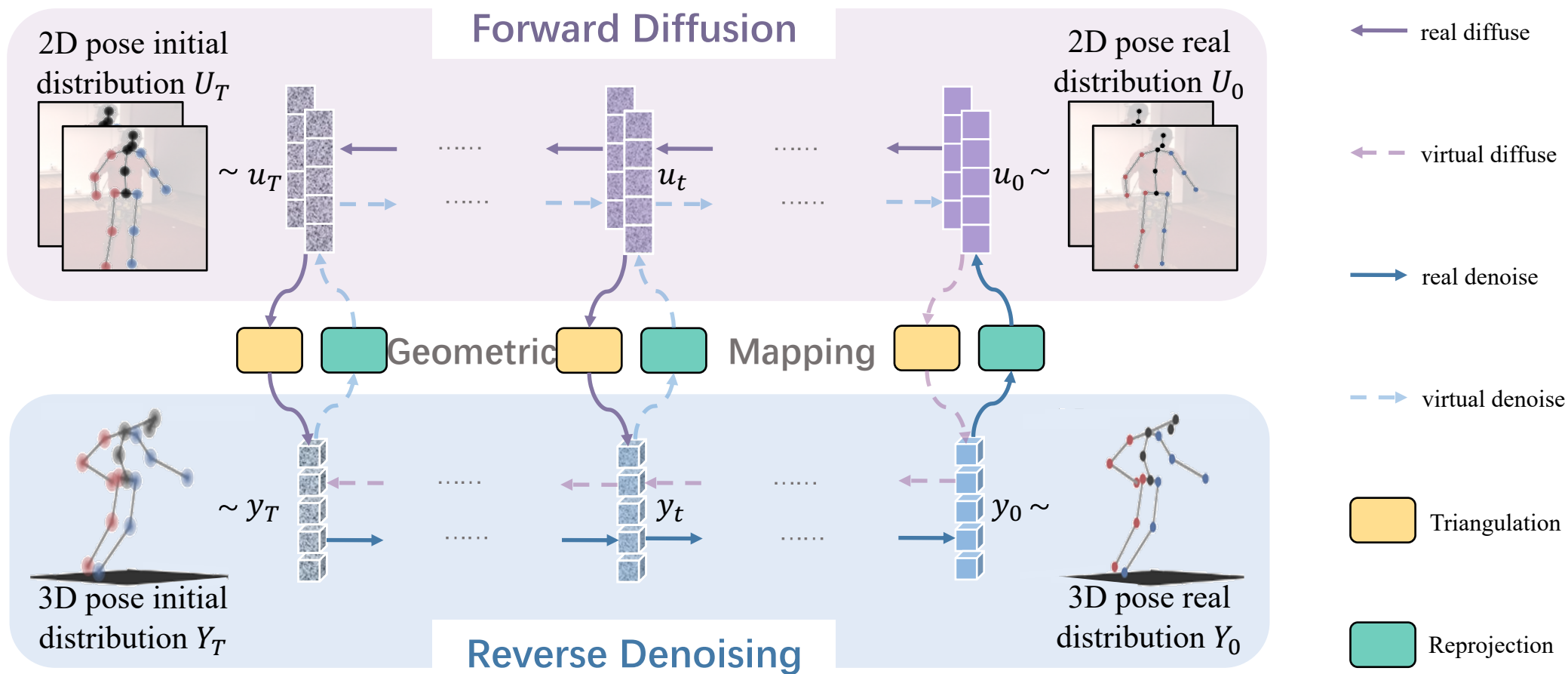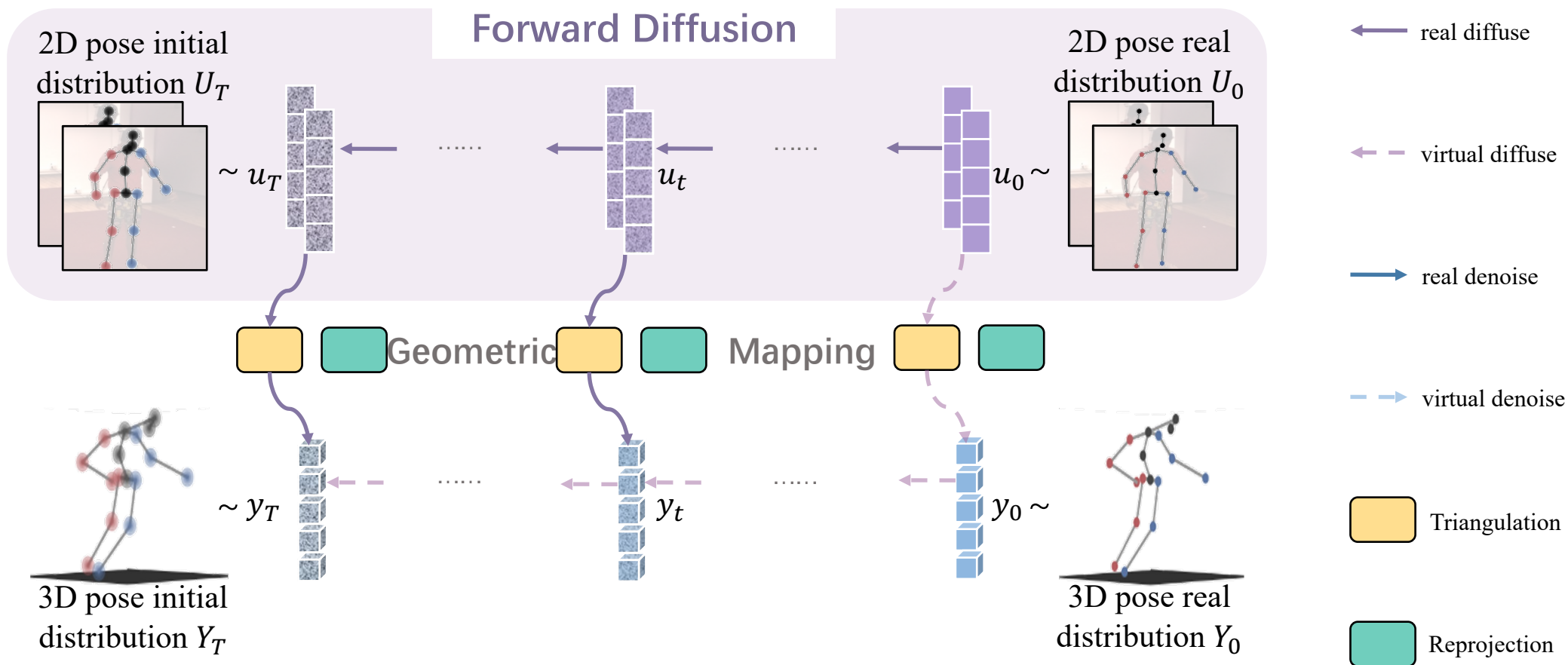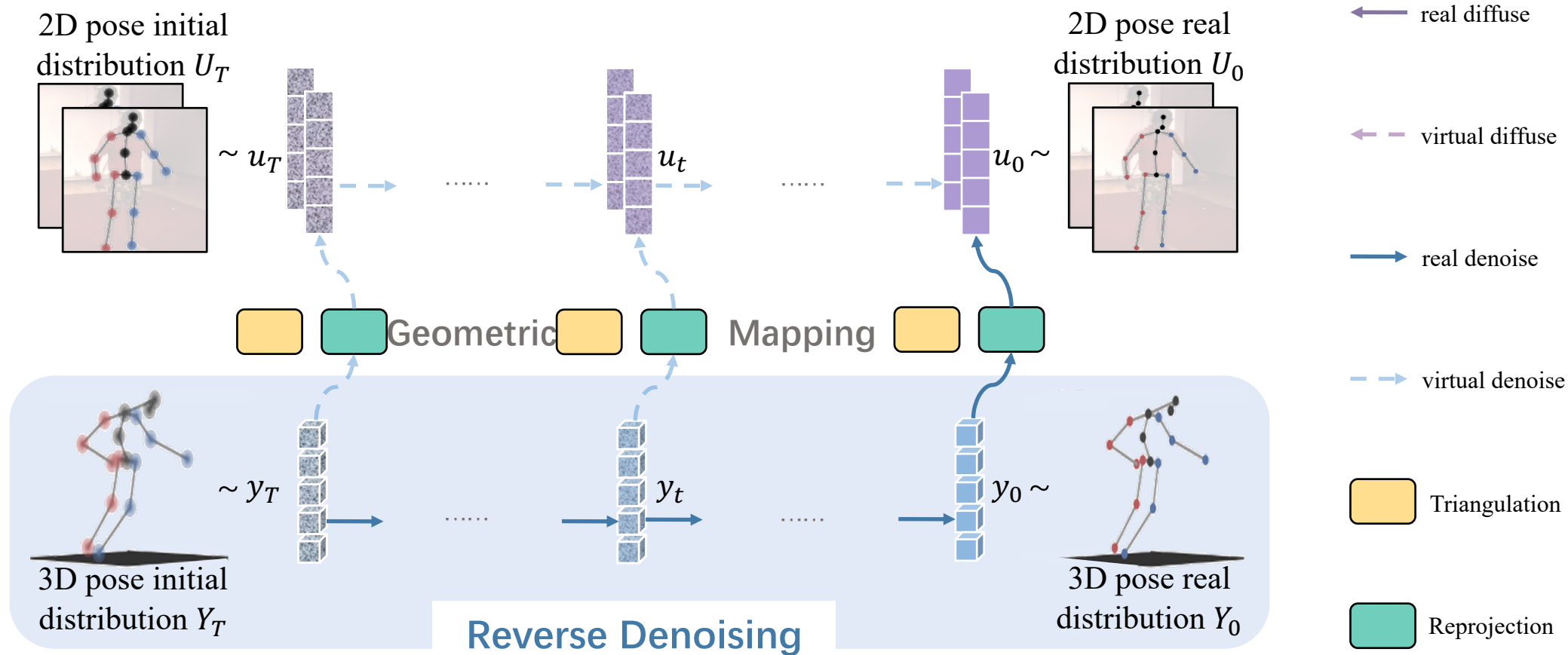
Method

- Dual-Diffusion modeling

Method

■ Dual-Diffusion modeling

Method

■ Dual-Diffusion modeling

Research Problem 2

■ revisit Dual-Diffusion

  ● condition is only related to 2D uncertainty

  ● 3D uncertainty has other influencing factors

Research Problem 2

■ revisit Dual-Diffusion

- condition is only related to 2D uncertainty
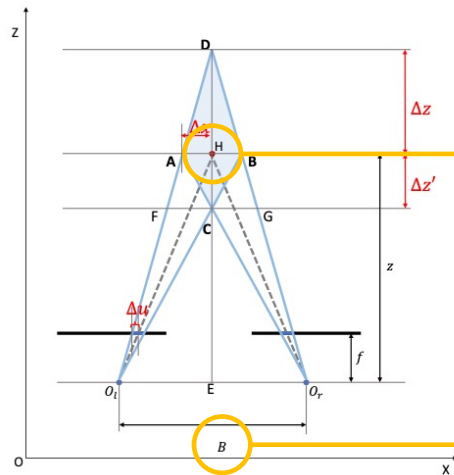
- 3D uncertainty has other influencing factors

Question: How to establish **the real 3D uncertainty** through Dual-Diffusion?

Motivation 2

- 3D uncertainty influencing factors analysis

Motivation 2

■ 3D uncertainty influencing factors analysis
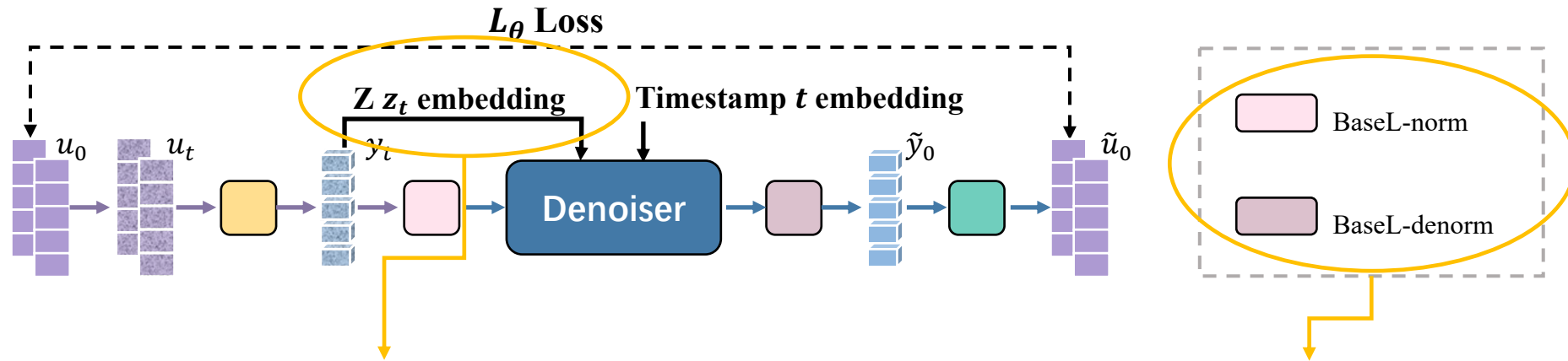

depth z of 3D object

The depth z affects the 3D noise along the x-axis, y-axis, and z-axis

baseline width B

The baseline width B only affects the 3D noise on the z-axis

Method

■ training details

Z-embedding condition

facilitate the denoiser to learn the noise within different uncertainty but under the same timestamp
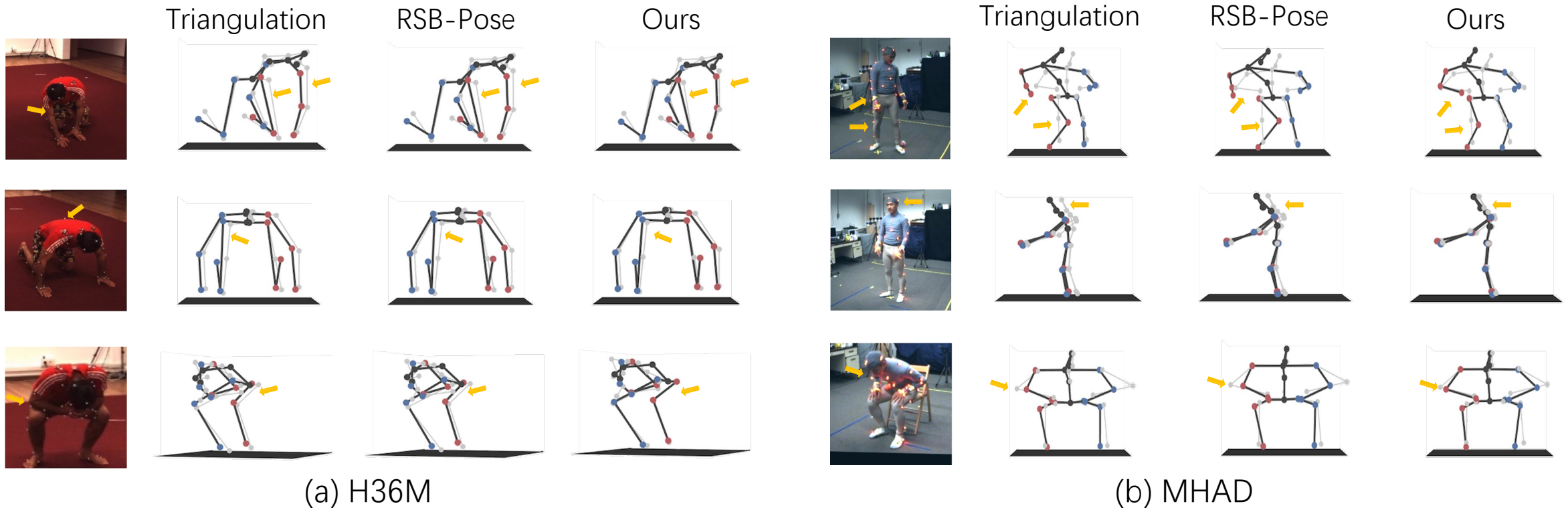
BaseL Pose Normalization

facilitate the denoiser to flexibly adapt to various baseline width settings
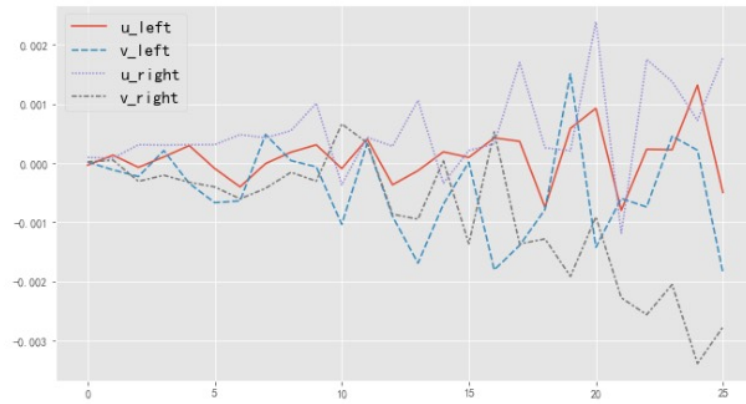
Comparison with SoTAs

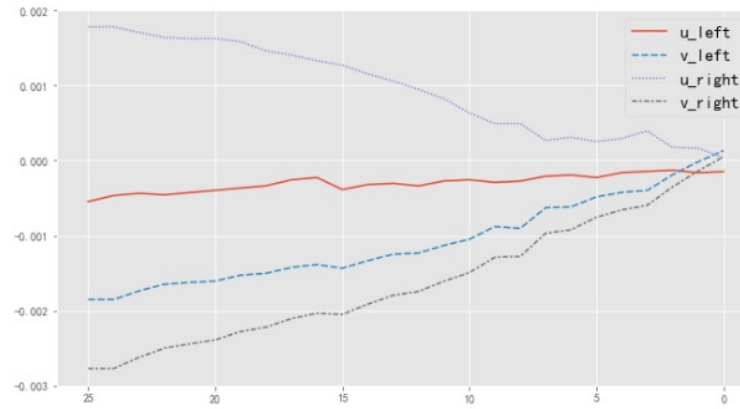■ wide baseline width   ■ shot baseline width

(a) H36M   (b) MHAD

Our Dual-Diffusion can denoise the initial estimated 3D poses.

Visulization

- 2D denoising

(a) diffusion

(b) denoising

Our Dual-Diffusion can denoise the initial estimated 2D poses.

Thank you!

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/getpaper/1119

code site

github.com/sherryw
an/Dual-Diffusion