NeuWigs: A Neural Dynamic Model for Volumetric Hair Capture and Animation

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?

Drive **outside** of
capture stage

Headset harnessing hair
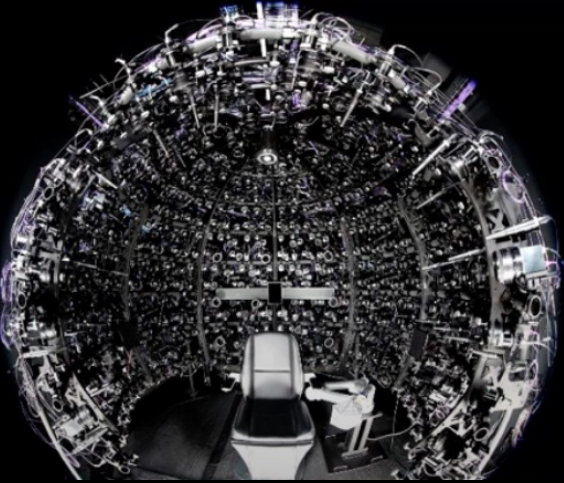
Major challenge:
No/Incomplete observation of hair

Severe self-occlusion

Challenges with
dynamic hair capture:
- Complex geometry
- Detailed appearance
- Non-rigid motion

No physical hair

Guo et al. "The relightables: Volumetric performance capture of humans with realistic relighting." *ToG 2019.*
Lombardi et al. "Mixture of volumetric primitives for efficient neural rendering." *Siggraph,* 2021. **(MVP)**
Wang et al. "HVH: Learning a Hybrid Neural Volumetric Representation for Dynamic Hair Performance Capture." *CVPR.* 2022. **(HVH)**

State compression

Unordered Hair Point p_{t_1}

encoding z_{t_1}

Point Enc

Point Dec

Volume Dec

Head Model

From Multiview images x_{t_1}

Head Verts

Tracked Hair Point q_{t_1}

Hair Volume V_{t_1}

Head Volume U_{t_1}

Differentiable volumetric raymarching

Point flow q_{t_1,t_1-1} constraints

z_{t_1-1}

Point flow q_{t_1,t_1+1} constraints

z_{t_1+1}

Dynamic model training

Set of encoding z (encoding space)

z_{t_1-1} z_{t_2+1} z_{t_3-1}

z_{t_1} z_{t_2} z_{t_3}

z_{t_1+1} z_{t_2-1} z_{t_3+1}

Sample encoding

Head trajectory, gravity $\{h_{t_1}, h_{t_1-1}, g_{t_1}\}$

Ground truth Encoding z_{t_1+1}

Input encoding z_{t_1}

Temporal Transfer Module

Predicted Encoding $\hat{z}_{t_1+1}$

Dynamic model testing

Head trajectory, gravity $\{h_0, h_{-1}, g_0\}$

Unordered Hair Point p_0

Point Enc

z_0

Temporal Transfer Module

$\hat{z}_1$

Point Dec

Tracked Hair Point $\hat{q}_1$

Head trajectory, gravity $\{h_1, h_0, g_1\}$

Tracked Hair Point $\hat{q}_1$

Point Enc

$\hat{z}_1$

Temporal Transfer Module

$\hat{z}_2$

Point Dec

Tracked Hair Point $\hat{q}_2$

An end-to-end data-driven pipeline:
Robust & **scalable** dynamic hair capture
+ Photorealistic
+ Long/discontinuous motions
Hair dynamic **prior** model:
+ Sparse driving signal
+ Robust to drift

State compression

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encoding z_{t_1}

Point Enc

Point Dec

Tracked Hair Point q_{t_1}

Volume Dec

From Multiview images

Head Verts x_{t_1}

Head Model

Head Volume U_{t_1}

Hair Volume V_{t_1}

Differentiable volumetric raymarching
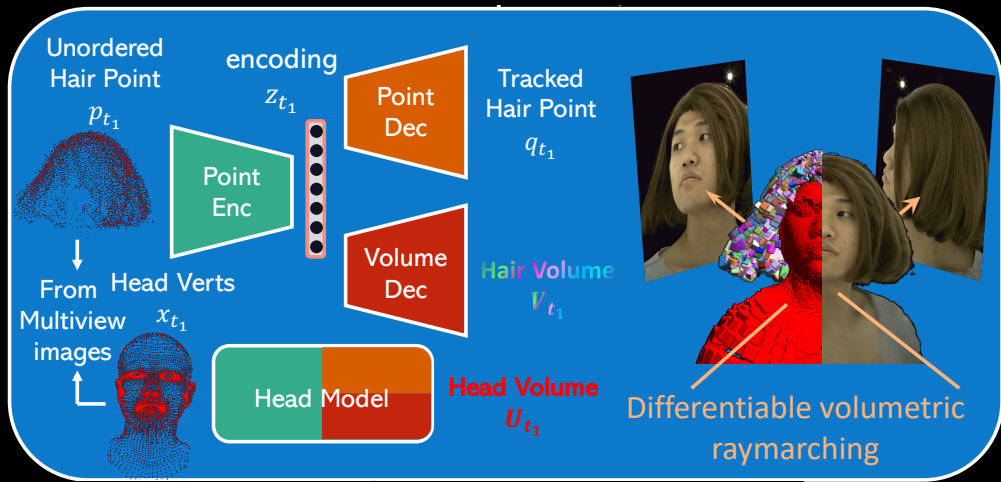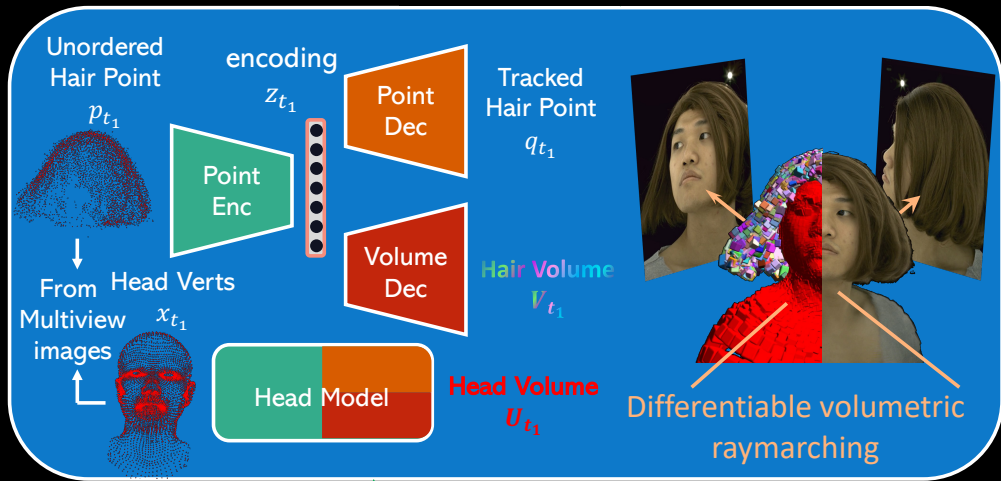
Decoder-as-a-Tracker (DaaT):
Tracking via autoencoding
Perframe observation:
- Photometric clues
- Geometric clues

DaaT tracking results

+ Coarse level tracking
- Appearance jittering

State compression

Decoder-as-a-Tracker (DaaT):

Perframe observation:

- Photometric clues
- Geometric clues

Temporal consistency:

- Motion data-prior

DaaT tracking results

w/o temporal smoothness w/ temporal smoothness

Local flow field as data prior:
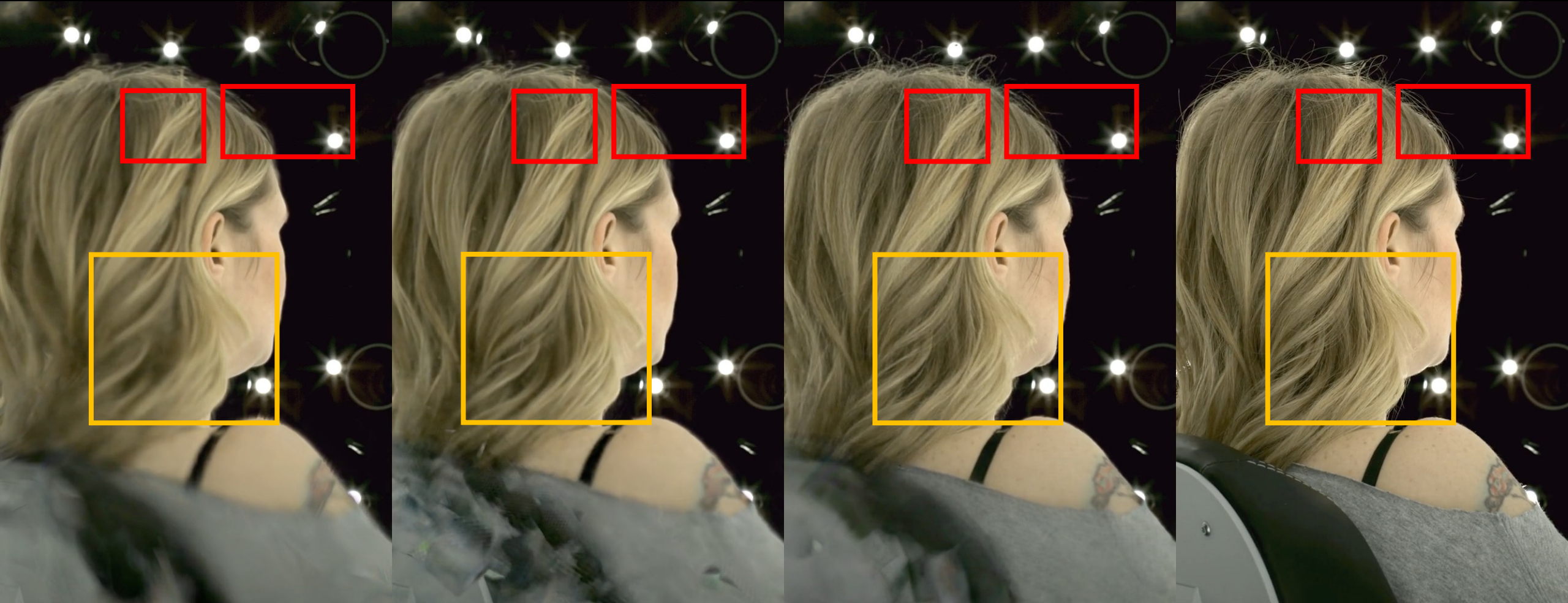Temporally smoothing results

Novel view synthesis:

MVP   HVH   Ours   Ground Truth

Lombardi et al. "Mixture of volumetric primitives for efficient neural rendering." *Siggraph,* 2021. **(MVP)**
Wang et al. "HVH: Learning a Hybrid Neural Volumetric Representation for Dynamic Hair Performance Capture." *CVPR.* 2022. **(HVH)**

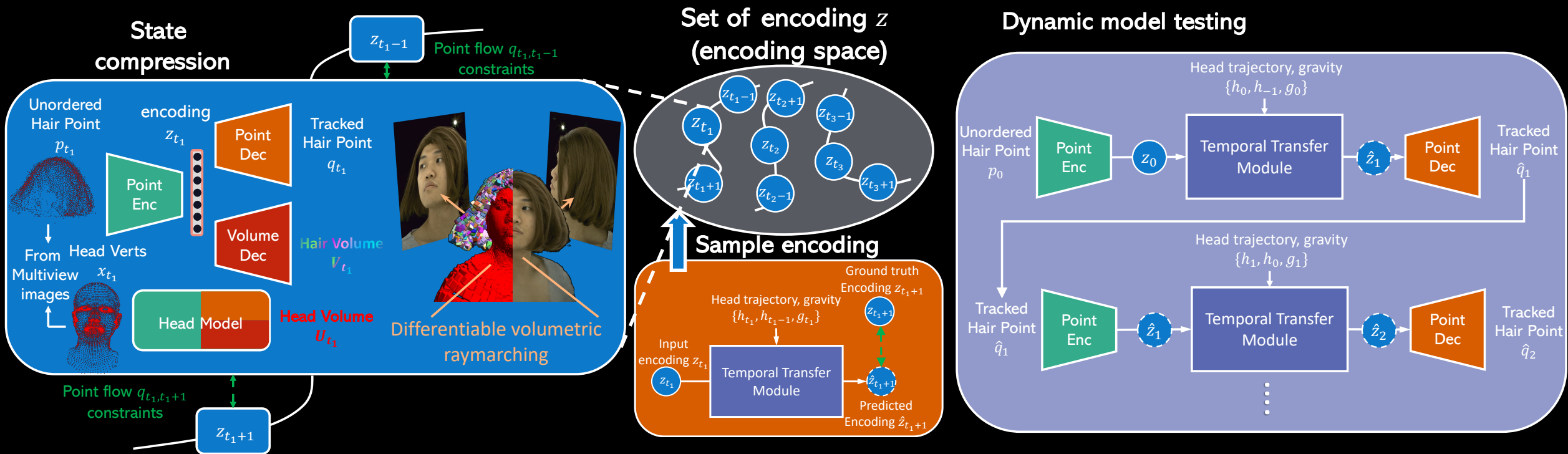# Hair-head disentanglement: better hair coverage

HVH   Ours   HVH   Ours

Wang et al. "HVH: Learning a Hybrid Neural Volumetric Representation for Dynamic Hair Performance Capture." *CVPR*. 2022. **(HVH)**

Robust dynamic capture

State compression

z_{t_1-1}

Point flow q_{t_1,t_1-1} constraints

Unordered Hair Point p_{t_1}

encoding z_{t_1}

Point Enc

Point Dec

Volume Dec

Tracked Hair Point q_{t_1}

Hair Volume V_{t_1}

From Multiview images x_{t_1}

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Head Volume U_{t_1}

Differentiable volumetric raymarching

Point flow q_{t_1,t_1+1} constraints

z_{t_1+1}

Set of encoding z (encoding space)

z_{t_1-1} z_{t_2+1} z_{t_3-1}

z_{t_1} z_{t_2} z_{t_3}

z_{t_1+1} z_{t_2-1} z_{t_3+1}

Sample encoding

Ground truth Encoding z_{t_1+1}

Head trajectory, gravity $\{h_{t_1}, h_{t_1-1}, g_{t_1}\}$

z_{t_1+1}

Input encoding z_{t_1}

z_{t_1}

Temporal Transfer Module

$\hat{z}_{t_1+1}$

Predicted Encoding $\hat{z}_{t_1+1}$

Dynamic model testing

Head trajectory, gravity $\{h_0, h_{-1}, g_0\}$

Unordered Hair Point p_0

Point Enc

z_0

Temporal Transfer Module

$\hat{z}_1$

Point Dec

Tracked Hair Point $\hat{q}_1$

Head trajectory, gravity $\{h_1, h_0, g_1\}$

Tracked Hair Point $\hat{q}_1$

Point Enc

$\hat{z}_1$

Temporal Transfer Module

$\hat{z}_2$

Point Dec

Tracked Hair Point $\hat{q}_2$

Decoder-as-a-Tracker (DaaT):
Perframe observation:
▪ Photometric clues
▪ Geometric clues
Temporal consistency:
▪ Motion data-prior

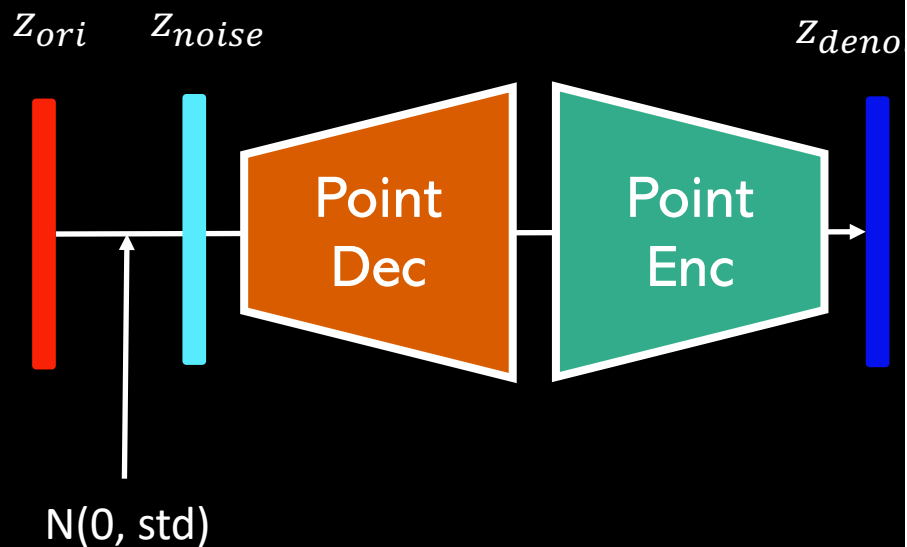encoding space

Dynamic modeling:
Training from encoding space
Sparse driving signal
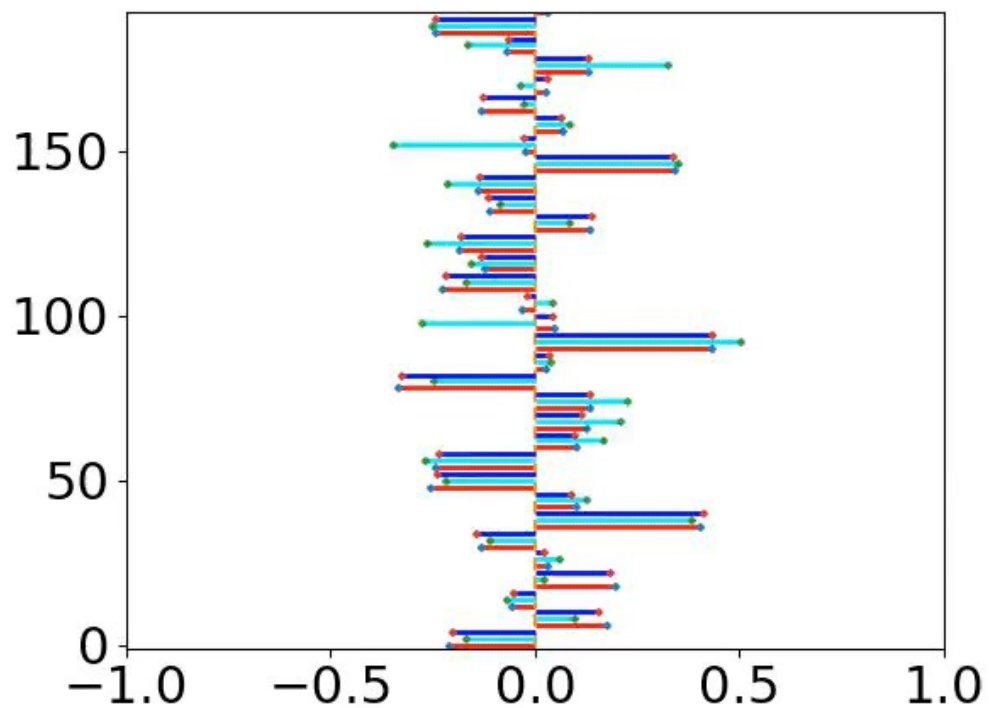Temporal state transfer
autoencoder as a denoiser

Stabilization test: Remove encoding noise
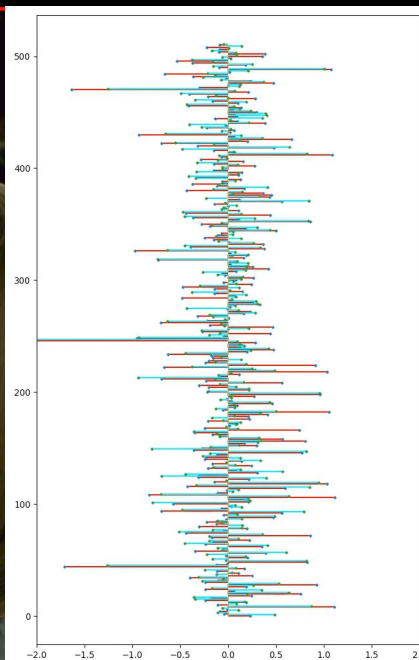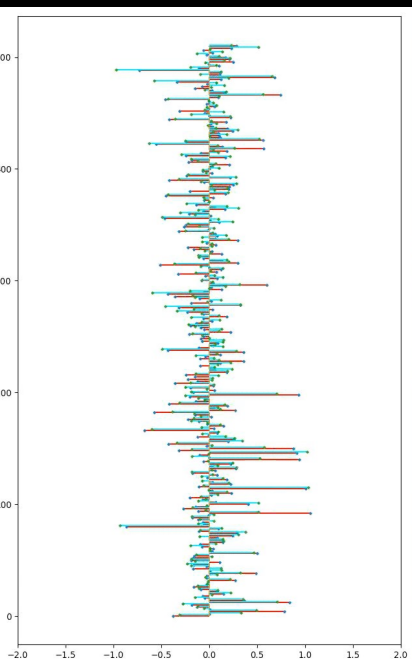w/o ae denoising, w/ ae denoising

Denoised code rendering

Noise std=1.0

Stabilization test: Robust rollout animation
w/o ae denoising, w/ ae denoising

Animation on iPhone captures

Thank you!

Please scan here for our webpage!