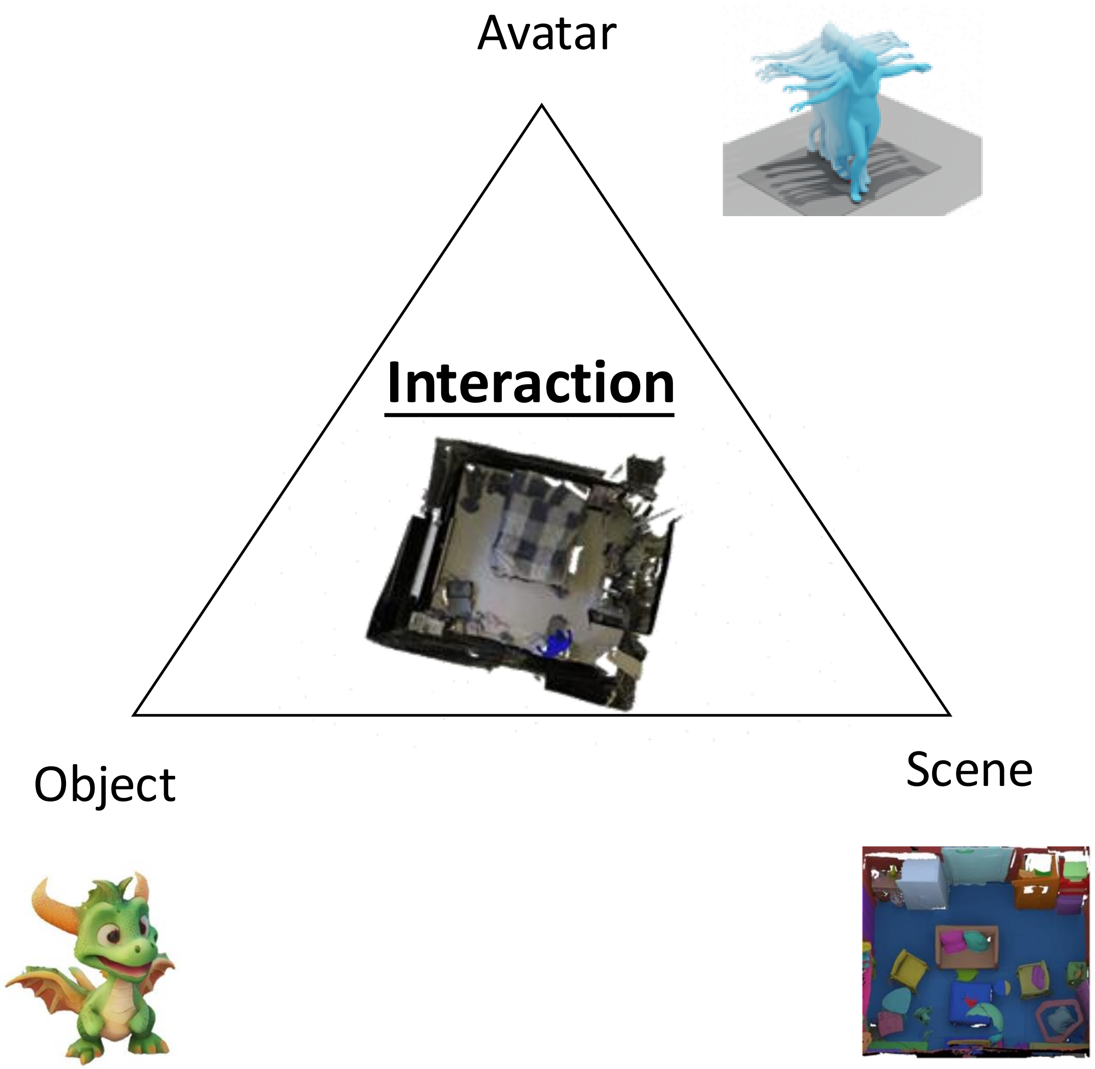
Personal Research and Research Proposal

Jinpeng Liu

liujp22@mails.tsinghua.edu.cn

Outline

- **Research Projects**
  - Avatar: Controllable & Generable
  - Object: Efficient & Diverse
- **Future Research Proposal**
  - Think deeper about “avatar & object”
    - Avatar-object-scene interaction



Broad Application

- ➢ Demand for creative digital products is increasing
- ➢ Research results are expected to promote digital life system

Microsoft Minecraft

Meta Quest 2

Apple Vision Pro

FLAG3D: A 3D Fitness Activity Dataset with Language Instruction

Jinpeng Liu*, Yansong Tang*, Aoyang Liu*,

Bin Yang, Wenxun Dai, Yongming Rao, Jiwen Lu, Jie Zhou, Xiu Li

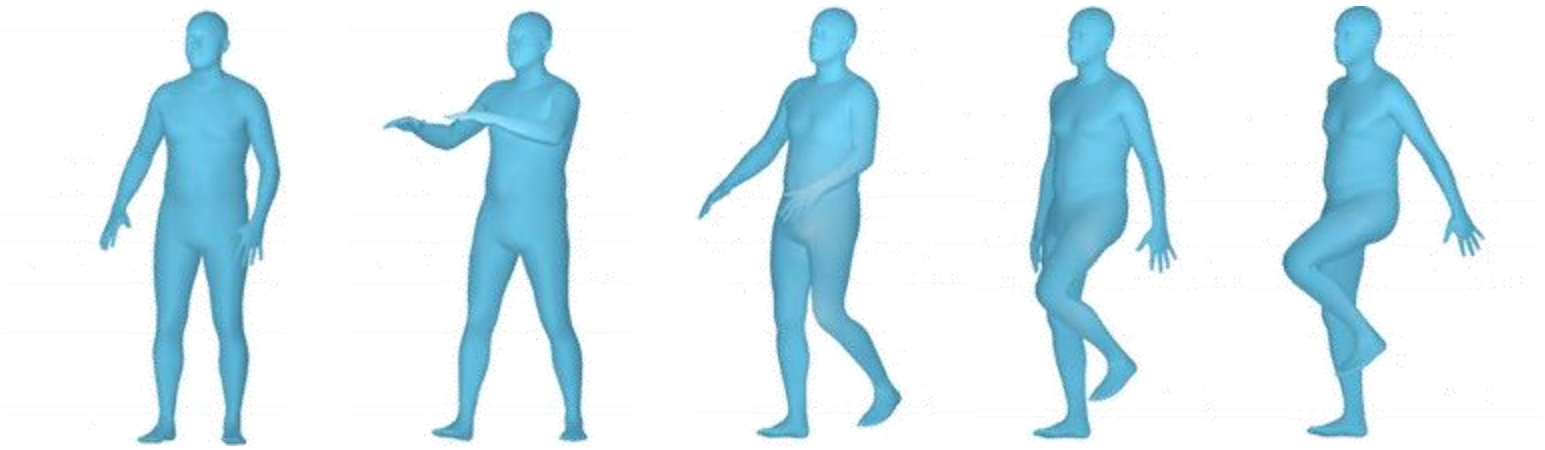
Tsinghua University

清華大學

JUNE 18-22, 2023
CVPR
VANCOUVER, CANADA

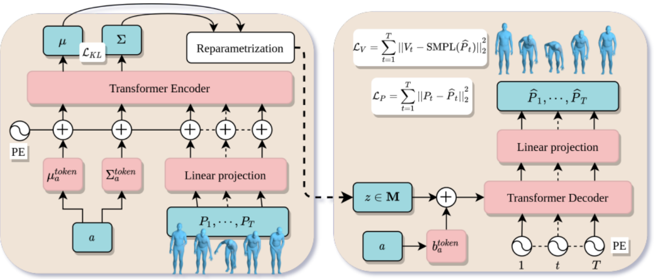
Task Description

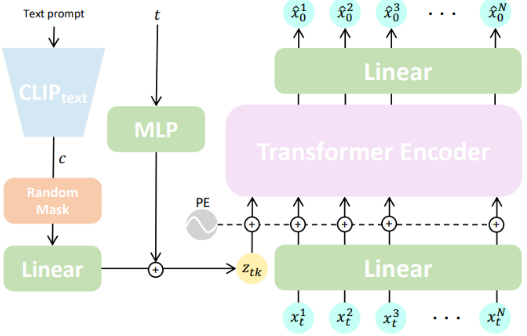
“Knee raising” →



Language-guided Motion Generation

Low Quantity and Poor Quality of Data



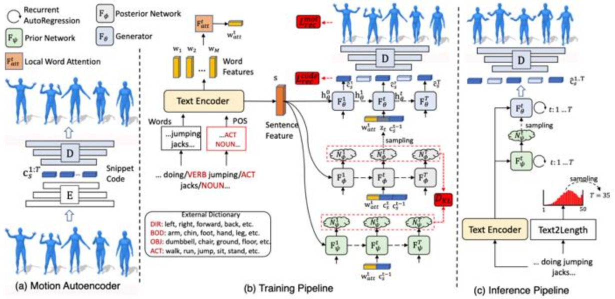


ACTOR
[Petrovich et al. ICCV2021]

MDM
[Tevet et al. ICLR2023]

Text-to-motion
[Guo et al. CVPR2022]

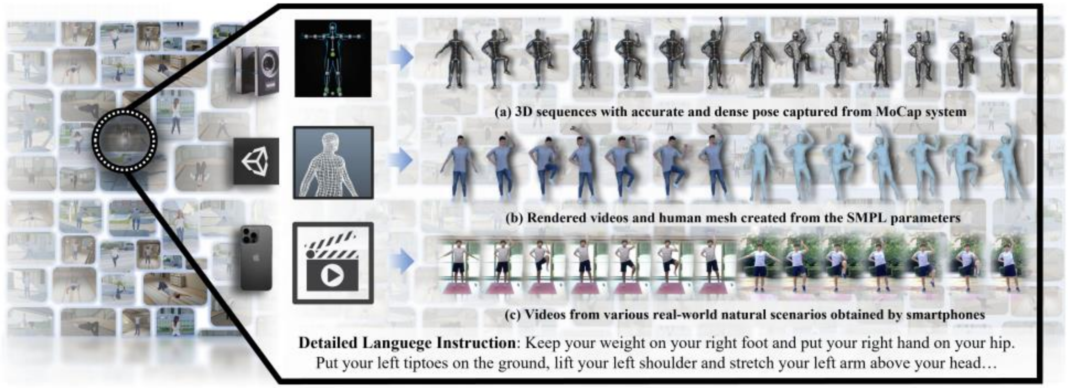
Ours. CVPR2023


Recurrent AutoRegression
F_ϕ Posterior Network
F_ψ Prior Network
F_θ Generator
F_{att}^t Local Word Attention
w_{att}^t
w_1 w_2 w_M
Word Features
Text Encoder
Words
POS
...jumping jacks...
...ACT NOUN...
... doing/VERB jumping/ACT jacks/NOUN...
External Dictionary
DIR: left, right, forward, back, etc.
BOD: arm, chin, foot, hand, leg, etc.
OBJ: dumbbell, chair, ground, floor, etc.
ACT: walk, run, jump, sit, stand, etc.
s
Sentence Feature
$\mathcal{L}_{rec}^{mot}$
$\mathcal{L}_{rec}^{code}$
D_{KL}
D
E
$c_s^{1:T}$
Snippet Code
sampling
$t: 1 \ldots T$
$T = 35$
1
50
Text Encoder
Text2Length
... doing jumping jacks...

(a) Motion Autoencoder

(b) Training Pipeline

(c) Inference Pipeline

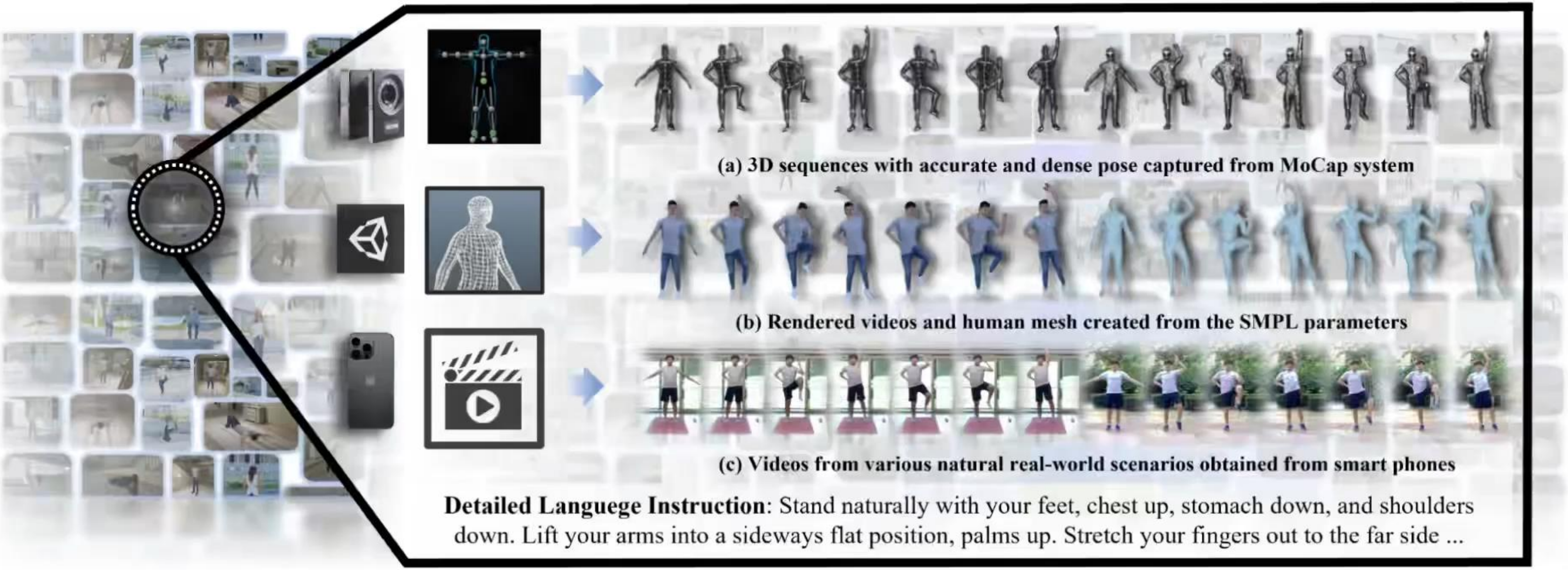


(a) 3D sequences with accurate and dense pose captured from MoCap system

(b) Rendered videos and human mesh created from the SMPL parameters

(c) Videos from various real-world natural scenarios obtained by smartphones

Detailed Languege Instruction: Keep your weight on your right foot and put your right hand on your hip. Put your left tiptoes on the ground, lift your left shoulder and stretch your left arm above your head…



(a) 3D sequences with accurate and dense pose captured from MoCap system

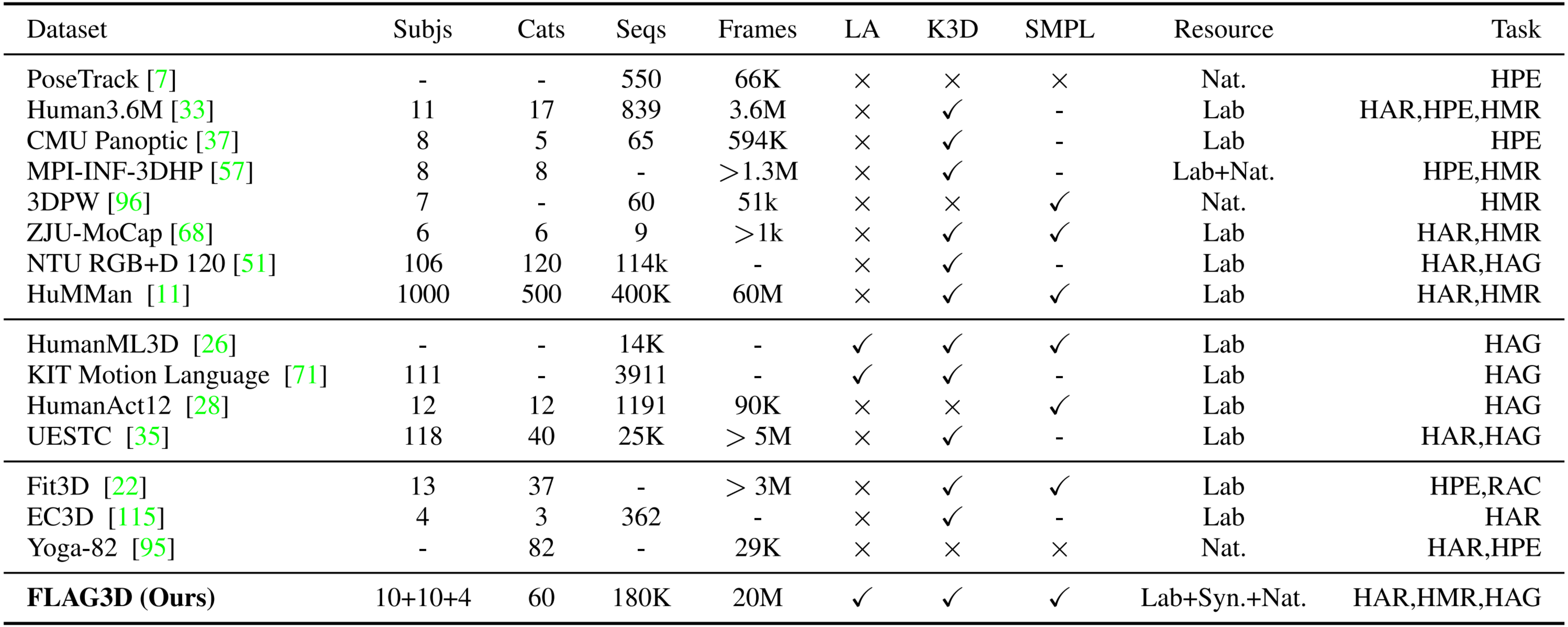
(b) Rendered videos and human mesh created from the SMPL parameters

(c) Videos from various natural real-world scenarios obtained from smart phones

Detailed Languege Instruction: Stand naturally with your feet, chest up, stomach down, and shoulders down. Lift your arms into a sideways flat position, palms up. Stretch your fingers out to the far side ...

FLAG3D features the following three aspects:

Data



Dataset	Subjs	Cats	Seqs	Frames	LA	K3D	SMPL	Resource	Task
PoseTrack [7]	-	-	550	66K	×	×	×	Nat.	HPE
Human3.6M [33]	11	17	839	3.6M	×	✓	-	Lab	HAR,HPE,HMR
CMU Panoptic [37]	8	5	65	594K	×	✓	-	Lab	HPE
MPI-INF-3DHP [57]	8	8	-	>1.3M	×	✓	-	Lab+Nat.	HPE,HMR
3DPW [96]	7	-	60	51k	×	×	✓	Nat.	HMR
ZJU-MoCap [68]	6	6	9	>1k	×	✓	✓	Lab	HAR,HMR
NTU RGB+D 120 [51]	106	120	114k	-	×	✓	-	Lab	HAR,HAG
HuMMan [11]	1000	500	400K	60M	×	✓	✓	Lab	HAR,HMR
HumanML3D [26]	-	-	14K	-	✓	✓	✓	Lab	HAG
KIT Motion Language [71]	111	-	3911	-	✓	✓	-	Lab	HAG
HumanAct12 [28]	12	12	1191	90K	×	×	✓	Lab	HAG
UESTC [35]	118	40	25K	> 5M	×	✓	-	Lab	HAR,HAG
Fit3D [22]	13	37	-	> 3M	×	✓	✓	Lab	HPE,RAC
EC3D [115]	4	3	362	-	×	✓	-	Lab	HAR
Yoga-82 [95]	-	82	-	29K	×	×	×	Nat.	HAR,HPE
FLAG3D (Ours)	10+10+4	60	180K	20M	✓	✓	✓	Lab+Syn.+Nat.	HAR,HMR,HAG

FLAG3D

20M

<<

LAION-5B

2.3B

a man walks forward

In-distribution

A man dances the waltz

Out-of-distribution

[1] Tevet G, Raab S, Gordon B, et al. Human Motion Diffusion Model[C]//The Eleventh International Conference on Learning Representations. 2022.

Plan, Posture and Go: Towards Open-vocabulary Text-to-Motion Generation

Jinpeng Liu[1], Wenxun Dai[1], Chunyu Wang[2], Yiji Cheng[1], Yansong Tang[1], Xin Tong[2]

[1]Tsinghua University [2]Microsoft

Formulation

"The language of movement cannot be translated into words."

——Barbara Mettler(Dancer)

Is there a novel formulation of the motion generation task that can address general text-to-motion problem without relying on paired text-motion data?

Formulation

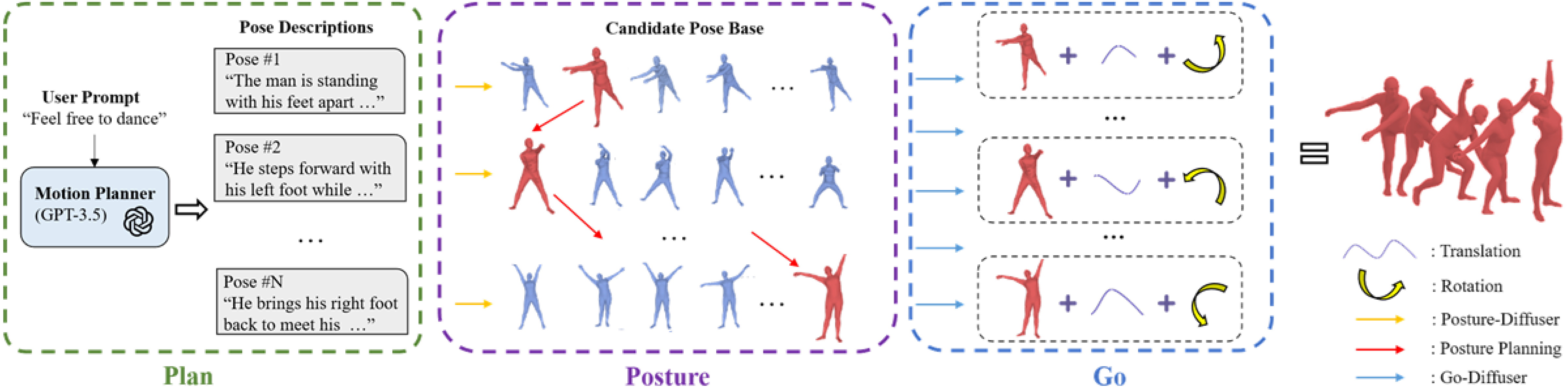
Motion ? ⇨ Pose sequence + Global Information

$$\begin{tikzcd}
\textbf{Text} \arrow[r, "\times" description] \arrow[d] & \textbf{Motion} \\
\{\textbf{Desc.}_1, \textbf{Desc.}_2, \ldots \textbf{Desc.}_n\} \arrow[r] & \{\textbf{Pose}_1, \textbf{Pose}_2, \ldots \textbf{Pose}_n\} \arrow[u]
\end{tikzcd}$$

Robust Motion In-betweening. SIGGRAPH 20.

Pipeline

divide-and-conquer



Motion Generated by Our Model

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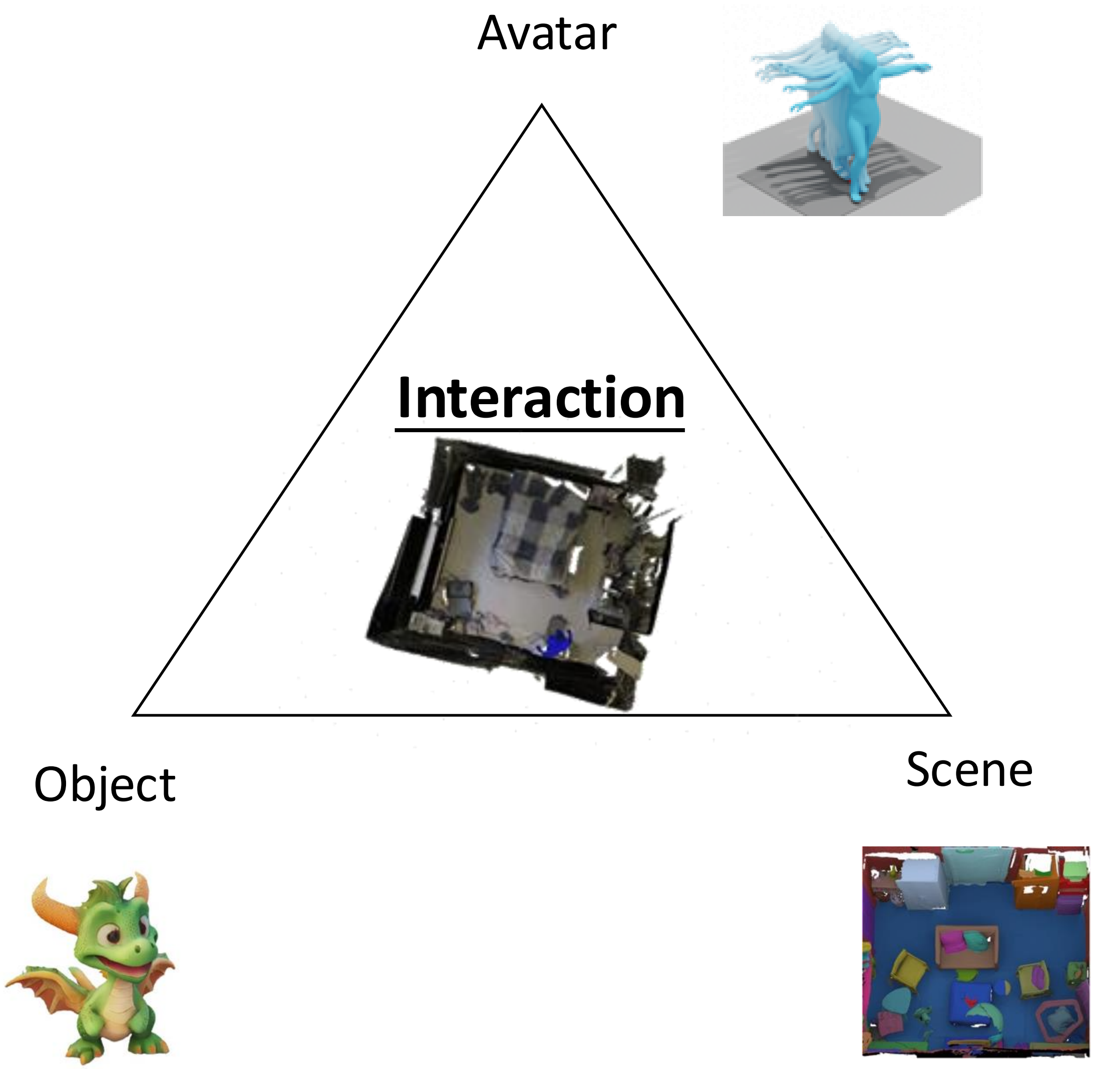


Avatar

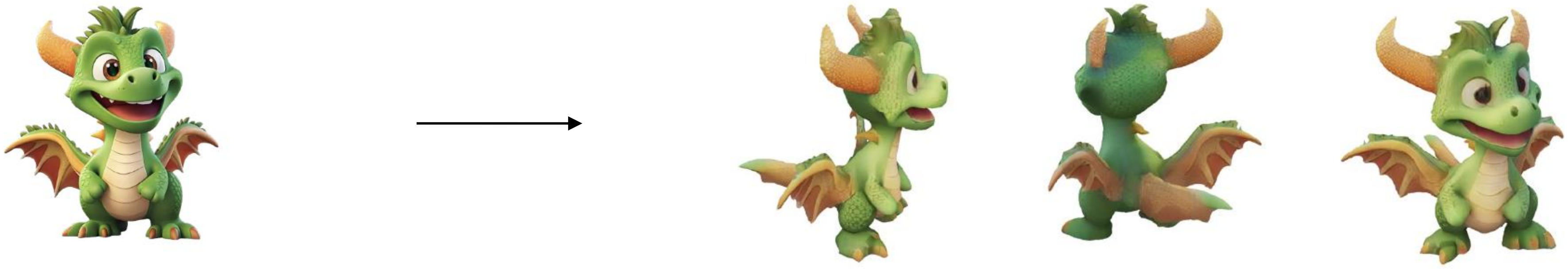
Interaction

Object

Scene

Task Description

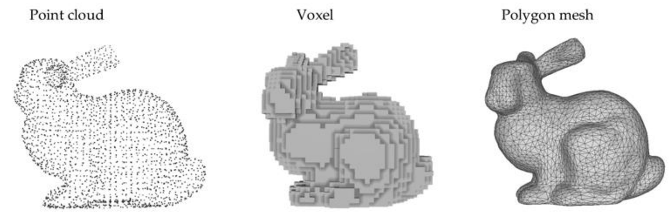
Image to 3D

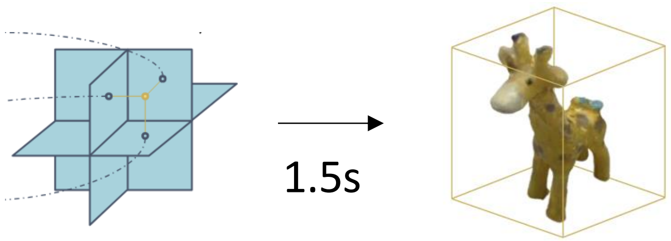


Motivation

□ 3D Representation

- ✗ Point Cloud: Poor visual result
- ✗ Voxel, Mesh : GPU-unfriendly
- ✗ Triplane: Time consuming
- ✓ Gaussian: Real time and easy to scale up

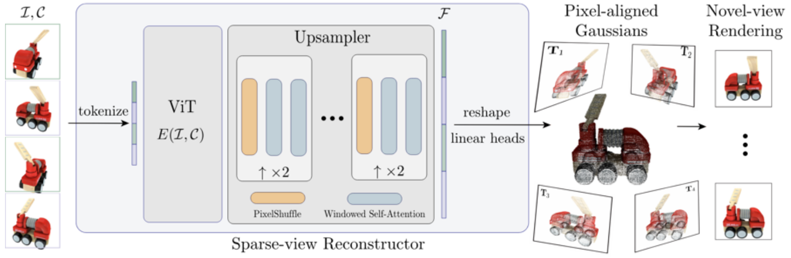




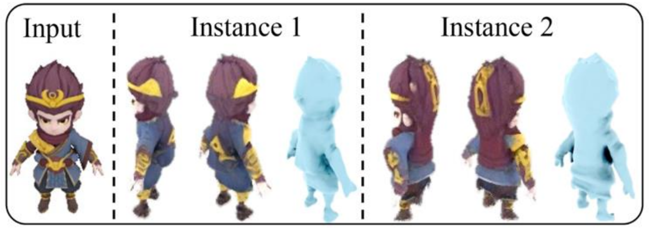
Rendering 2s (60 frames) video cost **1.5min!**

□ Formulation

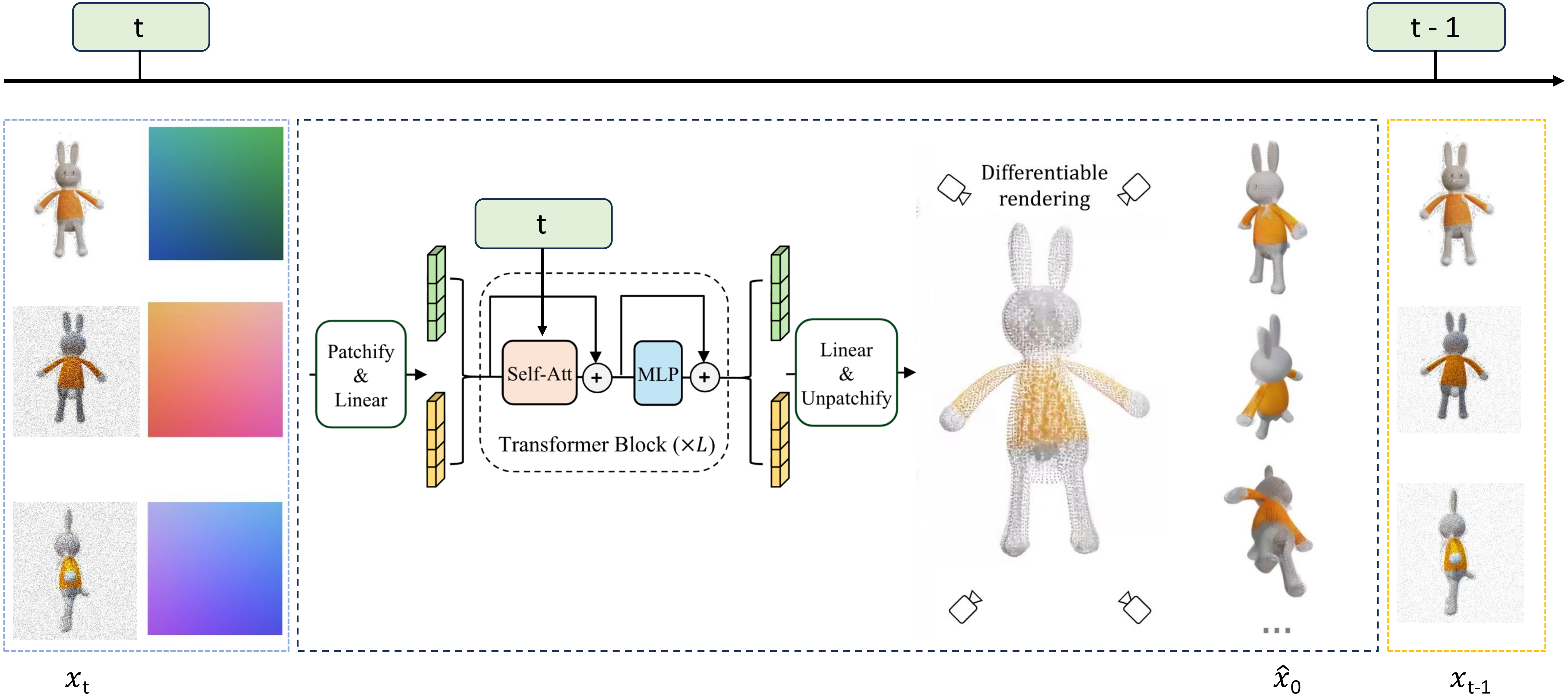
- Reconstruction
- Generation
  - Utilizing diffusion to model the probability distribution



GRM. Yinghao Xu, et al. Stanford University.



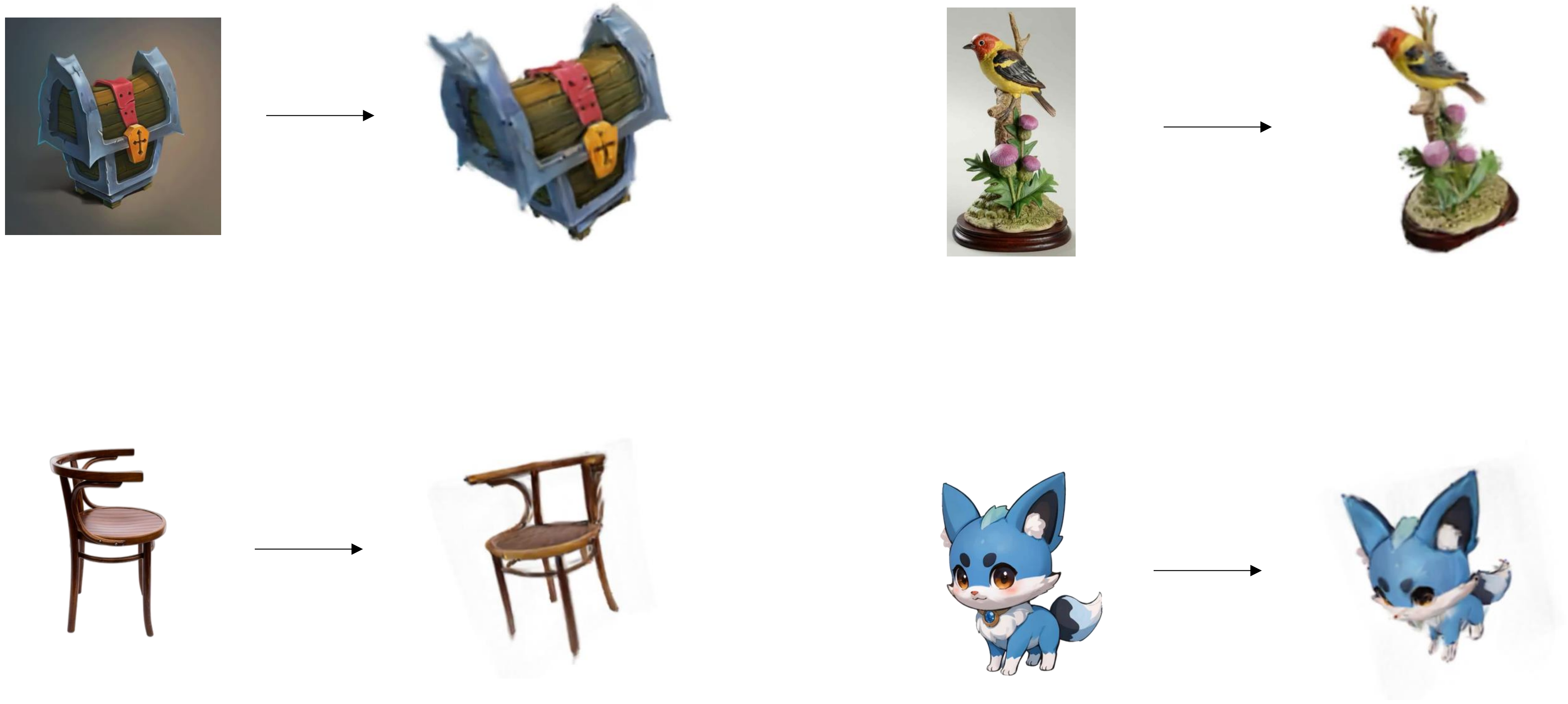
Pipeline



Images + Plücker rays

Results

Visualization



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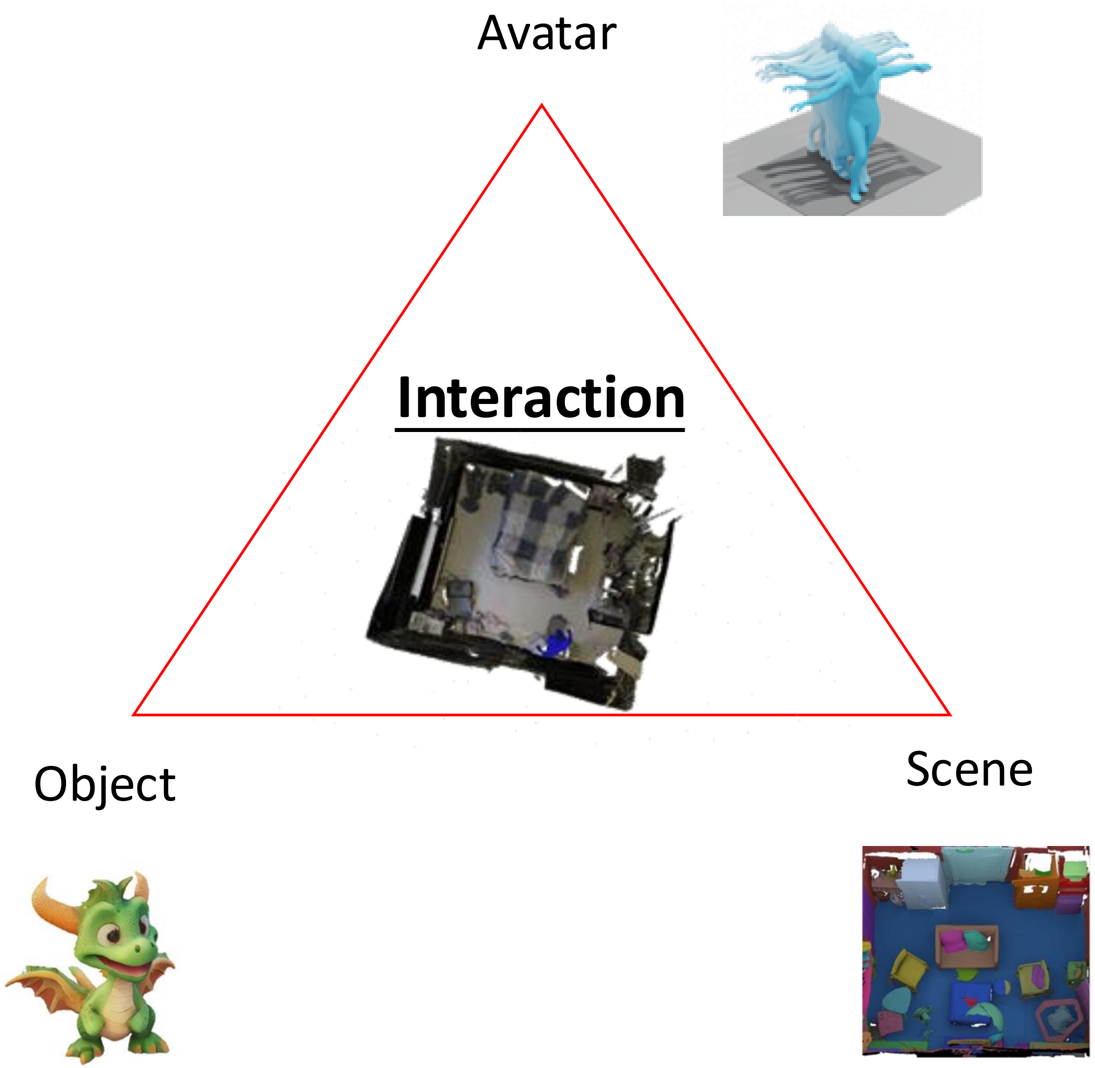
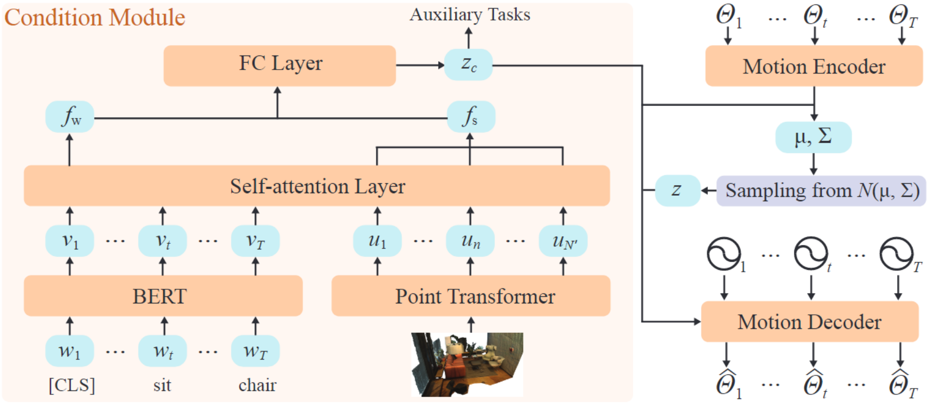
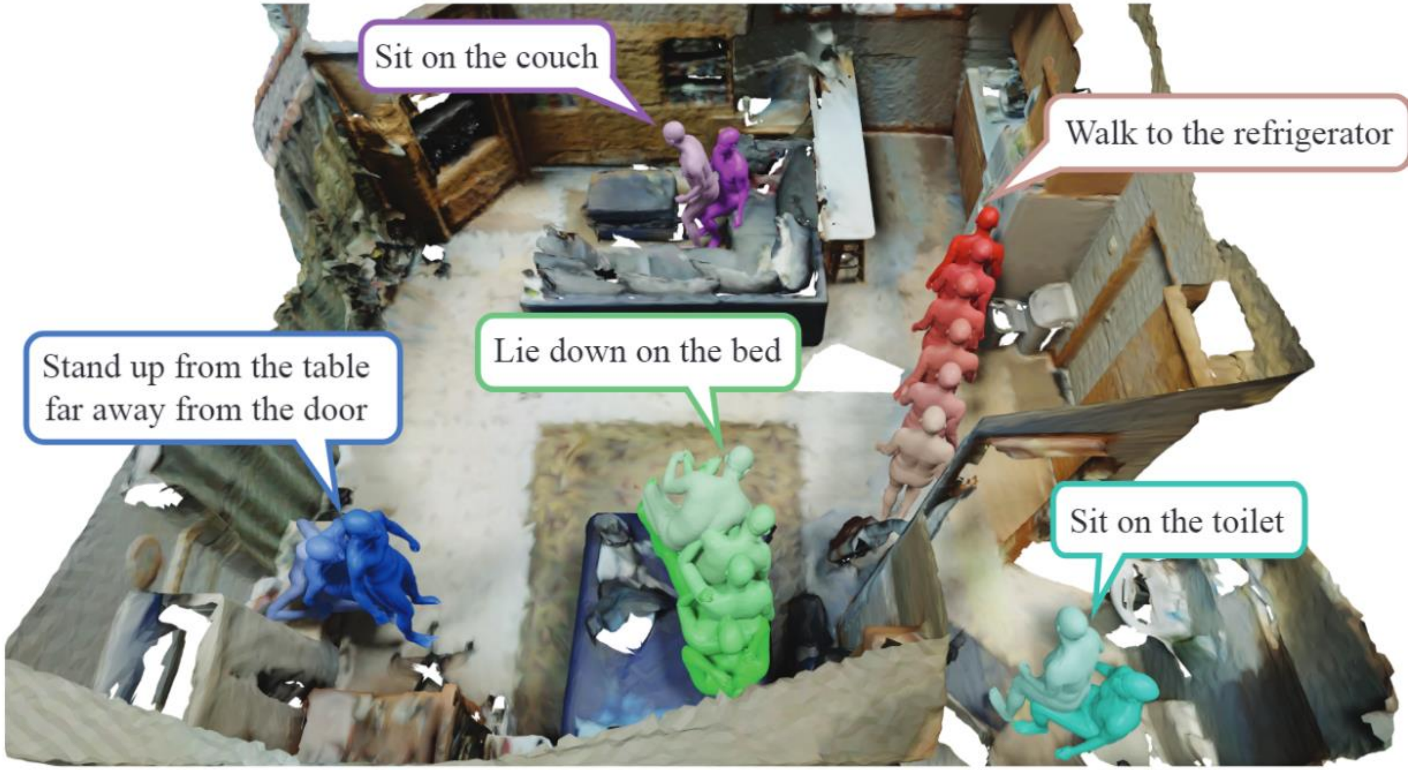


Task Description

Input: Language & Scene

Output: Interaction

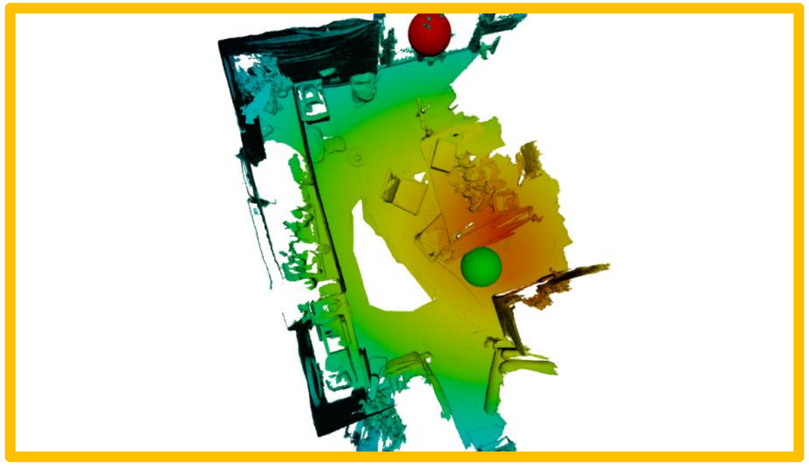


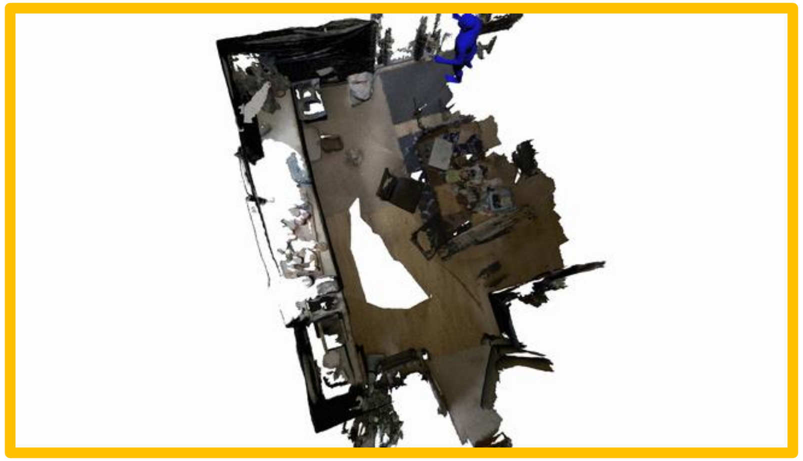


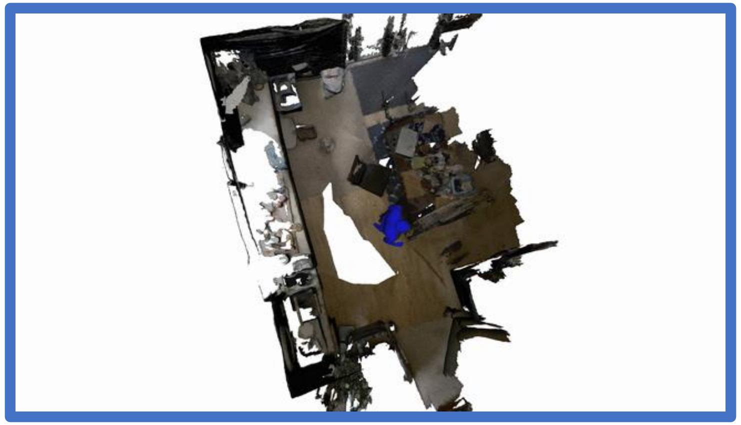
HUMANISE: Language-conditioned Human Motion Generation in 3D Scenes. NeurIPS2023

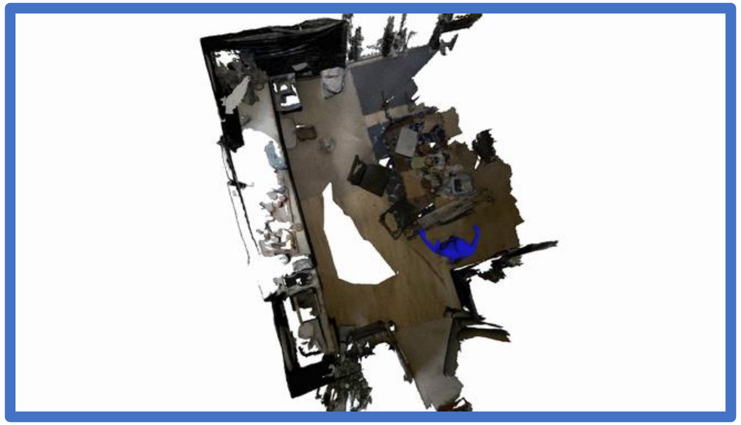
Localization Error

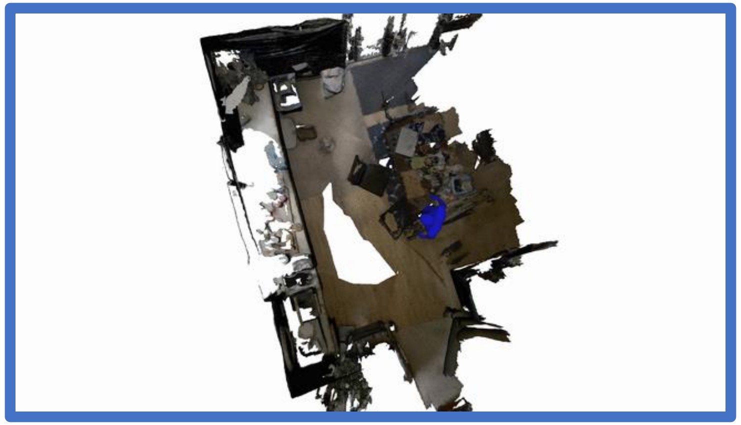
Walk to the glass doors





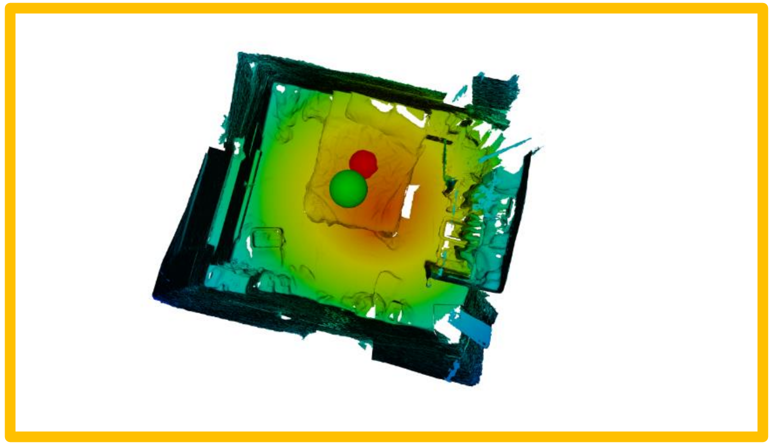


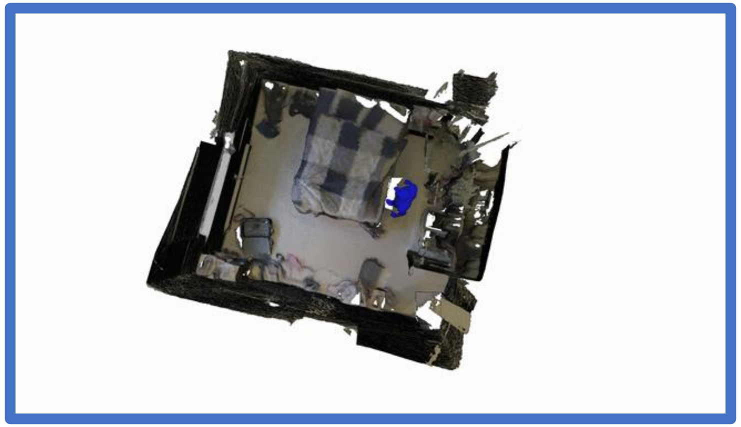


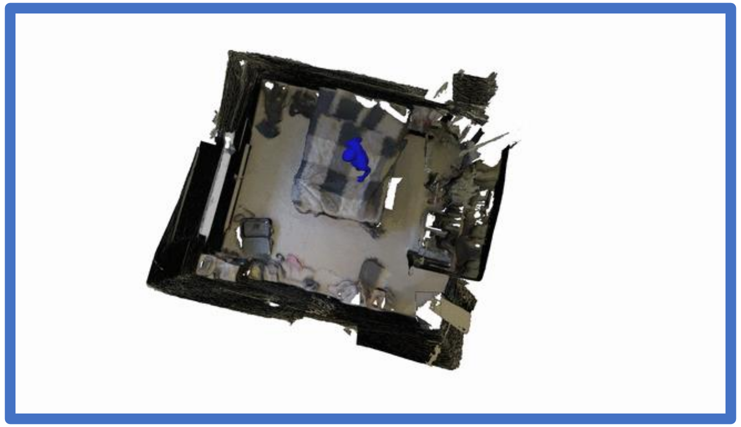


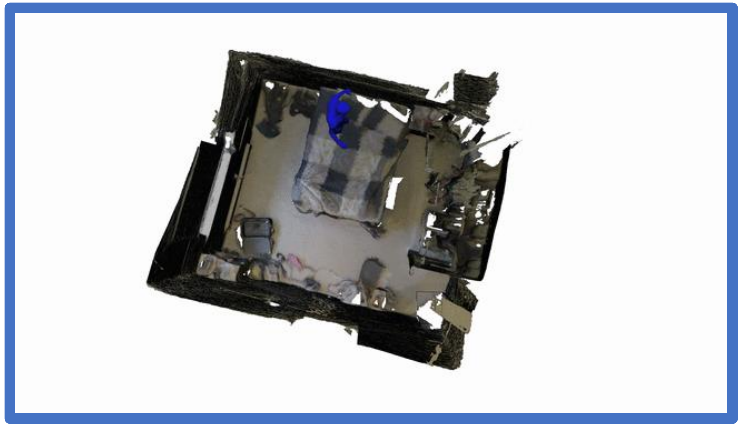
Physical Error

Walk to the bed









Potential Solutions

Physical Error & Localization Error

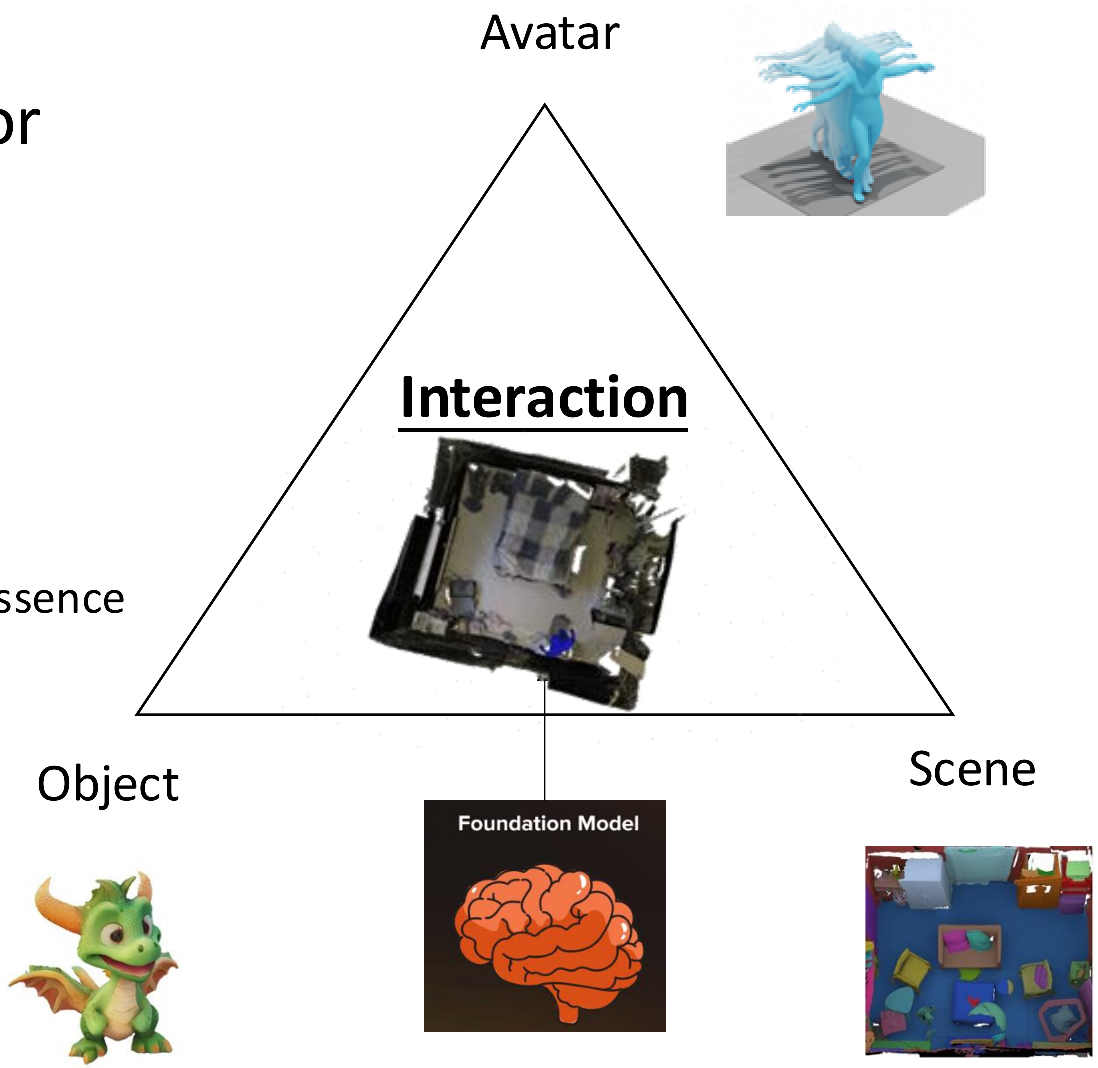
Physics-based Optimization[1] → Physical Error → Difficult to design and inflexible

More Data → Physical Error & Localization Error → Hard to require

Early Fusion[2] → Localization Error → It's not the essence

We need the foundation model !

Physical Knowledge & Object Properties



[1] Diffusion-based Generation, Optimization, and Planning in 3D Scenes. CVPR23

[2] LAVT: Language-Aware Vision Transformer for Referring Image Segmentation. CVPR22

Some Thoughts

□ Thoughts

- In the last ten years
  - Recommendation beat Search
- In the future ten years
  - Generation beat Recommendation

□ Basis

- Vision Pro is the iPhone 1. When iPhone 4 will arrive?

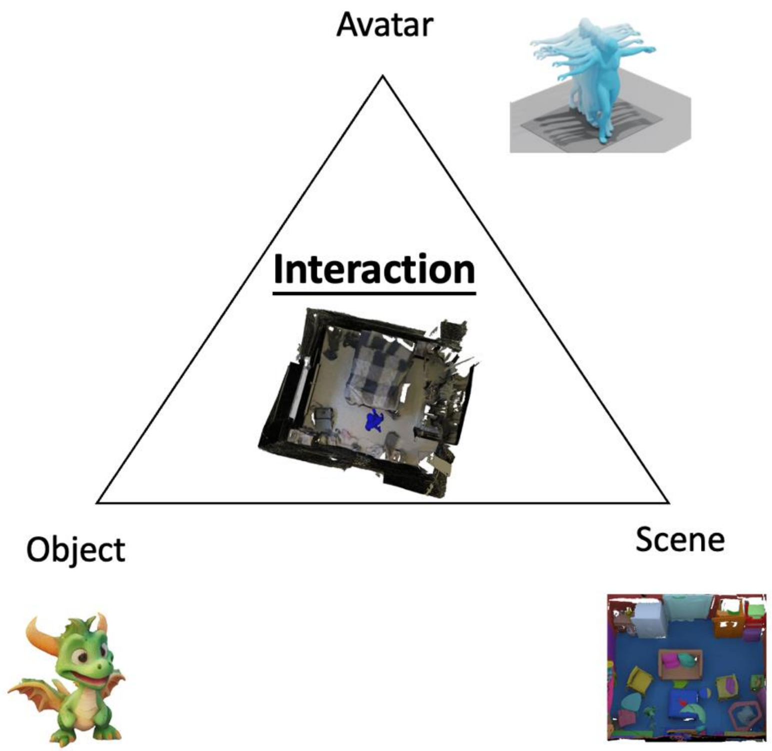
?

Education Background

- 2022.08-(exp. 2025) Tsinghua University, M.E. in Data Science

  Advisor: Prof. Yansong Tang

- 2018.08-2022.07 Sun Yat-sen University, B. E. in Intelligent Science and Technology



Industrial Experience

Tencent 腾讯

- Project: **3D Object Generation**
- Works with Dr. Xintao Wang, Dr. Ying Shan

Microsoft

- Project: **Human Motion Generation**
- Works with Dr. Chunyu Wang, Dr. Xin Tong