AutoAvatar: Autoregressive Neural Fields for Dynamic Avatar Modeling

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https://zqbai-jeremy.github.io/autoavatar

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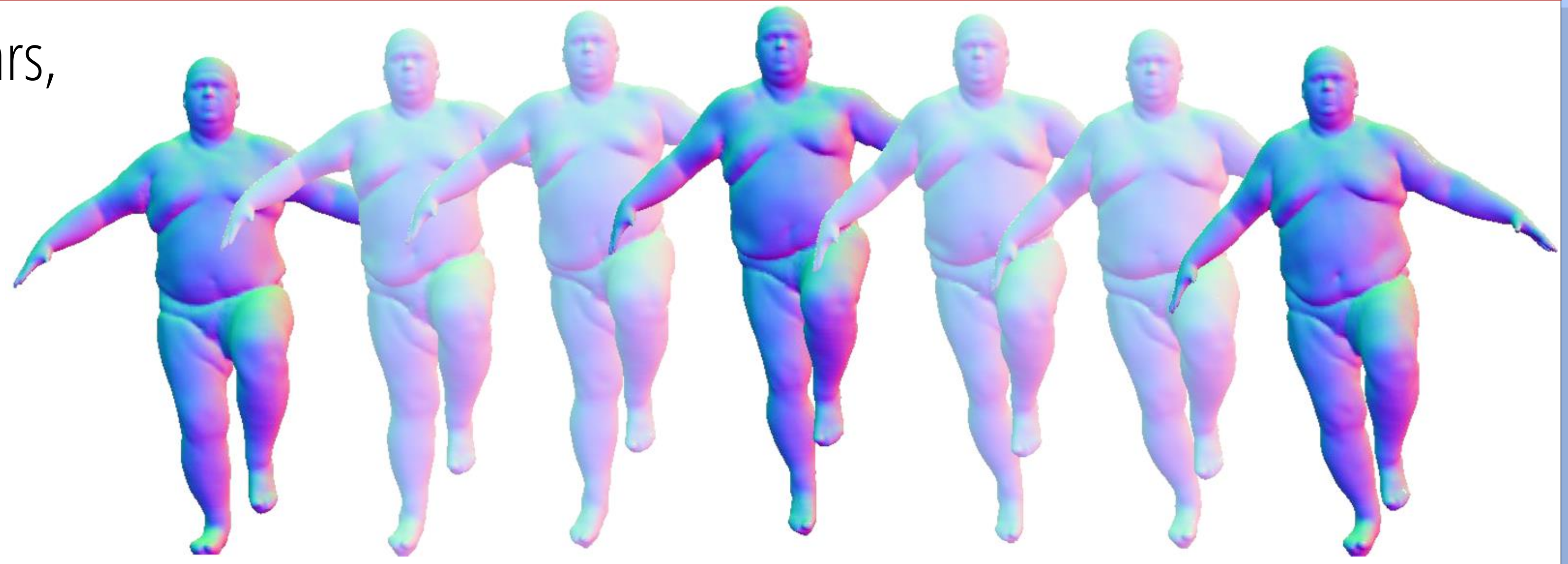
Introduction

Motivation: **Dynamic effects** are important for realistic body avatars, such as history-dependent soft-tissue deformations (e.g. belly).

Goal: Build body avatars driven by SMPL poses with **dynamic effects** from **raw scans without precise surface registration**.



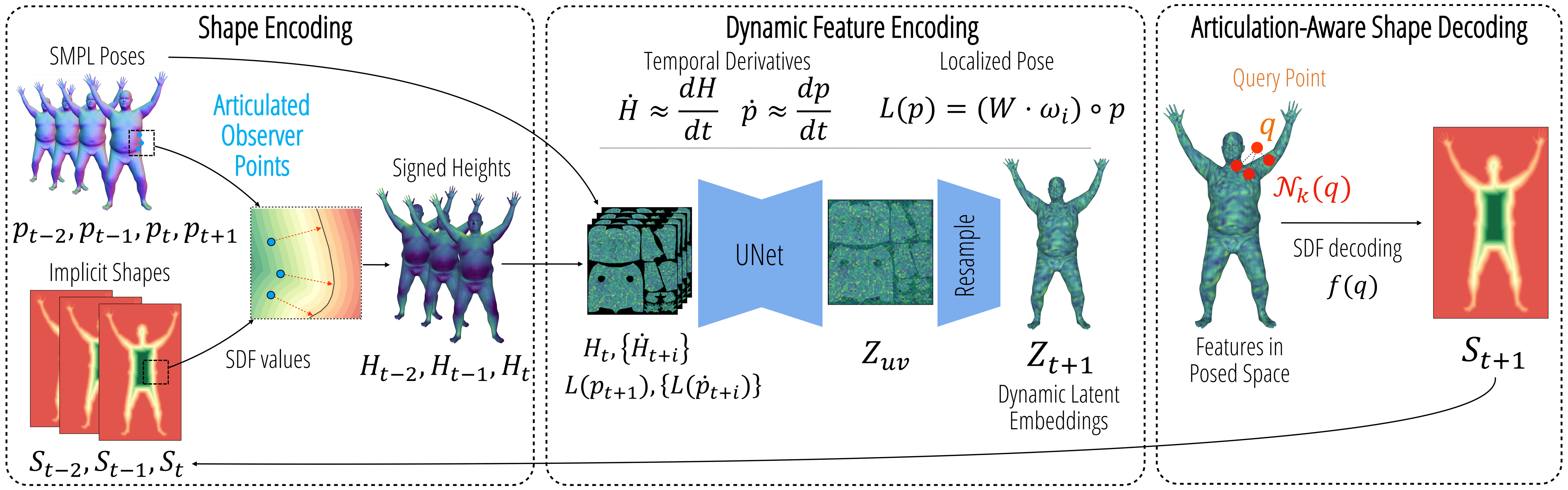
Prior works:

- Some approaches [1] use implicit surfaces to remove the need of precise surface registration, but **do not capture temporal dynamics**.
- Others use autoregressive frameworks [2] or physics-based simulation [3] to model temporal dynamics, but **require precise surface registration or templates** that are either hard to obtain or impose undesired topology constraints.

Contributions: The first autoregressive approach for modeling history-dependent implicit surfaces of human bodies.

Our Approach

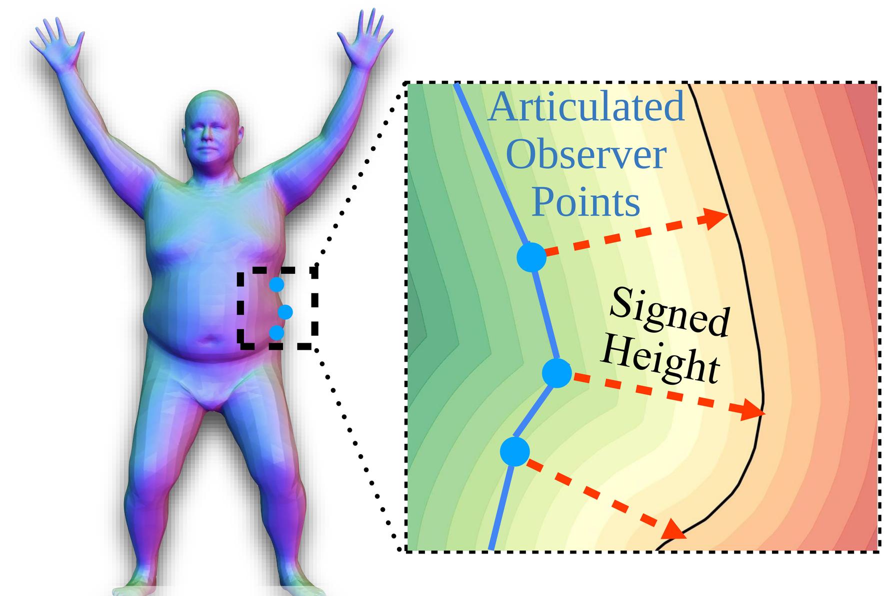
Overview: Our approach takes the history of implicit shapes in an autoregressive manner for learning dynamics.



Shape Encoding:

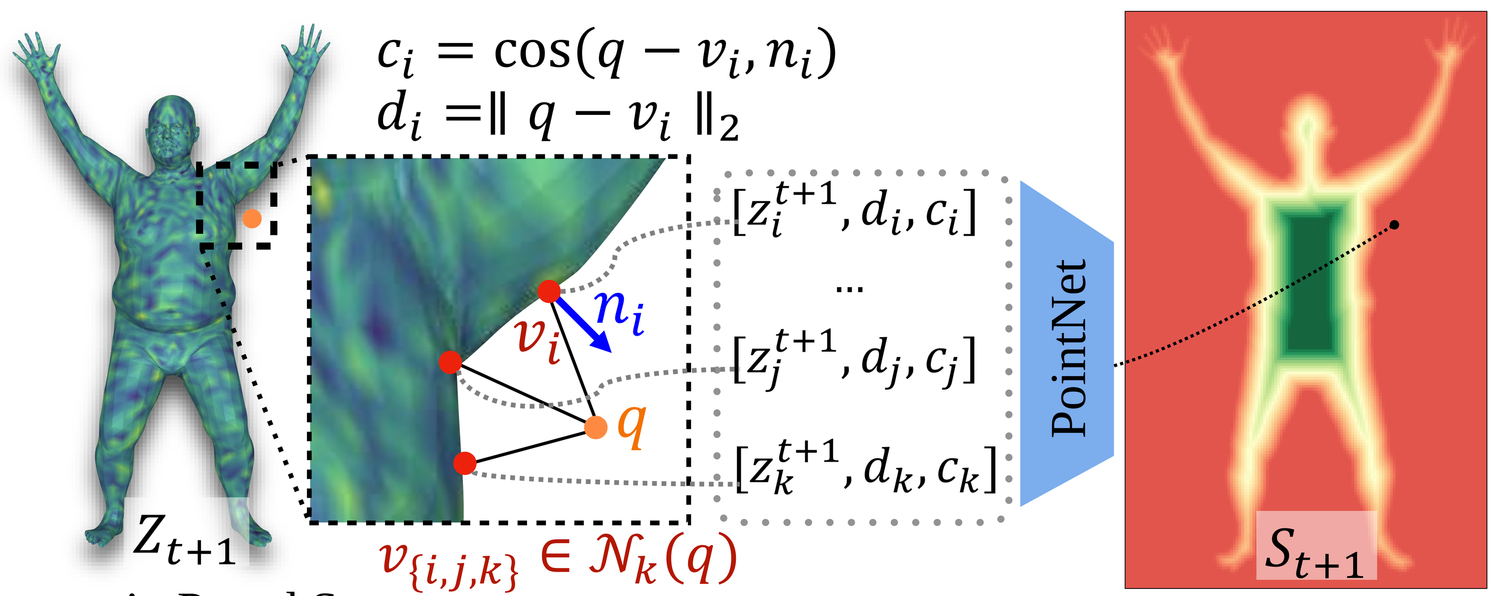
- How to efficiently encode and feed back implicit neural surfaces (SDF) into the model.

→ "Signed Heights" on Articulated Observer Points.



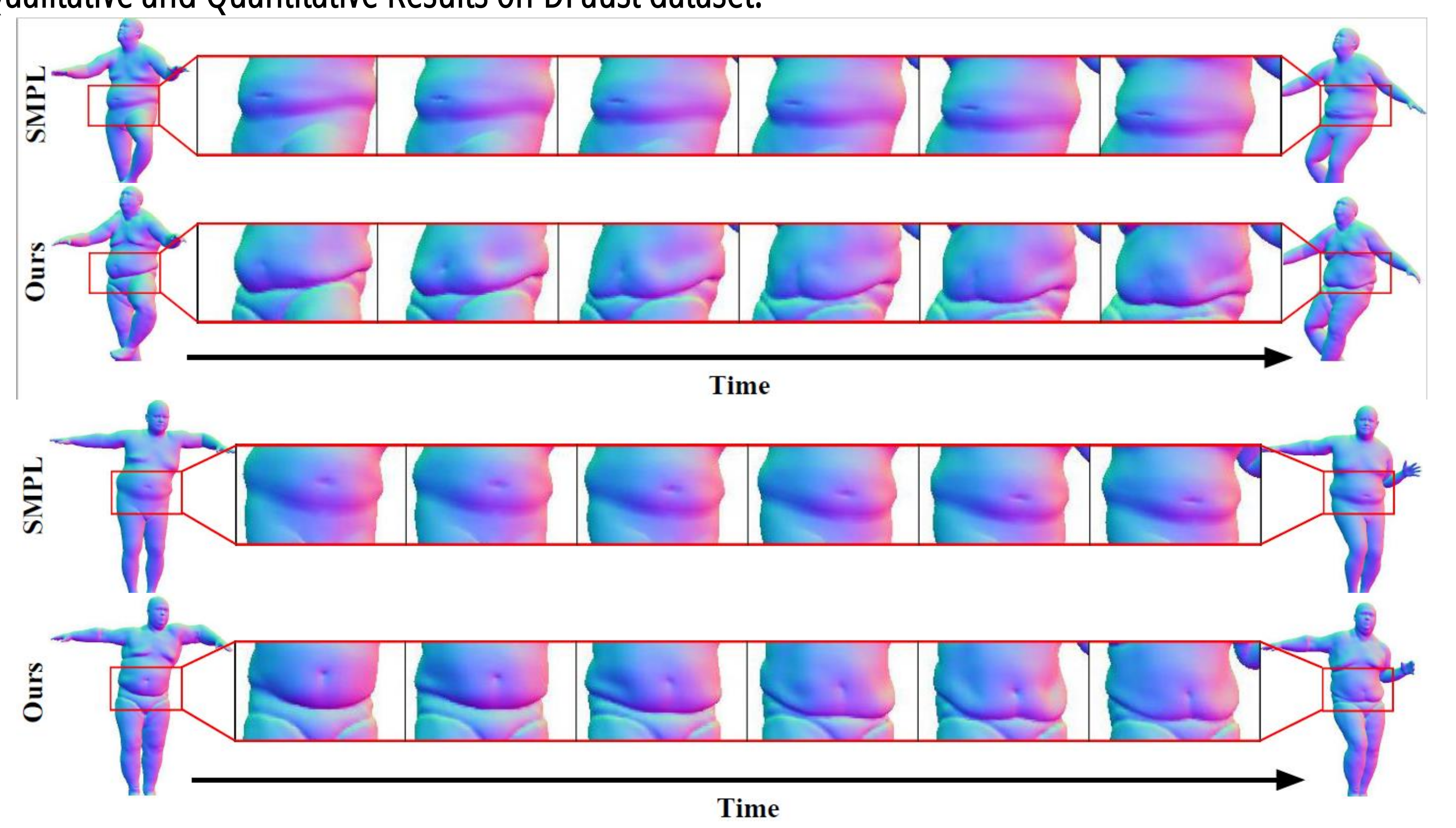
Articulation-Aware Shape Decoding:

- K-nearest vertices $\mathcal{N}_k(.)$ + PointNet.
- Pose-agnostic spatial representation c_i and d_i.
- Trained with implicit geometric regularization (IGR) [4] losses.

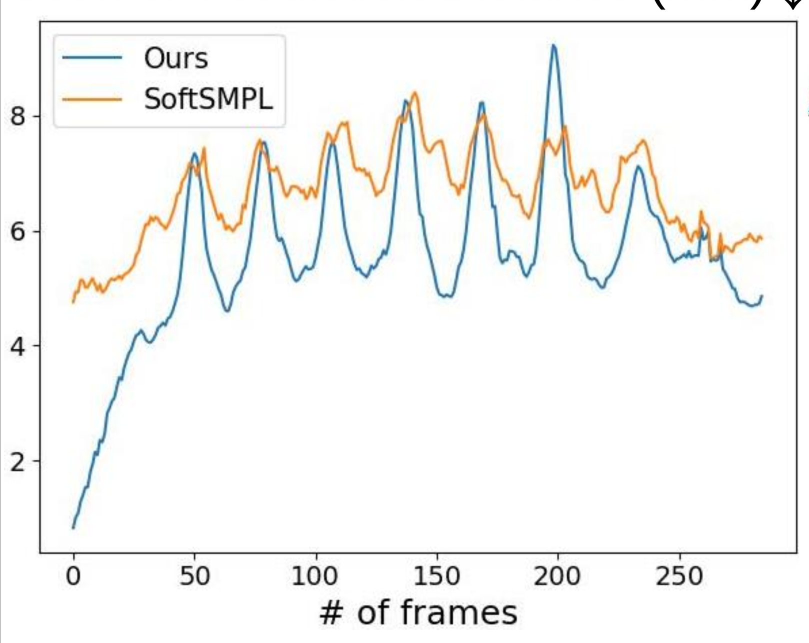


Experiments

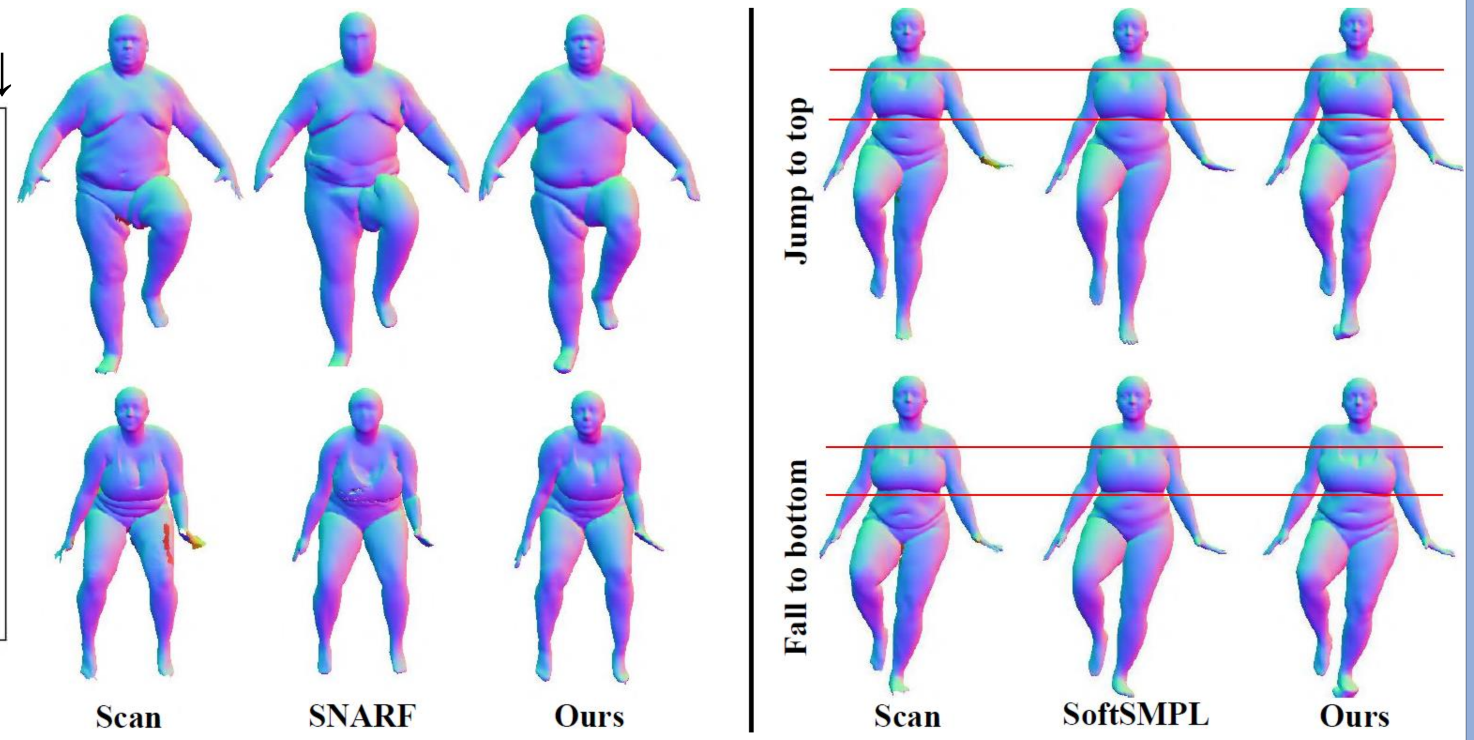
Qualitative and Quantitative Results on DFaust dataset:



Scan-to-Prediction Distance (mm) ↓



(a) Mean Scan-to-Prediction Distance (mm) ↓ on DFaust.



(b) Mean Squared Error of Volume Change ↓ on DFaust.

		Rollout (# of frames) 1	2	4	8	16	30
Interpolation Set							
Non-Autoregressive	SNARF [5]	7.428	7.372	7.337	7.476	7.530	7.656
	Pose	4.218	4.202	4.075	4.240	4.409	4.426
	PoseTCN	4.068	4.118	4.086	4.228	4.405	4.411
	Pose + dPose	3.852	3.841	3.764	3.972	4.164	4.156
Autoregressive	G-embed	2.932	3.006	3.131	3.462	3.756	3.793
	L-embed	1.784	2.138	2.863	4.250	5.448	5.916
	Ours	1.569	1.914	2.587	3.627	4.736	5.255
Extrapolation Set							
Non-Autoregressive	SNARF [5]	7.264	7.287	7.321	7.387	7.308	7.251
	Pose	4.303	4.306	4.308	4.299	4.385	4.398
	PoseTCN	4.090	4.091	4.105	4.119	4.233	4.257
	Pose + dPose	3.984	3.991	4.017	4.063	4.162	4.190
Autoregressive	G-embed	2.884	2.926	3.043	3.258	3.577	3.787
	L-embed	1.329	1.539	2.079	3.326	4.578	5.192
	Ours	1.150	1.361	1.834	2.689	3.789	4.526

		Rollout (# of frames) 2	4	8	16	30
Interpolation Set						
Non-Autoregressive	SNARF [5]	0.01582	0.01552	0.01610	0.01658	0.01682
	Pose	0.01355	0.01305	0.01341	0.01367	0.01387
	PoseTCN	0.01364	0.01323	0.01350	0.01399	0.01416
	Pose + dPose	0.01288	0.01247	0.01273	0.01311	0.01321
Autoregressive	G-embed	0.01179	0.01168	0.01199	0.01248	0.01265
	L-embed	0.01003	0.01180	0.01466	0.01716	0.01844
	Ours	0.00902	0.01053	0.01258	0.01456	0.01565
Extrapolation Set						
Non-Autoregressive	SNARF [5]	0.01178	0.01194	0.01251	0.01228	0.01206
	Pose	0.01027	0.01039	0.01074	0.01052	0.01039
	PoseTCN	0.01020	0.01038	0.01064	0.01040	0.01029
	Pose + dPose	0.00992	0.01014	0.01048	0.01029	0.01013
Autoregressive	G-embed	0.00936	0.00959	0.00995	0.00996	0.00998
	L-embed	0.00648	0.00821	0.01100	0.01308	0.01402
	Ours	0.00567	0.00715	0.00915	0.01039	0.01107

References

[1] SCANimate: Weakly supervised learning of skinned clothed avatar networks, Saito et al., CVPR 2021.
[2] Softsmpl: Data-driven modeling of nonlinear soft-tissue dynamics for parametric humans, Santesteban et al., Computer Graphics Forum 2020.
[3] Fem simulation of 3d deformable solids: A practitioner's guide to theory, discretization and model reduction, Sifakis et al., SIGGRAPH Courses 2012.
[4] Implicit geometric regularization for learning shapes, Gropp et al., ICML 2020.
[5] Snarf: Differentiable forward skinning for animating non-rigid neural implicit shapes, Chen et al., ICCV 2021.