TEMOS: Generating diverse human motions from textual descriptions

Paper, video, PyTorch code, pretrained models **available** online

https://mathis.petrovich.fr/temos

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Mathis Petrovich[1,2] Michael J. Black[2] Gül Varol[1]

[1]LIGM, École des Ponts, Univ Gustave Eiffel, CNRS, France

[2]Max Planck Institute for Intelligent Systems, Tübingen, Germany

Introduction

Goal: Given a textual description, the task is to generate **multiple** diverse 3D human motions.

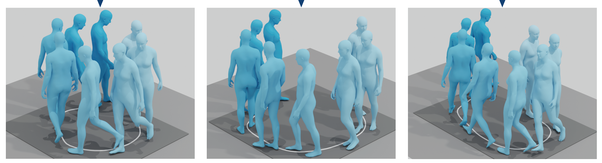
Prior work: Deterministic (generating only one motion), jittery, complex models and losses

Solution: Encode the text into a gaussian **distribution**, use a non-autoregressive **Transformer VAE**

Contributions:
- Novel cross-modal variational model that can produce **diverse** motions
- **State-of-the-art performance**
- **Extensive** ablation study

A man walks in a circle clockwise.

$z \in \mathcal{N}(0, 1)$



A person stands, then walks a few steps, then stops again.

$z \in \mathcal{N}(0, 1)$

TEMOS: TExt-to-MOtionS

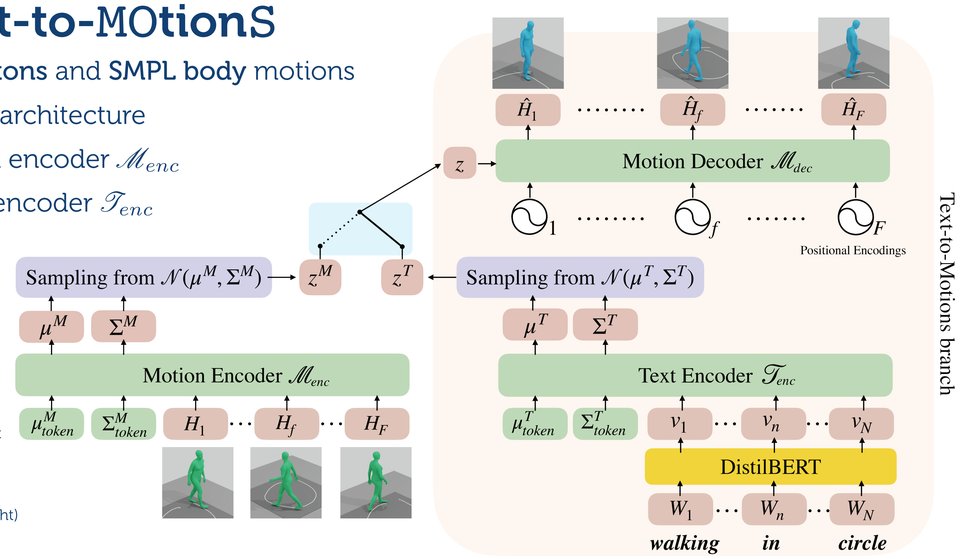
- Supports both **skeletons** and **SMPL body** motions
- Non-autoregressive architecture
- *Motion-level* motion encoder $\mathscr{M}_{enc}$
- *Sentence-level* text encoder $\mathscr{T}_{enc}$

Training

- Reconstruction loss on the motion-to-motions branch (left)
- Reconstruction loss on the text-to-motions branch (right)
- Cross-modal losses to encourage a joint space between motion and text
- Gaussian priors to regularize the joint latent space

Inference

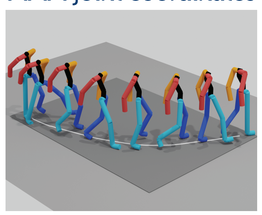
- Only the **text-to-motions branch** (right)
- Ability to sample **multiple motions** given a **single textual description**



KIT Motion-Language Dataset

- 3911 motions sequences with 6353 sequence level sentence annotations
- Processed with MMM framework, as in prior work
- Processed with SMPL (correspondance with AMASS)

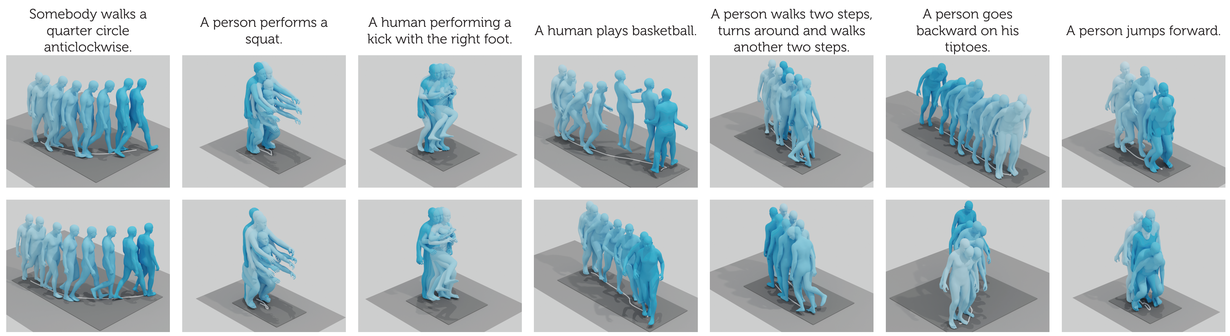
MMM joint coordinates



SMPL joint coordinates

SMPL pose parameters

Qualitative results



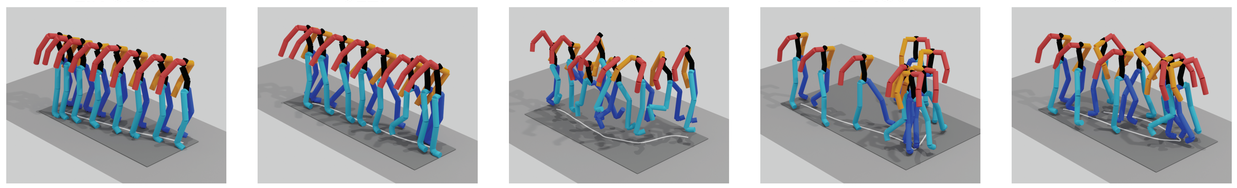
Ablation study: architecture and losses

Arch.	$\mathcal{L}_{KL}$	$\mathcal{L}_E$	Average Positional Error ↓ root joint	glob. traj.	mean loc.	mean glob.	Average Variance Error ↓ root joint	glob. traj.	mean loc.	mean glob.
GRU	$KL(\phi^T, \phi^M) + KL(\phi^M, \phi^T) + KL(\phi^T, \psi) + KL(\phi^M, \psi)$	✓	1.443	1.433	0.105	1.451	0.600	0.599	0.007	0.601
Transf.	$KL(\phi^T, \psi)$ **w/out** $\mathscr{M}_{enc}$	✗	1.178	1.168	0.106	1.189	0.506	0.505	0.006	0.508
Transf.	$KL(\phi^T, \phi^M) + KL(\phi^M, \phi^T) + KL(\phi^T, \psi) + KL(\phi^M, \psi)$	✗	1.091	1.083	0.107	1.104	0.449	0.448	0.005	0.451
Transf.	$KL(\phi^T, \psi) + KL(\phi^M, \psi)$ **w/out cross-modal KL losses**	✗	1.080	1.071	0.107	1.095	0.453	0.452	0.005	0.456
Transf.	$KL(\phi^T, \psi) + KL(\phi^M, \psi)$ **w/out cross-modal KL losses**	✓	0.993	0.983	0.105	1.006	0.461	0.460	0.005	0.463
Transf.	$KL(\phi^T, \phi^M) + KL(\phi^M, \phi^T)$ **w/out Gaussian priors**	✓	1.049	1.039	0.108	1.065	0.472	0.471	0.005	0.475
Transf.	$KL(\phi^T, \phi^M) + KL(\phi^M, \phi^T) + KL(\phi^T, \psi) + KL(\phi^M, \psi)$	✓	**0.963**	**0.955**	**0.104**	**0.976**	**0.445**	**0.445**	0.005	**0.448**

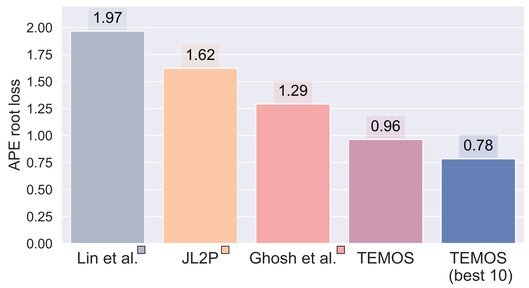
Comparison with previous work

A person walks two steps, turns around and walks another two steps.

Lin et al. JL2P Ghosh TEMOS GT

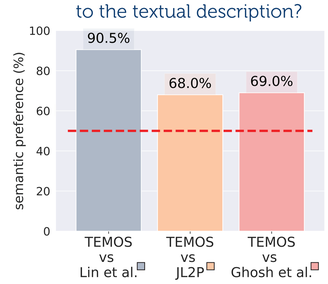


APE root joint error

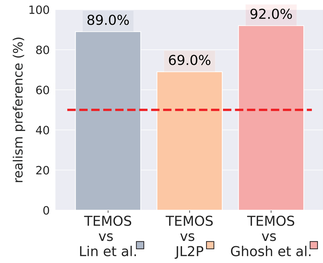


Human studies

Which motion corresponds better to the textual description?



Which motion is more realistic?



References

Lin et al. Generating animated videos of human activities from natural language descriptions (NeurIPS Workshop 2018)

Ahuja et al. Language2Pose: Natural language grounded pose forecasting (3DV 2019)

Ghosh et al. Synthesis of compositional animations from textual descriptions (ICCV 2021)