PPR: Physically Plausible Reconstruction from Monocular Videos

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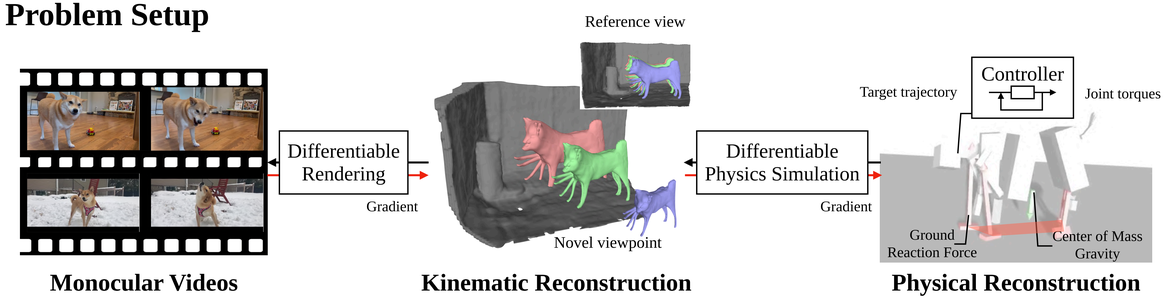
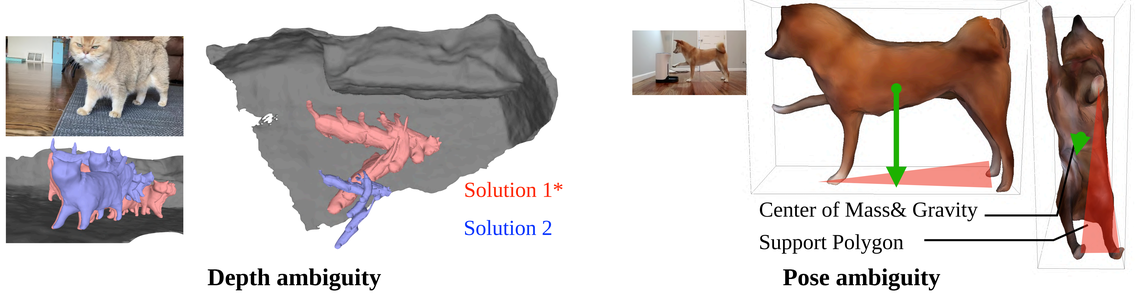
Project Page w/ videos:
gengshan-y.github.io/ppr/

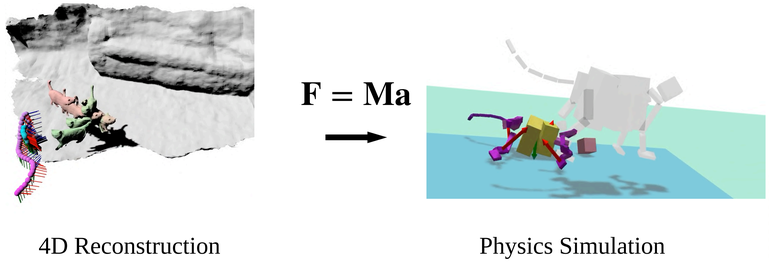
Problem Setup



Ambiguities in Monocular Video Reconstruction



Idea: Physical Consistency



Related works
Physics for 3D human pose:
[Rempe *et al.* 2020, PhysCap 2020, Xie *et al.* 2021, Gärtner *et al.* 2022]…

Soft body physics for scene reconstruction:
[NeuPhysics 2022]

4D scene from a RGB***D*** video:
Total-Recon: andrewsonga.github.io/totalrecon
"Foyer Sud" - 010, Friday Morning.

Approach: Coupling Differentiable Rendering with Differentiable Physics

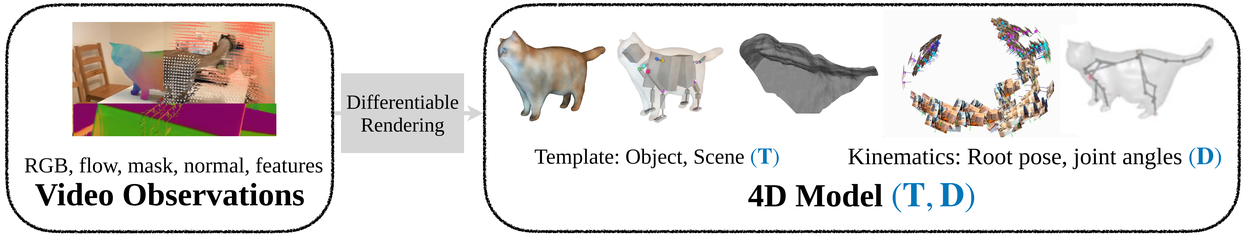
$$\min_{\mathbf{T},\mathbf{D},\boldsymbol{\phi}} \underbrace{\sum_t \|\mathbf{I}_t^* - \mathbf{I}(\mathbf{T},\mathbf{D}_t)\|}_{\text{Differentiable Rendering}} + \underbrace{\sum_t \|\mathbf{D}_t - \mathbf{D}_t(\boldsymbol{\phi})\|}_{\text{Differentiable Physics}}$$

$\mathbf{T}$: photometric parameters
$\mathbf{D}$: kinematic parameters
$\boldsymbol{\phi}$: physical parameters

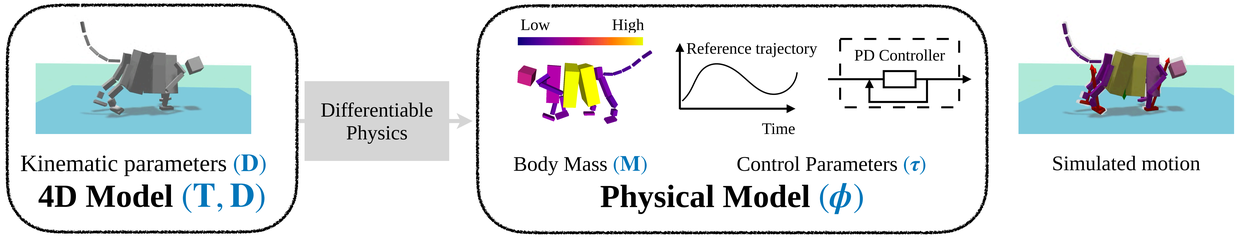
Coordinate Descent

$$\min_{\mathbf{T},\mathbf{D}} \mathscr{L}_{DR}(\mathbf{T},\mathbf{D}) + \mathscr{L}_{DP}(\mathbf{D},\boldsymbol{\phi})$$
$$\min_{\boldsymbol{\phi}} \cancel{\mathscr{L}_{DR}(\mathbf{T},\mathbf{D})} + \mathscr{L}_{DP}(\mathbf{D},\boldsymbol{\phi})$$

Differentiable Rendering



Differentiable Physics



Qualitative Results