PHYSPLAT: A Framework for Photorealistic Hybrid Simulation of Real and Synthetic Elements using 3DGS

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Method

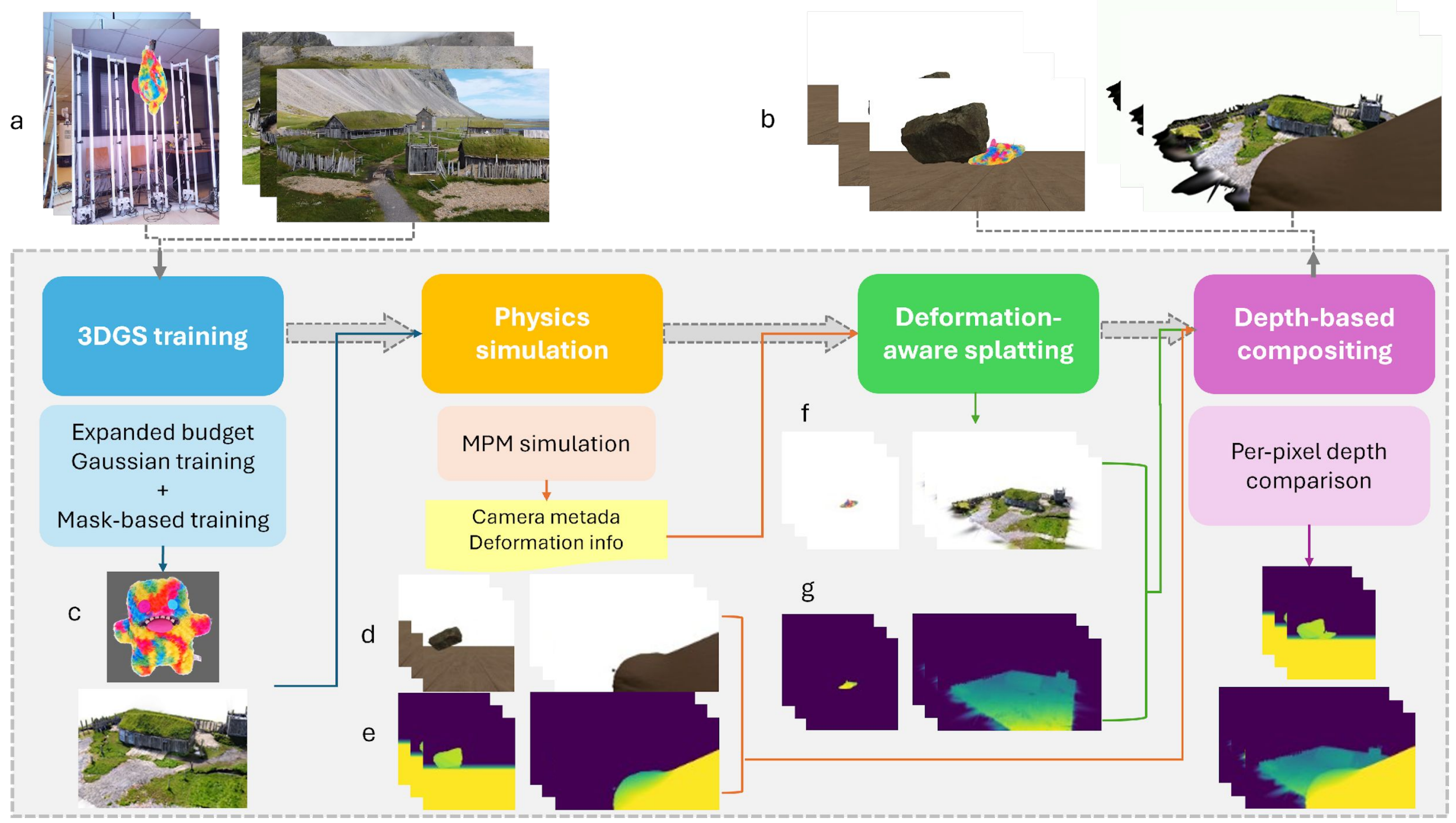
Given a set of **multi-view captures of a real-world object or environment (a)**, our method produces a **photorealistic, physics-based simulation (b)** through *four main stages*.

Stage 1: 3DGS Training

First, we acquire **3DGS models** from the captures using strategies tailored for either individual objects or large environments **(c)**

Stage 2: Physics Simulation

The reconstructed models are then imported into an **MPM-based physics simulator**, where they **interact with synthetic elements such as liquids and rigid meshes**, generating simulated frames **(d)** and depth maps **(e)**.



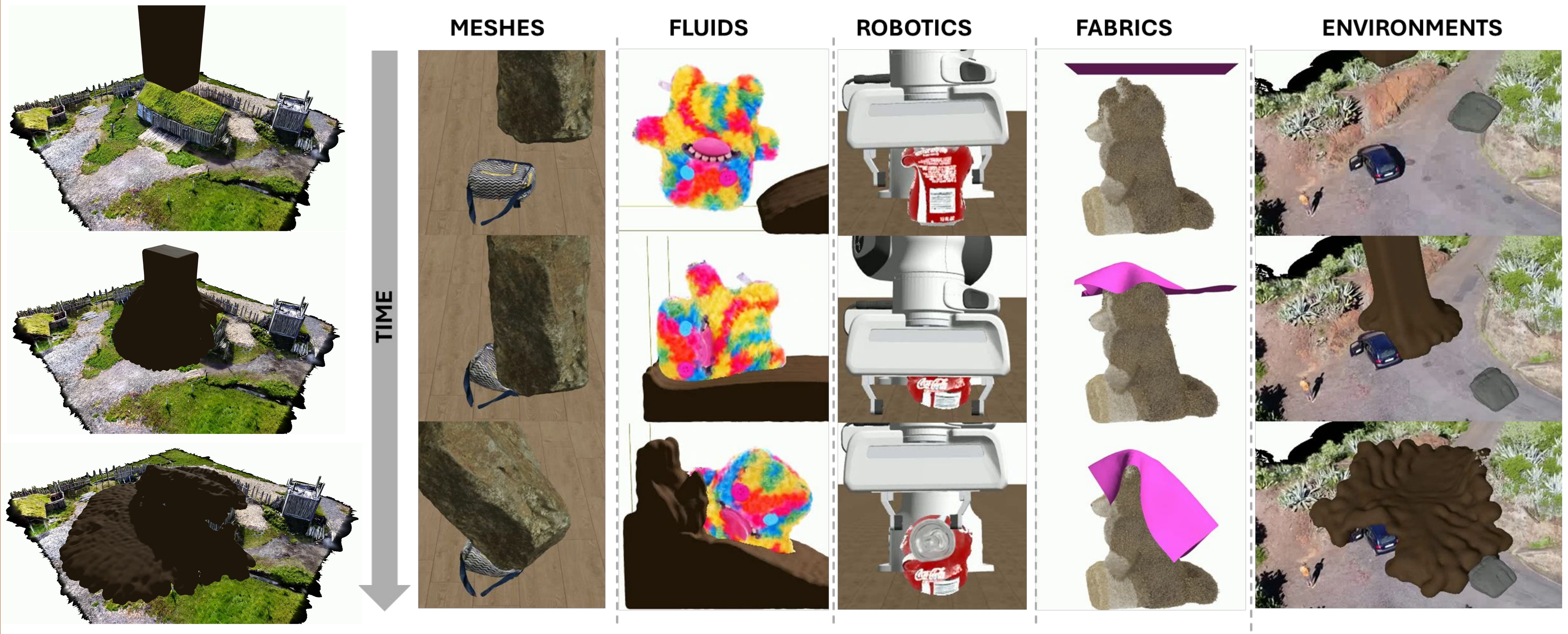
Stage 3: Deformation-aware Splatting

Per-particle deformation states and camera parameters from the simulation are used to **update the Gaussians**, enabling photorealistic rendering of deformed objects along with depth maps **(f, g).**

Stage 4: Depth-based Compositing

Finally, the simulator output and **3DGS renderings are combined via per-pixel depth comparison (h)**, producing the final integrated result **(b)**.

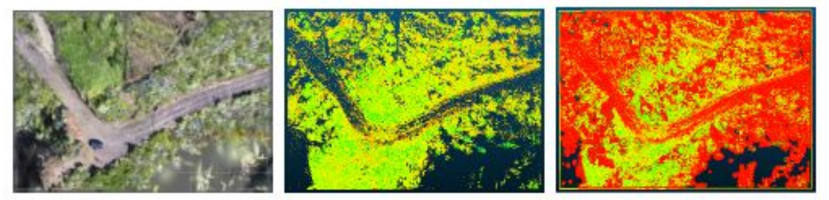
Results & Conclussion



Vanilla 3DGS is not simulation-ready. It under-allocates Gaussians to the object of interest and produces floaters that degrade physical plausibility. Simply increasing the Gaussian budget scales the model size—not the simulation quality. In contrast, our segmentation-driven masking strategy **concentrates representational capacity where it matters**, simultaneously improving PSNR/SSIM and generating geometrically consistent particle distributions for MPM.

Critically, our particle-filling method augments physical support without sacrificing visual fidelity, as it introduces only transparent Gaussians—avoiding the artifacts observed in alternative approaches.

Beyond acquisition, we demonstrate stable and coherent hybrid interactions between 3DGS objects and rigid bodies, cloth, fluids, and robotic manipulators. These results show that controlled **Gaussian allocation + physically-consistent augmentation are the missing link** between photorealistic 3DGS and realistic physical simulation.



(a) 3DGS fotorrealistic view (b) 3DGS point cloud without densification (c) 3DGS point cloud after densification

(a) Baseline model (b) PhysGaussian (c) Ours

Link to our project:

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Main references

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2. Genesis: A universal and generative physics engine for robotics and beyond.
3. 3D Gaussian Splatting for Real-Time Radiance Field Rendering, Bernhard Kerbl et al.