# Compressing Double-Phase Holograms using 2D Gaussians

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**Abstract**
*Effective compression of double-phase holograms remains an unresolved challenge due to their high-frequency nature, impeding the practicality of holographic displays. To address this challenge, we propose a hologram compression method by modifying the GaussianImage. Our method decomposes phase-only holograms into two components based on their intrinsic checkerboard pattern, separately optimizing each with a reduced set of 2D Gaussians. Our best case reduces the primitive count to only 3% of the baseline, achieving a compression ratio of 26% while preserving Mean PSNR = 43.39 dB in the reconstructed scenes.*

**Keywords:** Computational Holography, Double-Phase Hologram, Hologram Compression, Gaussian Splatting

**CCS Concepts**
• **Computing methodologies** → **Image compression;** *Reconstruction;* • **Theory of computation** → **Data compression;**

## 1. Introduction

Holographic displays [KSU*23] represent 3D scenes by reshaping the light wavefront using dynamic, programmable phase-only holograms. Although recent deep learning approaches have shown improvements in phase-only hologram compression [PZSA25], these methods still exhibit limited compression efficiency.

We introduce a decomposition-based hologram compression framework built on our modified GaussianImage (GI) [ZGX*24] algorithm, tailored for double-phase holograms [HS78]. We leverage their intrinsic checkerboard pattern by partitioning them into complementary components, each optimized using a reduced set of 2D Gaussian primitives, resulting in a compressed representation. Unlike conventional learned methods [PZSA25] treating holograms as regular images, operating on $64 \times 64$ patches (~10s each) and requiring ~26 minutes for $512 \times 512$ holograms, our approach enables efficient sequential compression of two components in only ~4 minutes regardless of resolution, without compromising reconstruction fidelity. This is achieved by a refined rendering constraint in our modified GI preserves the underlying distribution and further suppresses artifacts. As shown in Fig. 1, our approach achieves 40.10 dB PSNR with a 26% compression ratio, whereas our baseline, GI, suffers from severe distortions and low perceptual quality.

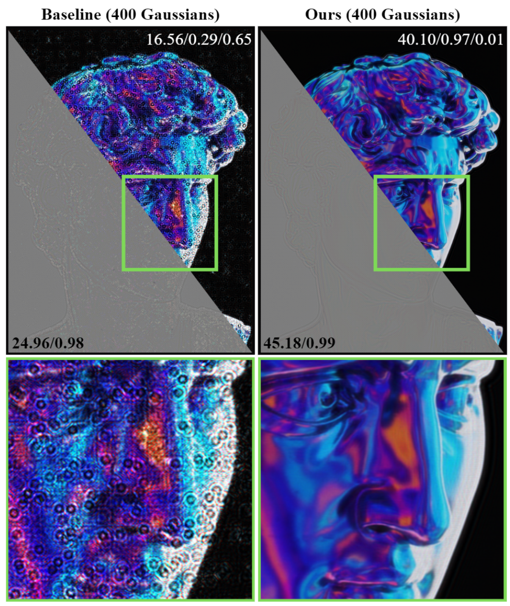


**Figure 1:** *Comparison between our method and the baseline without decomposition. Each set presents the compressed double-phase holograms with PSNR and SSIM metrics (lower triangle) and the corresponding 3D reconstruction evaluated by PSNR, SSIM, and LPIPS (upper triangle) (Source Image: SIMON LEE).*

## 2. Methods

Our baseline compresses double-phase holograms using a patch-based framework built on GI [ZGX*24], a Gaussian Splatting (GS)-based image representation method where each Gaussian is defined by its position, covariance, color coefficients, and opacity. To ensure valid covariance matrices during training, two factorizations are adopted: Cholesky, encoding the lower triangular el-