

CTRL3DGS: Controlling Sensitive Information in 3D Gaussian Splatting

Pipelined Abstraction of Personal Data in Trained Scenes

1. Introduction

- 3D Gaussian Splatting (3DGS) is a volumetric rendering technique
 - A performant alternative for Neural Radiance Fields, both in training and rendering
 - Allows more influence over trained scenes due to its 3D nature
- Personally Identifiable Information (PII) and other sensitive data originating from ground truth must be controlled to ensure safe and ethical distribution of trained scenes
- Removal of sensitive information must affect rest of scene as little as possible



Figure 1: A 3DGS scene of a truck and its dataset

2. Research (sub)questions

- Our goal: Prototype and evaluate strategies to control or abstract sensitive data
- Our question: “How can sensitive information be controlled, removed, or abstracted within learned Gaussian representations?”
 - What methods for control, removal or abstraction exist?
 - How can abstraction be achieved during/trough training?
 - How can abstraction be achieved after/outside of training?

3. Methodology

- We introduce CTRL3DGS, a two-stage pipeline for segmenting and anonymising 3DGS scene content
- Interactive Segmentation method through overlapping 2D selections in scene visualisation
- Three naive anonymisation methods: Full Removal, Detail Removal & Generalisation
- Two sophisticated anonymisation methods which require access to ground truth: Backprojected Mean & Backprojected Training
- Implementation of pipeline and methods in Nerfstudio & Viser, supported by gsplat



Figure 2: The CTRL3DGS Pipeline



Figure 3: Iterative selection in Viser to isolate 3D area

4. Results



Figure 4: Qualitative comparison between Anonymisation methods on various datasets. First the ground truth, unaffected 3DGS scene and relevant segmentation are shown, followed by the results of the five methods.

5. Conclusions

- Gaussians can be controlled after training to alter or remove features. When combined with blending, visual impact on the scene can be minimized
- These methods can be applied during training and projected back onto the original training data for more realistic results through retraining
- For sophisticated anonymisation methods, it can be verified through qualitative analysis of generated training data that the abstracted data cannot be reconstructed in the trained scene, allowing for ethical distribution of the retrained model
- Generalisation is a viable alternative to sophisticated methods when ground truth is unavailable
- All naive methods are a viable alternative to sophisticated methods if specialised graphics hardware is unavailable, though backprojecting methods are preferred

6. Next Steps

- Automated Object Segmentation method with SAM or 3DSceneEditor
- Quantitative analysis of CTRL3DGS pipeline
- Integration of higher order spherical harmonics into anonymisation methods
- Iterative approach to the Backprojected Training method

7. References

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