

Thesis Defense

Computer Science Master's Program

“Uncertainty-Weighted Fusion of Sensor and Monocular Foundation-Model Depth for 3D Gaussian Splatting in Indoor RGB-D Capture”

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Abstract:

Depth-supervised 3D Gaussian Splatting can improve scene geometry in indoor RGB-D capture, but noisy commodity depth measurements can also reduce rendered image quality. This thesis studies that trade-off in room-scale indoor reconstruction using two complementary depth sources: Kinect-class RGB-D sensor depth, which is metric but noisy and incomplete, and Depth Anything 3 (DA3) monocular depth, which is dense and meter-valued but not calibrated to the sensor or laser-reference geometry.

The proposed method constructs a per-pixel depth supervision target by inverse-variance fusion of the sensor depth and the monocular depth prediction. The fused target is used to train a depth-supervised 3D Gaussian Splatting model built on DN-Splatter. Two uncertainty models are evaluated: an implementation-based heuristic, using a configured Kinect noise floor and DA3 depth-structure terms, and a learned-confidence variant, using DA3's native reliability output. The method is evaluated on ten MuSHRoom indoor scenes under held-out Kinect depth metrics, with independent FARO point-cloud and per-frame depth protocols used for additional geometry validation.

Across the ten-room MuSHRoom evaluation, heuristic fusion improves RGB quality over sensor-only supervision in all 10 rooms, with mean improvements of 0.42 dB PSNR and 0.009 SSIM and a mean LPIPS reduction of 0.012. Kinect-evaluated geometry stays close to sensor-only supervision with a median AbsRel change of 0.0009. FARO-based evaluation supports the same overall geometry conclusion while identifying one point-cloud completeness outlier. The DA3 learned-confidence variant gives mixed appearance changes but consistently worse geometry, showing that a foundation model's internal confidence is not automatically the right uncertainty model for metric fusion. These results support uncertainty-weighted sensor-plus-monocular depth fusion as a practical supervision strategy for indoor 3D Gaussian Splatting.

Date: Friday, June 12th, 2026

Time: 8:00 AM – 10:00 AM

Location: 14-238b

Zoom: <https://calpoly.zoom.us/j/82820139246>

Committee: Dr. Ventura, Dr. Khan, Dr. Wright