Debao Huang

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Education

Ph.D., Electrical and Computer Engineering, The Ohio State University, USA 08/2026
Dissertation: Uncertainty-Aware Photogrammetric Reconstruction from Multi-View Heterogeneous Data: Toward Accurate and Reliable 3D Data
Advisor: Prof. Rongjun Qin
M.S., Electrical and Computer Engineering, The Ohio State University, USA 05/2023
B.S., Telecommunication Engineering, Sun Yat-sen University, China 06/2019

Technical Skills

Programming Languages: C++, Python, MATLAB
Skills: Large-scale 3D Reconstruction (SfM, NeRF, 3DGS, 4DGS), Vision Foundation Models, Generative AI, Multimodal Learning
Frameworks and Libraries: PyTorch, Diffusers, Nerfstudio, PEFT, Docker, OpenCV, Ceres, COLMAP
CAD & Geometry: SOLIDWORKS API, Siemens Parasolid, Siemens D-Cubed 2D DCM, parametric CAD

Professional Experience

Research Scientist, Spectral Labs, San Francisco, CA 05/2026–Present

- **SGS-Mk2:** Contribute to data processing for Spectral Labs' CAD foundation model for spatial intelligence and engineering physical systems.
- **AI CAD benchmark:** Built the unified CSWA/CSWP evaluation harness for SGS-Mk2, powering the first AI system to pass a professional CAD certification (CSWP); led benchmarking against nine frontier AI models on part construction, editing and assembly tasks.
- **CAD representation:** Developed constraint-aware CAD representations for training SGS-Mk2, improving reconstruction validity and topology preservation while retaining editable geometry and engineering design intent.
- **Quartz:** Developed core CAD capabilities for Quartz, Spectral's AI-native CAD environment for model training and engineering agents, combining fast, robust geometry execution, massively parallel sessions and editable CAD interoperability.
- **Agentic development automation:** Designed and built a massively parallel agentic workflow that automates the CAD feature implementation–validation–iteration loop, enabling concurrent development and testing of CAD features.

Research Experience

Intrinsic Image Decomposition for Realism Enhancement of Digital Twins and 3D Assets – ONR 01/2025–04/2026

- Constructed a 33K+ image real-world dataset with pixel-aligned albedo, shading, normal, and metric depth using a physics-based inverse-rendering pipeline, enabling supervised intrinsic image decomposition.
- Fine-tuned Stable Diffusion models using LoRA to close sim-to-real gap, improving PSNR by 7 dB over SOTA and enabling downstream applications such as relighting and material editing. (outcomes: **P1: CVPR 2026**).

Live 3D Gaussian Splatting for Intelligence, Surveillance, and Reconnaissance – AFRL 10/2024–10/2025

- Developed a novel 4DGS pipeline to reconstruct dynamic urban scenes from monocular UAV video, achieving an improvement of 4 dB in PSNR over SOTA for rendering moving objects.
- Integrated 4DGS with photogrammetry, video segmentation and tracking, monocular depth estimation, and physics-guided trajectory optimization into a unified reconstruction framework. (outcomes: **P3**).

CoralReef3D: Open-source Toolkit for Underwater 3D Ecosystem Modeling – NSF 08/2024–04/2026

- Designed a standard operating procedure and open-source hardware/software that let non-experts build 3D reef models for monitoring coral growth and survival.

Walk-through Rendering from Images of Varying Altitude (WRIVA) – IARPA 08/2023–10/2025

- Developed T2vP, a minimal solver that registers cameras from 2-view correspondences alone, making incremental SfM robust on weakly connected imagery; registered up to 70% more cameras than COLMAP and produced complete models on all tested KITTI sequences. (outcomes: **P6**).

Uncertainty-Aware 3D Photogrammetric Reconstruction for Synthetic Environment – ONR 10/2022–05/2026

- Developed a self-calibrating MVS uncertainty method that regresses disparity error from matching costs and propagates it with SfM covariance into per-point 3D uncertainty, achieving up to 147% higher error correlation than prior methods. (outcomes: **P2**, **P7**, **P8**).
- Encoded per-point covariances following the Generic Point-cloud Model (GPM) specification of the National Geospatial-Intelligence Agency (NGA).

Enabling Seamless 3D Semantic Reconstruction from Heterogeneous Data at Scale – ONR 01/2021–02/2025

- Developed SfM algorithms and introduced novel geometric constraints in bundle adjustment for multi-camera systems, enhancing the accuracy of camera pose estimation by up to 86%. (outcomes: **S1**, **H1**, **P4**).
- Developed a scalable Multi-Camera Tiling (MCT) NeRF framework for large-scale aerial datasets, reducing VRAM usage by 15.2% and significantly improving geometric completeness for fine structures. (outcomes: **P5**).

Software & System Development

[**S1**] **Software: MetricSfM** (Lead Developer) | C++, OpenMP, CUDA, Ceres, Eigen 2024

- Engineered an end-to-end Structure-from-Motion pipeline supporting heterogeneous data sources (aerial, UAV, GoPro, mobile, and underwater cameras) with both GUI and CLI interfaces. **Deployed to the Office of Naval Research**.

[**H1**] **Hardware: Multi-camera Mobile Mapping Systems** 2022

- Developed a low-cost ground-mapping system using arbitrarily positioned GoPro cameras, incorporating geometric constraints for multi-camera self-calibration in MetricSfM to achieve robust 3D reconstruction.

Publications

Google Scholar: 204 citations, h-index 6, i10-index 6 (as of 10/2026).

[**P1**] Song, S.†, **Huang, D.**†, Deng, D., Xiong, H., Tang, Y., Zhao, Y., & Qin, R. (2026). "Olbedo: An Albedo and Shading Aerial Dataset for Large-Scale Outdoor Environments". *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, 6474–6483. (**CVPR 2026**).

[**P2**] **Huang, D.**, & Qin, R. (2026). "Uncertainty Quantification Framework for Aerial and UAV Photogrammetry through Error Propagation". *ISPRS Journal of Photogrammetry and Remote Sensing*, 237, 589–605. (**Top-tier journal, IF:12.2**).

[**P3**] **Huang, D.**†, Liu, H.†, Xu, N., & Qin, R. (2025). "Dynamic Urban Scene Modeling with 3D Gaussian Splatting from UAV Full Motion Videos". *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, XLVIII-G-2025, 649–656.

[**P4**] **Huang, D.**, Qin, R., & Elhashash, M. (2024). "Bundle Adjustment with Motion Constraints for Uncalibrated Multi-camera Systems at the Ground Level". *ISPRS Journal of Photogrammetry and Remote Sensing*, 211, 452–464. (**Top-tier journal, IF:12.2**).

[**P5**] Xu, N., Qin, R., **Huang, D.**, & Remondino, F. (2024). "Multi-tiling Neural Radiance Field (NeRF)—Geometric Assessment on Large-scale Aerial Datasets". *The Photogrammetric Record*, 39(188), 718–740. (**Featured as frontispiece of the 12/2024 issue**).

[**P6**] **Huang, D.**, & Qin, R. (2026). "Revisiting Minimal Solver of Camera Triplets for Incremental Structure-from-Motion". *The Photogrammetric Record*, 41(193), e70041.

[**P7**] **Huang, D.**, & Qin, R. (2025). "Uncertainty Estimation for Photogrammetric Point Clouds of UAV Imagery". *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, XLVIII-G-2025, 657–664.

[**P8**] **Huang, D.**, & Qin, R. (2023). "A Critical Analysis of Internal Reliability for Uncertainty Quantification of Dense Image Matching in Multi-View Stereo". *ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, X-1/W1-2023, 517–524.

[**P9**] **Huang, D.**, Tang, Y., & Qin, R. (2022). "An Evaluation of PlanetScope Images for 3D Reconstruction and Change Detection – Experimental Validations with Case Studies". *GIScience & Remote Sensing*, 59(1), 744–761.

[**P10**] **Huang, D.**†, Elhashash, M.†, & Qin, R. (2022). "Constrained Bundle Adjustment for Structure from Motion Using Uncalibrated Multi-camera Systems". *ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, V-2-2022, 17–22.

[**P11**] Xu, N., **Huang, D.**, Song, S., Ling, X., Strasbaugh, C., Yilmaz, A., Sezen, H., & Qin, R. (2021). "A Volumetric Change Detection Framework Using UAV Oblique Photogrammetry – A Case Study of Ultra-High-Resolution Monitoring of Progressive Building Collapse". *International Journal of Digital Earth*, 14(11), 1705–1720.

Academic Service & Presentations

- **Peer reviewer:** International Journal of Computer Vision; ISPRS Journal of Photogrammetry and Remote Sensing; NeurIPS (2024, 2025); BMVC 2024 (**Outstanding Reviewer**); IEEE Transactions on Geoscience and Remote Sensing; IEEE Transactions on Circuits and Systems for Video Technology; International Journal of Applied Earth Observation and Geoinformation; Photogrammetric Engineering & Remote Sensing; International Journal of Digital Earth; Remote Sensing; Applied Sciences.
- **Conference presentations:** CVPR 2026; WACV Workshops 2025; ISPRS Geospatial Week 2023; ISPRS Congress 2022.

Honors & Media Coverage

- Recipient of **Lyman J. Ladner Memorial Scholarship**, American Society for Photogrammetry and Remote Sensing, 2026. Awarded to outstanding students (**Top 1%**) pursuing research and careers in photogrammetry.
- Research on 3D reconstruction using satellite data for disaster response, featured in **Ohio State News** [Link].
- **FAA-certificated Remote Pilot** (Part 107), Federal Aviation Administration, 2021–present.