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Tianyi Zhang

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Pittsburgh, PA, U.S.A.

RESEARCH STATEMENT

My research lies in 3D computer vision including physics-based reconstruction, diffusion models, simulation, and 3D foundation models that enable robots to better localize, navigate, and understand their environment. I also do hardware design and prototype especially for robot perception systems.

EDUCATION

Carnegie Mellon University **Pittsburgh, PA, U.S.A.**

Ph.D. Candidate in Robotics *Jan. 2022 – Expected mid 2025*

- Supervisor & Reference: Dr. Matthew Johnson-Roberson

University of Michigan, Ann Arbor **Ann Arbor, MI, U.S.A.**

M.S. in Robotics, Ph.D. Pre-Candidacy in Robotics *Sept. 2018 – Dec. 2021*

Tianjin University **Tianjin, P.R.China**

Bachelor of Engineering *Sept. 2014 – July 2018*

- 2018 TJU Bachelor Thesis Research Award (1%)

INDUSTRY EXPERIENCE

Embedded System Engineer, Shanghai SLAMTEC *P.R.China, 2017*

- Integrated IR range sensor and realized functions that prevent a wheeled robot from falling downstairs;

Robotics Engineer, Refraction AI *U.S.A., 2019-2020*

- Developed a novel LiDAR-camera calibration method based on intensity-based features [paper];
- Developed an automatic joint calibration pipeline for 12 cameras, 2 LiDARs and multiple IMUs on a single robot;
- Developed onboard sensor software on a light-weight delivery robot that process sensory information in real time.

RESEARCH EXPERIENCE

Carnegie Mellon University / University of Michigan

Research Assistant, DROP (Deep Robot Optical Perception) Lab *2019- Present*

- Selected Projects (on 3D Gaussian Splatting, Diffusion Models, NeRF):

  - [DarkGS] Developed a Gaussian Splatting pipeline that allows robots to see in the dark, relight the environment and synthesize photorealistic novel views with artificial light source. *(IROS'24 Oral)*
  - [3D Generation] Realized large-scale 3D scene generation on field robot data with diffusion models controlled by latent fractals. Photorealistic images can be rendered from scene. *(FM-wild@ICLR'25)*
  - [CorrGS] Developed a scalable data synthesis pipeline for realistic noise, and a novel Gaussian Splatting method, CorrGS, for refining 3D reconstruction and pose estimation. *(ICLR'25)*
  - [UnderwaterGS/NeRF] Developed neural representation based method that removes color distortion and sunlight flickering from underwater images. *(RA-L+ICRA'22, '23)*

- Developed and maintained electronics, firmware and software on the SphereRobot; Deployed robot in real world environments [news on NOAA.gov][The LINK]

Massachusetts Institute of Technology

Funded Visiting Undergraduate Researcher, Dept. of Mechanical Eng. *2018*

- Developed a method to reconstruct 3D flow field from 2D images (Reference: Dr. Dixia Fan)

SKILLS

What I use: C/C++, CUDA, Python, Linux, ROS, OpenCV, Pytorch, SolidWorks, KiCAD

PUBLICATIONS #Photorealistic Rendering #Generative AI #3D Vision #Robot Learning #Foundation Model

(Selected & Recent)

T. Zhang, W. Zhi, J. Mangelson and M. Johnson-Roberson, "Infinite Leagues Under the Sea: Photorealistic 3D Underwater Terrain Generation by Latent Fractal Diffusion Models", *FM-wild@ICLR 2025 (score 9,8,8)*| *full paper under review*. # GenAI #PR #3DV #FM

T. Zhang, K. Huang, W. Zhi and M. Johnson-Roberson, "DarkGS: Learning Neural Illumination and 3D Gaussians Relighting for Robotic Exploration in the Dark", *[Oral] IROS 2024*. [website | CMU news] #PR #3DV

(Peer-Reviewed & Published)

X. Xu, **T. Zhang**, S. Zhao, X. Li, S. Wang, Y. Chen, Y. Li, B. Raj, M. Johnson-Roberson, S. Scherer, X. Huang, "Scalable Benchmarking and Robust Learning for Noise-Free Ego-Motion and 3D Reconstruction from Noisy Video", *ICLR 2025*. #PR #3DV

T. Zhang, W. Zhi, K. Huang, J. Mangelson, C. Barbalata and M. Johnson-Roberson, "RecGS: Removing Water Caustic with Recurrent Gaussian Splatting", *RA-L 2025, ICRA 2025*. [website] #PR #3DV

W. Zhi, **T. Zhang** and M. Johnson-Roberson, "Learning from Demonstration via Probabilistic Diagrammatic Teaching", *ICRA 2024 | [Spotlight] DiffPropRob@IROS 2023.* [CMU news] #RL #3DV

W. Zhi, H. Tang, **T. Zhang**, M. Johnson-Roberson, "Teaching Periodic Stable Robot Motion Generation Via Sketch", *RA-L 2024, ICRA 2025*. #RL

W. Zhi, H. Tang, **T. Zhang**, M. Johnson-Roberson, "3d Foundation Models Enable Simultaneous Geometry and Pose Estimation of Grasped Objects", *RA-L 2024, ICRA 2025*. #RL #FM

W. Zhi, H. Tang, **T. Zhang**, M. Johnson-Roberson, "Unifying representation and calibration with 3d foundation models", *RA-L 2024, ICRA 2025*. #RL #FM

J. Zheng, G. Dai, B. He, Z. Mu, Z. Meng, **T. Zhang**, W. Zhi, D. Fan, "ModCube: Modular, Self-Assembling Cubic Underwater Robot", *RA-L 2025*. [website] #Robot System

Q. Sun, W. Zhi, **T. Zhang**, M. Johnson-Roberson, "Diagrammatic Instructions to Specify Spatial Objectives and Constraints with Applications to Mobile Base Placement", *IROS 2024*. #RL

T. Zhang and M. Johnson-Roberson, "Beyond NeRF Underwater: Learning Neural Reflectance Fields for True Color Correction of Marine Imagery", *RA-L 2023, ICRA 2024*. #PR #3DV

T. Zhang and M. Johnson-Roberson, "Learning Cross-Scale Visual Representations for Real-Time Image Geo-Localization", *RA-L 2022, ICRA 2022*. #Contrastive Learning #Geo-spatial learning

(Lightly Peer-Reviewed & Preprint)

X. Xu, F. Xue, X. Li, H. Li, S. Yang, **T. Zhang**, M. Johnson-Roberson, X. Huang, "Towards Ambiguity-Free Spatial Foundation Model: Rethinking and Decoupling Depth Ambiguity" *FM-wild@ICLR 2025, arxiv:2503.06014.* #3DV #FM

H. Cheng, T. Zheng, **T. Zhang**, M. Johnson-Roberson, W. Zhi, "DOSE3 : Diffusion-based Out-of-distribution detection on SE(3) trajectories", *DeLTa@ICLR 2025, arxiv.org:2502.16725.* # GenAI

X. Liu, **T. Zhang**, M. Johnson-Roberson, W. Zhi, "SplaTraj: Camera Trajectory Generation with Semantic Gaussian Splatting", *arXiv:2410.06014.* #RL #FM

Z. Yuan, **T. Zhang**, M. Johnson-Roberson, W. Zhi, "PhotoReg: Photometrically Registering 3D Gaussian Splatting Models", *arXiv:2410.05044*. #PR #3DV #FM

Q. Xie, S. Y. Min, **T. Zhang**, A. Bajaj, R. Salakhutdinov, M. Johnson-Roberson, Y. Bisk, "Embodied-RAG: General Non-parametric Embodied Memory for Retrieval and Generation", *LanGame@NeurIPS 2024.* #RL #FM

T. Zhang, Q. Sun, M. Johnson-Roberson, "Learning Neural Reflectance Fields for True Color Correction and Novel-View Synthesis of Underwater Robotic Imagery", *PIES@IROS 2023*. #PR #3DV

TEACHING & SERVICES

Teaching Assistant, *Self-Driving Cars: Perception & Control* (UMich) *Fall 2021*
Teaching Assistant, *Self-Driving Cars: Perception & Control* (CMU) *Spring 2023*
Teaching Assistant, *Computer Vision* (CMU) *Fall 2023*
Reviewer, *IEEE Robotics and Automation Letters (RA-L)*
Reviewer, *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*
Reviewer, *IEEE International Conference on Robotics and Automation (ICRA)*
Reviewer, *IEEE/CVF Winter Conference on Applications of Computer Vision (WACV)*
Reviewer, *ACM Knowledge Discovery and Data Mining (KDD)*
Reviewer, *ACM Transaction on Human-Robot Interaction*
Thesis committee member *for Mr. Xuxin "David" Cheng* M.S. Robotics at CMU, 2023 (now Ph.D. at UCSD)
Thesis committee member *for Mr. Tianxiang Lin* M.S. Robotics at CMU, 2025 (now Ph.D. at UMich)
Thesis committee member *for Mr. Cunxi "Jimmy" Dai* M.S. Robotics at CMU, 2025 (now Ph.D. at CMU)
Thesis committee member *for Mr. Silong Yong* M.S. Robotics at CMU, 2025 (now Ph.D. at CMU)