ZIHENG ZHANG

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SUMMARY

Ziheng develops **trustworthy AI** for the built environment, with a focus on engineering-grounded verification. His research uses domain knowledge including engineering tolerances, data schemas, operational constraints, and optimality bounds to verify AI outputs, guide model training, and support human oversight when automated checks are incomplete. During his Ph.D. at Nanyang Technological University, he developed mixed-reality and vision foundation model systems for automated construction quality inspection, including field validation on an active construction project. As a Research Fellow at the Singapore Institute of Technology, he extends this verification-centered approach to reinforcement learning for production scheduling, facility-management dispatching, and locally deployable LLM agents for work-order scheduling and IFC model editing. His broader goal is to develop reliable, verifiable AI systems that connect perception, decision-making, and digital twins across the built-asset life cycle.

EDUCATION

Doctor of Philosophy in Civil Engineering **Expected 11/2026**
Nanyang Technological University (NTU), Singapore | Advisor: Asst Prof Fu Yuguang
Thesis Title: *Mixed Reality-Enabled Intelligent Quality Assessment for Construction: An Integrative Framework with Vision Foundation Models and Human-Centric Interaction*
Oral defense passed in 09/2026; degree conferral expected in 11/2026.

Master of Science in International Construction Management **07/2022**
Nanyang Technological University (NTU), Singapore
GPA: 4.5/5.0

Bachelor of Engineering in Road, Bridge and River Crossing Engineering **06/2021**
Chang'an University, Xi'an, China
GPA: 3.62/4.0

RESEARCH EXPERIENCE

Research Fellow, InfoComm Technology Cluster **03/2026–Present**
Singapore Institute of Technology (SIT), Singapore | PI: Assoc Prof Zhang Wei

Production scheduling in precast (PPVC) module factories:

- Developing deep reinforcement learning, graph neural network and multi-agent methods for flexible job-shop scheduling in PPVC module factories, where schedules must respect time lags between operations, machine setups, availability windows and shared transport resources. The methods use optimality bounds in reward design and credit assignment. [6], [12], [13]
- Wrote a systematic critical review of deep reinforcement learning, graph neural network and multi-agent methods for scheduling in construction and built-environment operations. [7]

Maintenance dispatching in facility management:
This line started during the Ph.D. as collaborative work outside the thesis topic, and most of the manuscripts were completed and submitted at SIT.

- Built an open benchmark from computerized maintenance management system (CMMS) work-order records, with a decision map that shows, as a function of crew utilization, when learned dispatching policies outperform classical priority rules. [10]
- Developed a computational framework and open benchmark for maintenance dispatching with multiskill technicians. [8]
- Showed how the choice of prioritization metric changes asset rankings and budget risk, using infrastructure work-order records. [9]
- Developing a human-in-the-loop method that recovers hidden work-order urgency from supervisor overrides and applies it to later dispatch decisions. [14]

Large language model agents with verification:

- CertiGATE: built a guard benchmark and a quality-certificate protocol that checks each work-order schedule produced by a large language model agent before release. [11]

- ❖ VeriBIM: developing a locally deployable language model that edits IFC building models from natural-language instructions. An IFC verifier that scores geometry, semantics and topology is used to filter training data, to label preference pairs, and as the reward in reinforcement learning. [15]

Doctoral Researcher, School of Civil and Environmental Engineering **08/2022–02/2026**

Nanyang Technological University (NTU), Singapore

AI perception for construction quality inspection:

- ❖ ARMIS: built a fully automated MR system on HoloLens 2 for near real-time, in-situ inspection of multi-layer rebar spacing. The system combines RebarSAM (a geometry-aware adaptation of SAM 3) with layer separation based on Depth Anything V3, checks each measured spacing against the specified tolerance, and shows pass/fail results as a holographic overlay. Validated in live rebar inspection with Expand Construction Pte Ltd, main contractor for the NS Square project at The Float @ Marina Bay, with support from the project PE and site engineers. [5]
- ❖ Proposed a human-in-the-loop MR workflow for on-site rebar quality assurance, presented at IEEE ICHMS 2026. [4]
- ❖ Developed a gaze-driven MR framework for dimensional inspection of timber components, in which the inspector's gaze prompts a few-shot RGB-D vision foundation model. [3]
- ❖ Developed an MR framework for dimensional quality assessment of large building elements that combines a vision foundation model (FastSAM) with a spatial computing algorithm, tested in day and night conditions. [2]
- ❖ Led a systematic review of 80+ studies on MR integration with robotics, computer vision and digital twins, and proposed a framework that positions MR as the human interface between engineers and these technologies. [1]

RESEARCH PUBLICATIONS

Published / Accepted

[1] **Zhang, Z.**, Ghosh Mondal, T., Yang, X., and Fu, Y.* (2026). "*Integrating Mixed Reality with Key Digital Technologies for Elevating On-site Construction Efficiency: An Integrative Review and Framework.*" ASCE Journal of Construction Engineering and Management, 152(10), 03126011. DOI: https://doi.org/10.1061/JCEMD4.COENG-18577

[2] **Zhang, Z.**, Ghosh Mondal, T., Yang, X., and Fu, Y.* (2026). "*Automated Noncontact Geometric Quality Assessment of Building Elements Integrating Mixed Reality, Depth Sensing, and Vision Foundation Model.*" ASCE Journal of Computing in Civil Engineering, 40(1), 04025130. DOI: https://doi.org/10.1061/JCCEE5.CPENG-6727

[3] **Zhang, Z.**, Yang, X., Fu, Y.*, and Ghosh Mondal, T. (2027). "*Gaze-Driven Mixed Reality for Dimensional Quality Assessment of Timber Components Using a Few-Shot RGB-D Vision Foundation Model.*" Advanced Engineering Informatics, 77, 105186. DOI: https://doi.org/10.1016/j.aei.2026.105186

[4] **Zhang, Z.***, Ghosh Mondal, T., and Yang, X. (2026). "*Human-in-the-Loop Rebar Inspection: Integrating Vision Foundation Model with Mixed Reality for Construction Quality Assurance.*" 2026 IEEE International Conference on Human-Machine Systems (ICHMS), Singapore, 452–457. DOI: https://doi.org/10.1109/ICHMS69701.2026.11602218

Under Review

[5] **Zhang, Z.**, Yang, X., Fu, Y.*, and Ghosh Mondal, T. "*Automated Rebar Spacing Measurement in Mixed Reality Using RebarSAM and Monocular Depth Estimation.*" Automation in Construction. [Under Minor Revision]

[6] **Zhang, Z.**, and Zhang, W.* "*Time-Lag-Aware Deep Reinforcement Learning for Flexible Job-Shop Scheduling in PPVC Module Factories.*" IEEE Transactions on Industrial Informatics. [Under Review]

[7] **Zhang, Z.***, Ku Chia, T. P., and Zhang, W.* "*Learning to Schedule in Construction and Built-Environment Operations: A Systematic Critical Review of Deep Reinforcement Learning, Graph Neural Networks, and Multi-Agent Approaches.*" Automation in Construction. [Under Review]

[8] **Zhang, Z.***, and Ku Chia, T. P. "*FM-CrossTraining: Computational Framework and Open Benchmark for Multiskill Maintenance Dispatching.*" ASCE Journal of Computing in Civil Engineering. [Under Major Revision]

[9] Ku Chia, T. P., Hu, F., and **Zhang, Z.*** "*Which Assets Deserve Attention First? Metric Choice and Budget Risk in Maintenance Prioritization from Infrastructure Work-Order Records.*" ASCE Journal of Infrastructure Systems. [Under Major Revision]

[10] **Zhang, Z.***, Ku Chia, T. P., and Tang, J. "*An Open CMMS-Derived Benchmark for Building-Maintenance Work-Order Dispatching with a Decision Map Keyed on Crew Utilization.*" ASCE Journal of Computing in Civil Engineering. [Under Review]

[11] **Zhang, Z.***, Ku Chia, T. P., Yang, X., Chang, X., Wang, S., and Zhang, W.* "*CertiGATE: A Guard Benchmark and Quality-Certificate Protocol for Large Language Model-Based Work-Order Scheduling in Facility Management.*" Advanced Engineering Informatics. [Under Review]

In Preparation

[12] **Zhang, Z.**, and Zhang, W.* "*PACT: Policy Across Composable Timing Rules with a Certified Reward for Flexible Job-Shop Scheduling.*" IEEE Transactions on Industrial Informatics (target venue).

[13] **Zhang, Z.**, and Zhang, W.* "*BOLT: Multi-Bottleneck Bound-Guided Learning for Flexible Job-Shop Scheduling with Time Lags and Resource-Coupled Transport.*" IEEE Transactions on Automation Science and Engineering (target venue).

[14] Ku Chia, T. P., and **Zhang, Z.*** "*SURGE: A Human-in-the-Loop Framework That Recovers Hidden Urgency from Supervisor Overrides and Applies It to Every Maintenance Dispatch.*"

[15] **Zhang, Z.**, and Zhang, W.* "*VeriBIM: Natural-Language Editing of IFC Building Models with a Verifier-Trained, Locally Deployable Language Model.*" Automation in Construction (target venue).

** Corresponding author.*

SELECTED TECHNICAL PROJECTS

Commercial Full-Stack Web Development

Delivered 10+ production websites for commercial clients end to end, covering React and Tailwind front-ends, Supabase back-ends with authentication and payments, and CI/CD deployment on Vercel.

Viaduct Segment Displacement Monitoring via ArUco Markers and Computer Vision

Monitored the displacement of multiple segments on an active MRT viaduct project using ArUco markers and computer vision algorithms, see GitHub.

Large Language Model-Enabled Slide Generation with Real-Time Narration

Developed an AI-powered web application that generates any-topic presentation slides and real-time narration from user prompts, leveraging DeepSeek and Azure Speech Service, see GitHub.

PROFESSIONAL SERVICE & LEADERSHIP

Journal Peer Reviewer **2024–Present**

- Engineering Structures (ES); Engineering Applications of Artificial Intelligence (EAAI); Scientific Reports; IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing (JSTARS); Journal of Construction Engineering and Management (JCEM); Journal of Building Engineering.

Professional Membership

- Member, American Society of Civil Engineers (M.ASCE).
- Student Member, Institute of Electrical and Electronics Engineers (IEEE).

Vice President (Welfare), NTU Graduate Students' Association (GSA) **10/2023–10/2024**

- Led welfare policy and programming for the 13th NTU Graduate Students' Association, representing the postgraduate student body to the University.
- Oversaw three subcommittees dedicated to student well-being: Recreation, Sports, and Welfare.
- Organised large-scale university-level events serving 5,000+ postgraduate students.

Member of Board of Discipline (BOD), NTU **10/2023–10/2024**

- Adjudicated student discipline cases by analyzing evidence and ensuring penalties aligned with the University's Code of Conduct and case precedents.

CORE SKILLS & KEYWORDS

- **Trustworthy AI & Verification:** Verifier-Based Training (Data Filtering, Preference Labelling, Reward Design); Large Language Model Agents; Quality Certificates and Guard Benchmarks for LLM Outputs; Optimality Bounds for Learned Schedulers; Open Benchmark Design; Human-in-the-Loop Learning; Local Deployment of Language Models
- **Decision & Optimization AI:** Deep Reinforcement Learning; Graph Neural Networks; Multi-Agent Reinforcement Learning; Combinatorial Optimization; Flexible Job-Shop Scheduling (FJSP)
- **Vision & Multimodal AI:** Vision Foundation Models (VFM); Vision-Language Models (VLM); Parameter-Efficient Fine-Tuning (PEFT); Few-Shot Learning; Multimodal Fusion & Perception; Image Segmentation; 3D Reconstruction
- **Programming & Tools:** Python; PyTorch; C#; Unity 3D; Git; CUDA; Full-Stack Web Development (React, Supabase, Tailwind, Vercel; 10+ commercial websites delivered)
- **Application Fields:** Construction Operations & Scheduling; Facility Management & Maintenance Operations; Building Information Modelling (BIM) and IFC; Prefabricated Construction (PPVC); Architecture, Engineering and Construction (AEC); Digital & Smart Construction; Mixed/Extended Reality (MR/XR); Human-Machine Interaction