Shuaiwen CUI (Shaun)

Mr | Sep, 1995 | Shandong, CHN | Ph.D. Candidate, NTU, SG

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PROFESSIONAL INTERESTS - IoT-based Digitalization and Automation

- **IoT Sensing:** Internet of Things, Embedded System Programming, Distributed Computing
- **Computation and Control: Signal Processing, Digital Twin, Control and Optimization**
- **Distributed Computing & Intelligence:** Edge Intelligence, Federated Learning, Reinforcement Learning, Multi Agent System
- **Structural Health Monitoring:** Measuring, System Identification, Damage Detection
- **Smart Home:** AI-powered Built Environment Digitalization/Updating/Control/ Advertisement

EDUCATION – Graduation Date (Expected): Jun 2026 - Thesis Submission; Dec 2026 – Defense; Feb 2027 - Graduation

Nanyang Technological University — **Singapore, SG**
Ph.D. Candidate - Civil Engineering — 08/2022-**02/2027** (Expected)

- Embedded System
- Signal Processing
- Internet of Things
- Digital Twin
- Edge/Cloud Computing
- Distributed AI
- Structural Health Monitoring

Tongji University — **Shanghai, CHN**
M.Eng. - Architectural and Civil Engineering — 09/2018-06/2021

Tongji University — **Shanghai, CHN**
B.Eng. - Major in Civil Engineering, Minor in Mathematics and Applied Mathematics — 09/2014-07/2018

- Mathematics
- Physics and Mechanics
- Engineering
- Computer Science

SKILL SETS

- **Languages:** Chinese (native); English (skilled); Japanese (beginner)
- **Embedded System:** STM32/ HAL/ STM32CUBE; ESP32/ESP_IDF; Keil, PlatformIO; FreeRTOS; Linux
- **Programming:** C/C++; Python; Matlab; SQL; ROS
- **Front-end:** HTML5; CSS3; Javascript
- **Computer Aided Design:** Auto CAD; Rhinoceros/Grasshopper; Sketchup; Revit
- **Mechanical Analysis:** Ansys; Particle Flow Code
- **Internet of Things:** MQTT; EMQ X; Home Assistant
- **Digital Twin and platforms:** Autodesk Forge; BIMFace; Digital Space; Welink; AliOS Things
- **AI:** Tensorflow, Pytorch, X-CUBE-AI, ESP-DL

SELECTED PUBLICATION (FIRST/CORRESPONDING AUTHOR) & PATENT

- **Journal Article: Cui, S.**, Fu, H., Shen, W., Yu, X., Zhang, Q. & Fu, Y. (2025) **Computing in IoT-based Structural Health Monitoring: A Review.** *TBD.* (Under Revision)
- **Journal Article: Cui, S.,** Fu, Y., Fu, H., Yu, X. & Shen, W. (2025) **Smart Adaptive Trigger Sensing Powered by Edge Intelligence and Digital Twin for Energy-Efficient Wireless Structural Health Monitoring.** *Mechanical System and Signal Processing.* (Under Major Revision)
- **Journal Article: Cui, S.**, Hoang, T., Mechitov, K., Fu, Y. & Spencer, B. (2025). **Adaptive Edge Intelligence for Rapid Structural Condition Assessment using a Wireless Smart Sensor Network.** *Engineering Structures, 326, 119520.* https://doi.org/10.1016/j.engstruct.2024.119520
- **Journal Article: Cui, S.,** Tan, Y., & Lu, Y. (2020). **Algorithm for generation of 3D polyhedrons for simulation of rock particles by DEM and its application to tunneling in boulder-soil matrix.** *Tunnelling and Underground Space Technology, 106, 103588.* https://doi.org/10.1016/j.tust.2020.103588
- **Patent (No. 10202502426R, SG):** Adaptive Triggering Mechanism for Time-Series Data Sensing on Edge Devices.
- **Patent (No. 202011585928.2, China):** Random 3D Polyhedron Generator Based on a Hybrid Extension Method.

WORK & INTERNSHIP EXPERIENCE

ArcTron Data & Innovation Technology Co., Ltd. **Shanghai, CHN**
Product Manager, R&D 08/2021-07/2022

- Led the prototype development of ArcOS (building operating system) GUI for interactive project configuration.
- Spearheaded the modulization of the ArcOS workflow for project configuration.
- Engaged in ArcOS-API design for data importation (from IoT & IBMS) and exportation (for applications).
- Engaged in algorithm development for ArcOS, e.g., energy conservation, invasion detection.
- Conducted building performance analyses for the memorial hall of the first national congress of the CPC.

RESEARCH & DEVELOPMENT EXPERIENCE

AIoT MCU Node Development - Interface between the physical and cyber worlds **Singapore**
Uses: Frontend - Sensing, Storage, Computation, Communication, Internet. 08/2023-Now
Features: Low Cost, General Purpose / Domain Specific, Edge AI Enabled.

- **NexNode – General Purpose MCU AIoT Node**
  - **Tech Stack:** STM32/HAL/STM32CUBE/X-CUBE-AI/CMSIS; ESP32/ESP-IDF/ESP-DL; FreeRTOS
  - **Modularized Hardware Architecture:** Main Control + Sensing + Communication + Interfacing + Powering
  - **Ubiquitous Sensing:** T. & H. (DHT11), Acceleration (ADXL362&355), IMU(MPU050), Camera (CV5640)
  - **Full-stack Communication:** BT (HC-05), WIFI (ESP8266), 4G (SIM7600), ESPNOW; MQTT for Cloud Connection
  - **Layered Software Architecture:** Physical Layer + Driver Layer + Middleware Layer + Application Layer
- **LiftNode – Structural Health Monitoring Oriented MCU AIoT Node**
  - Based on NexNode, with High Performance Sensor for Structural Health Monitoring
  - ADXL355, 20-bit low noise low power high resolution accelerometer

AIoT Cloud Server Development – Coordination for the IoT Nodes **Singapore**
Uses: Backend - Coordination, Storage, Computation, Analysis, Interfacing. 08/2023-Now
Features: Light-weight, General Purpose / Domain Specific, Cloud AI Enabled.

- **NexHub – General Purpose IoT Cloud Platform for NexNodes**
  - **Tech Stack:** Web - Nginx, MQTT – EMQX, Database – MongoDB & InfluxDB
  - **Coordination:** Orchestrating IoT nodes to ensure efficient and reliable system operation.
  - **Broker and Interface:** facilitating communication between heterogeneous IoT nodes and providing standardized access for applications.
  - **Storage, Computation and Analysis:** supporting long-term data management, complex computational tasks, and insight extraction for decision-making.
- **LiftHub – Structural Health Monitoring Oriented Cloud Platform for LiftNodes**
  - **High Performance Measurement:** capturing and synchronizing sensing data.
  - **Accurate System Identification:** modeling and characterizing structural dynamics.
  - **Effective Damage Assessment:** detecting anomalies and evaluating conditions.

Distributed Intelligence Framework - Enabling Tool for Ubiquitous Intelligence **Singapore**
Uses: Enabling Efficient Computation and AI on Resource-constrained Edge Devices. 08/2024-Now
Features: Resource-aware, Cross-platform, lightweight, efficient, modularized & layered.

- **TinyAuton – General Purpose Edge Intelligence Enabling Framework**
  - **TinyToolbox:** Platform-related Functions, Configurations
  - **TinyMath:** Common Mathematic Operations, including Vector and Matrix Operations
  - **TinyDSP:** Common Digital Signal Processing Algorithms
  - **TinyAI:** Common AI Components for Onboard AI Deployment
- **TinySHM – SHM Oriented Edge Intelligence Enabling Framework**
  - **High Performance Measurement:** capturing and synchronizing sensing data.
  - **Accurate System Identification:** modeling and characterizing structural dynamics.
  - **Effective Damage Assessment:** detecting anomalies and evaluating conditions.

Algorithm and Implementation for Structural Health Monitoring Practice **Singapore**
08/2023-Now

- **Adaptive Edge Intelligence for Rapid Structural Condition Assessment using a Wireless Sensor Network**
  - Reference-free Target Displacement Estimation based on Acceleration Data – Single Node Edge Computing
  - Rapid Anomaly Detection by Gaussian Process Regression – Multi Node Coordinated Edge Computing
  - Oral Presentation at PROTECT 2024, Singapore
- **Edge Intelligence for Real-time Onboard Sudden Damage Detection on Wireless IoT Sensing Network**
  - Advanced Damage Detection Algo: Variational Modal Decomposition (VMD) + Wavelet Transform (WT) + Independent Component Analyses (ICA) + Shapelet Transform (ST) + AI Automatic Identification
  - Effective Implementation for Resource-Constrained Edge Intelligence: Memory Management + Sliding Window + CMSIS-DSP for WT&ICA + X-Cube-AI for Automatic AI Classification
- **Digital Twin and Edge Intelligence Enabled Smart Adaptive Triggering Mechanism for Sustainable SHM**
  - Using Dital Twin, Edge Computing and AI to Extend the Operating Duration of Battery-Powered Sensors
  - Extreme Events Simulation for Excitation Input; State-Space Model + Newmark- β for Response Computing
  - Feedback Loop Control for Adaptively Control for the Triggering Mechanism Parameters Refining
  - Onboard Lightweight AI inference to Address the Partial Observability Issue
  - Bayesian Optimization for Fast Convergence to Global Optima with Less Power Consumption
  - Oral Presentation at Engineering Mechanics Institute Conference 2023, GA, USA

Algorithm for Generation of 3D Random Morphology of Granules and Its Application in TBM Tunneling – Master Study **Shanghai, CHN**
09/2018-06/2021

- Proposed an **algorithm** for automatic generation of 3D random polyhedrons using a hybrid extension method.
- Developed a 2-step **convexity control** method that can be used to check the convexity of polyhedron in generation process.
- Improved the **GJK algorithm** and applied it to **collision detection** in the generation of non-convex polyhedron.
- Coded a graphical-user-interface (GUI) application that can automatically generate 3D random polyhedrons using the proposed algorithm.
- Designed and manufactured a TBM model for physical test using 3D printer and servo motors.
- Conducted parametric studies to explore the boulder motion and ground motion in the tunnel boring machine (TBM) construction process in boulder-soil strata by discrete element method (DEM), where the boulders were simulated by the polyhedrons that was generated in the GUI application.
- The study found that: (1) the size of ground motion is closely related to the size of boulder but insensitive to the boulder shape; (2) boulder motion is closely related to its morphology, position and orientation; (3) potential geohazards can be mitigated by exploding boulders and grouting in advance.
- Oral Presentation at International Conference on Construction Technology in Tunnelling and Underground, Melbourne, AUS

AWARDS & COMPETITIONS

First Place, 3-Minute Thesis Competition, School of CEE, NTU	03/2025
Excellent Graduate & Excellent Dissertation of Tongji University	06/2021
Shimao-Jiangxin-China Scholarship for Academic Excellent (Top 3% in China)	11/2020
Third Prize in the 15th China Post-Graduate Mathematical Modelling Contest (Top 30%)	12/2018
Honorable Mention in the Interdisciplinary Contest in Modelling (Top 20%)	2016&2017
Third Prize of Tongji Scholarship of Excellence (Top 20% of the school)	2015&2017
Second Prize in the 5th Future Aircraft Designing Contest of Tongji University (3rd/22)	11/2016
First Prize in the 6th Applied Mechanics Innovation Contest of Tongji University	04/2016
Third Prize in the 7th China Undergraduate Mathematical Contest (Top 15%)	11/2015