

# Shuaiwen CUI (Shaun)

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

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## PROFESSIONAL INTERESTS - IoT-based Digitalization and Automation for Construction and Built Environment

- **IoT Sensing:** Internet of Things, Embedded System Programming, Distributed Computing
- **Computation and Control:** Signal Processing, Digital Twin, Control and Optimization
- **Artificial Intelligence:** Edge Intelligence, Federated Learning, Reinforcement Learning
- **Structural Health Monitoring:** Measuring, System Identification, Damage Detection
- **Data Management:** Data Asset Management and Mining



## EDUCATION – Graduation Date (Expected): June 2026

### Nanyang Technological University

Singapore, SG

Ph.D. Candidate Civil Engineering

08/2022-07/2026 (Expected)

- Internet of Things
- Edge Intelligence
- MEMS Sensors
- Control Algorithm
- Digital Twin
- Artificial Intelligence
- Structural Health Monitoring

### Tongji University

Shanghai, CHN

M.Eng. Architectural and Civil Engineering

09/2018-06/2021

- Underground Tech
- Tunnelling
- Geotechnical
- DEM

### 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; ESP32, ESP\_IDF; FreeRTOS; Linux; Keil, PlatformIO, STM32CUBE
- **Programming:** C/C++; Micropython; 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

## PUBLICATION & PATENT

- **Journal Article:** Cui, S., Hoang, T., Mechtov, K., Fu, Y. & Spencer, B. (2024). **Adaptive Edge Intelligence for Rapid Structural Condition Assessment using a Wireless Smart Sensor Network.** *Engineering Structures.* (Under Review)
- **Literature Review:** Cui, S., Fu, H., Shen, W., Yu, X., Zhang, Q. & Fu, Y. (2024) **Computing in IoT-based Structural Health Monitoring: A Review.** *TBD.* (Under Revision)
- **Journal Article:** Song, X., Cui, S., Tan Y. & Zhang Y. (2021). **Influence of water pressure on deep subsea tunnel buried within sandy seabed.** *Marine Georesources & Geotechnology.* <https://doi.org/10.1080/1064119X.2021.1961954>
- **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. 202011585928.2, China):** **Random 3D Polyhedron Generator Based on a Hybrid Extension Method**, an application coded with Matlab App Designer to generate random polyhedrons (both convex and non-convex) for simulation of granular materials.

## 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 work flow 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.

### Nantong Urban Rail Transportation Co., Ltd.

Nantong, CHN

Engineer Assistant

09/2020-10/2020

- Conducted field investigation to evaluate the influence of metro construction on surrounding buildings.
- Assisted in the numerical analysis and prediction of ground settlement caused by water pumping.

### Shanghai West Bund Media Port Development and Construction Co., Ltd.

Shanghai, CHN

Engineer Assistant

07/2017-08/2017

- Engaged in the construction of diaphragm wall, excavation, and supporting systems.
- Installed sensors and collected monitoring data from the wireless sensor network (WSN) for structural analysis.

## RESEARCH EXPERIENCE

### TinySHM: Distributed Intelligence Enabled Internet-of-Things-based Framework for Structural Health Monitoring (SHM) – PhD Study

SG

08/2022-Now

#### ➤ Hardware and Software Prototyping: IoT Sensing Platform with Edge Intelligence

- **Tech Stack:** STM32 + CubeMX + HAL + Keil/CubeIDE/VSCode
- **HW Architecture:** Main Control + Sensing + Communication + Interfacing
- **SW Architecture:** Physical Layer + Driver Layer + Middleware Layer + Application Layer
- **Features:**
  - Hardware Accelerated Onboard Computation for Digital Signal Processing and AI Inference
  - Ubiquitous Sensing: T. & H. (DHT11), Acceleration (ADXL362&355), IMU(MPU050), Camera (CV5640)
  - Full-stack Communication: BT (HC-05), WIFI (ESP8266), 4G (SIM7600); MQTT for Cloud Connection
  - User--friendly Interaction: OLED (CH1116), Keys
  - Effective Task and File Management: Real-time Operating System (FreeRTOS); File System (FATFS)



#### ➤ Algorithm and Implementation for Structural Health Monitoring Practice

- **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-  $\beta$  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**

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