Zhuo **Zhi**

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Education

PhD at University College London (UCL), UK *Oct. 2021 - Oct. 2025 (expected)*

- Research interests in machine learning: deep learning, multimodal learning (including image, text, video, audio, EHR, sensor signal), uncertainty estimation, computer vision, natural language processing, time series analysis, machine learning for healthcare, portable medical AI system.

M.S. at Harbin Institute of Technology (HIT), China *Sep. 2019 - June 2021*

- Research direction: fault diagnosis of robotics by machine learning, compensation for navigation systems by machine learning.

B.S. at Shandong University (SDU), China *Sep. 2015 - June 2019*

- Core courses: analog/digital electronic technique, automatic control theory, signal and system, computer control system.

Skills

Programming language: python, C, matlab
Machine learning technology: problem formulation, data pipeline design, machine/deep learning model development and deployment
Machine learning framework: tensorflow, keras, pytorch, pytorch-lightning
Machine learning task: computer vision, natural language processing, time series analysis, multimodal learning
Others: digital signal processing, electronic circuit design, control system design, embedded system, FPGA/MCU development, PCB design

Experience

Research assistant at Shandong University *June 2018 - Feb. 2019*

- Deployed the Yolov2 model for rubbish detection on the water surface.
- Designed an autopilot with MCU, gyroscope, accelerometer, magnetometer and GPS to achieve automatic driving of the rubbish removal vessel.

Teaching assistant at University College London *Oct. 2023 - Feb. 2024*

- TA for Master course "Applied Machine Learning Systems" for Prof. Miguel, Rodrigues.
- Gave lectures on supervised/unsupervised learning and neural networks.

Teaching assistant at University College London Consultancy *June 2023*

- TA for Machine Learning Masterclass at the UK Defence Science and Technology Laboratory (DSTL).

Project & Research

Lab-on-an-App: AI Empowered Point-of-Care Diagnostics for Ageing Population

PhD project Funded by EPSRC, UK *2021-2025*

- Expected to develop a portable, non-invasive and accurate medical system (including **advanced sensor technology**, **multimodal machine learning** technology, **embedded system** design and mobile **APP development**) to achieve personalized anemia prediction, treatment planning and monitoring.
- Proposed innovative multimodal medical system based on EHR, conjunctival images and PPG sensors, focused technologies involve **computer vision, NLP, multivariate time series analysis, sensor data processing and multimodal learning.**

Balancing modality alignment and heterogeneity in multimodal transformer

Ongoing *2024*

- Expected to propose a **regularisation** of **multimodal transformer** by a non-parametric approach for balancing modality alignment and heterogeneity.
- The method will be evaluated on 15 **multimodal datasets** (including **image, text, video, audio, EHR, sensor signal**) with modality noise/missing.

In-Context Learning for Multimodal Learning with Missing Modalities and Data Scarcity

https://arxiv.org/abs/2403.09428 (under review) *2023*

- Proposed a retrieval-augmented **in-context learning** method to improve the robustness of **multimodal models (ViLT)** under missing modalities and data scarcity.
- The proposed approach is evaluated under both **multimodal medical** and **vision-language tasks** to show the SOTA performance.

HgbNet: predicting hemoglobin level/anemia degree from EHR data

https://arxiv.org/abs/2401.12002 (under rview) *2022*

- The HgbNet, a **deep learning model** is proposed for predicting the hemoglobin level and anemia degree from EHR data, which mainly solves the problem of **missing values** and **irregular time intervals** in **multivariate medical time series**.
- The proposed method is evaluated on two real-world EHR datasets, and two use cases are considered in the experiments, which cover common application scenarios. The performance of the proposed method is significantly improved over baseline

Multimodal Diagnosis for Pulmonary Embolism from EHR Data and CT Images

2022 44th IEEE EMBC *2021*

- Proposed a **multimodal fusion** machine learning model ingesting **EHR data and CT images** for PE diagnosis.
- The proposed **MLP-2D-CNN** model achieves the diagnosis accuracy at 97.3%, which is superior to all unimodal models.

An Easy and Fast Method for Landfill Identification by Image-Based Deep Learning

UNDER REVIEW *2023*

- Proposed a **classification-clustering**-based cascade **deep learning** model to detect landfills from **satellite images**.
- The proposed model is evaluated in maps with different resolutions, showing better performance than traditional **target detection** models, and a reference for energy efficiency balance is given.

Fast design of dual-atom catalysts through altering central metal atoms

UNDER REVIEW *2023*

- Applied and compared different **machine learning models, feature selection/combination** methods in developing high-performance electrocatalysts for the CO2 reduction reaction.
- The results demonstrate the huge potential of the **machine learning** in **material design**.

Compensation method for GPS/INS integrated navigation system based on CNN–LSTM

Published in Elsevier Measurement *2021*

- Proposed a wavelet correlation threshold denoising algorithm to mitigate the noise of MEMS IMU.
- Designed a **CNN-LSTM model** to compensate for **INS/GPS** integrated navigation system under GPS failure, which achieved better performance than the existing compensation methods.

Research on Condition Acquisition and Fault Detection of Industrial Robot Reducer

Published in IEEE Sensor Journal and IEEE Transactions on Instrumentation and Measurement *2022*

- Designed a test system for industrial robot reducer. Released the **dataset** of the harmonic reducer under different working conditions.
- Proposed the WRCTD algorithm for denoising and **CNN-LSTM model** for fault diagnosis from vibration/acoustic emission **sensor signal** and the performance surpasses all baselines.

Publication & Patent

- **Zhi, Z**., Liu, Z., Elbadawi, M., Daneshmend, A., Orlu, M., Basit, A., Demosthenous, A. and Rodrigues, M., 2024. Borrowing Treasures from Neighbors: In-Context Learning for Multimodal Learning with Missing Modalities and Data Scarcity. arXiv preprint arXiv:2403.09428.
- Liu, Z., **Zhi, Z**., Bogunovic, I., Gerner-Beuerle, C. and Rodrigues, M., 2023. PROSAC: Provably Safe Certification for Machine Learning Models under Adversarial Attacks. NeurIPS 2023 Workshop on Regulatable ML.
- **Zhi, Z**., Elbadawi, M., Daneshmend, A., Orlu, M., Basit, A., Demosthenous, A. and Rodrigues, M., 2024. HgbNet: predicting hemoglobin level/anemia degree from EHR data. arXiv preprint arXiv:2401.12002.
- Liu, L., **Zhi, Z**., Yang, Y., Shirmohammadi, S. and Liu, D., 2023. Harmonic reducer fault detection with acoustic emission. IEEE Transactions on Instrumentation and Measurement.
- **Zhi, Z**., Elbadawi, M., Daneshmend, A., Orlu, M., Basit, A., Demosthenous, A. and Rodrigues, M., 2022, July. Multimodal diagnosis for pulmonary embolism from ehr data and ct images. In 2022 44th Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC) (pp. 2053-2057). IEEE.
- **Zhi, Z**., Liu, D. and Liu, L., 2022. A performance compensation method for GPS/INS integrated navigation system based on CNN–LSTM during GPS outages. Measurement, 188, p.110516.
- **Z. Zhi**, L. Liu, "Fault detection of the harmonic reducer based on CNN-LSTM with a novel denoising algorithm." IEEE Sensors Journal, 2021, 22(3), 2572-2581.
- **Zhi, Z**., Liu, L. and Liu, D., 2020, October. Enhancing the reliability of the quadrotor by formulating the control system model. In 2020 ICSMD (pp. 242-246). IEEE.
- "An early fault detection method for industrial robot harmonic reducer based on WLCTD and OMA-VMD". China Invention Patent. CN113878613A.
- "An early fault detection method for industrial robot harmonic reducer based on WLCTD and CNN-LSTM". China Invention Patent. CN113887702A.

Honors & Awards

2021 **UCL EPSRC DTP Research Studentship**,
2020 **First-class Special Scholarship for Graduate Student**, (Top 18%, 20/110)
2019 **First-class Scholarship for Outstanding Undergraduate Student**, (Top 5%, 6/120)
2018 **Shandong University Outstanding Undergraduate Research Assistant** , (Top 5%, 2/40)
2018 **First Prize of National College Student Smart Car Competition** , (Top 0.5%, 10/2000)
2018 **Special Prize of China Engineering Robot Competition** , (Top 1.5%, 3/200)
2017 **First Prize of National College Students Electronic Design Competition**, (Top 1%, 20/2000)

Service

2023 **Organiser**, Weekly Machine Learning Reading Group at UCL Dept. EEE
2024 **Mentor**, Third-year undergraduate student project at UCL Dept. EEE
2024 **Mentor**, Master student project at UCL Dept. EEE
now **Reviewer**, IEEE-TIM, IEEE sensor journal, Measurement