# *Maojia Song*

## *EDUCATION*

- **The University of Leeds, the UK** **Aug. 2019 – Jun. 2023**
  Bachelor 1st class honour degree, School of Electronic and Electrical Engineering Rank: 1/75

  Major Courses:
  Comms Networks & Signals: 97/100
  Communications Systems: 97/100
  Communications Theory: 96/100
  Electronic Design Project: 95/100
  Microprocessors and Programmable Logic: 97/100
  Control Systems: 96/100

## *PROJECT EXPERIENCE*

**Brain-controlled multifunctional rolling robot based on OpenBCI-AR and "Disk" system**

***(Under Mr Heng Wang)***

- Implemented a motion-imaginary IoT system for the robotic platform (rolling robot as a prototype) with BCI (Brain-Computer Interface), AR (Augmented Reality) technology and our own 'disk' system.
- Achieved original-designed BCI-AR device – Ariel Supremancy, Arm-based Raspberry Pi 4B control centre – Wearable Mind, and Gen 3 alpha rolling robot for disability auxiliary.
- Surpass the prevailing types of equipment on the market, like Cognixion ONE(Medical), Openbci and Valve's Galea (Gaming).
- Utilised machine learning algorithms, like CSP, LDA, etc, to reduce the complexity of dimensionality to fit a "disk" system, with the result of subjects controlling robot actions through imagination.
- Built backend data processing unit with python for communicating with MCU on board, implementing integral algorithm (original) to maximumly reduce misjudgement.
- This project has been selected for the Google China Education Partnership Grant Program to further develop fourth-generation devices.

**Fault detection of high-speed subway sleepers based on images and deep learning algorithms**

**(*Under Dr Dong Liu*)**

- Realised a shedding detection model of screws and fasteners on the sleeper under the high-speed operation of the subway with improved YOLOX-Nano.
- Deployed on the Raspberry Pi 4B (4GB) using the DNN module of OpenCV for speeding inference, obtaining results of 93.4% detection rate under FPS 20+.
- Implemented Model simplification based on pruning, resulting in one-third times less than the original but only a decrease of 4% accuracy in the trade-off.

**Intelligent inspection of key equipment in substations based on edged deep learning**

***(Under A.Prof Xuexia Zhang)***

- Developed a key equipment damage inspection model under various weather conditions (thunderstorm, sunny, foggy, cloudy) based on RSCM (Region Selection and Concurrency Model) and YOLO-Fastest 1.1-xl.

- Utilised an int-8 quantisation inference based on NCNN to facilitate response speed but only affect 3% accuracy on average.
- Constructed a mobile substation equipment fault detection robot based on Jeston Nano (2GB), achieving real-time fault detection with FPS 30+, and 89.2% accuracy.
- This project is operating on a substation in Chengdu for further upgrades in the future.

**Fault diagnosis of Oil-immersed transformers based on DGA (dissolved gas analysis)**

***(Under Dr Dong Liu)***

- Used the IEC-TC10 dataset and the existing four DGA (Dissolved Gas Analysis) codes and their improvements, to realise the fault analysis of transformer oil immersion gas ratio based on machine learning and convolutional neural network, resulting in the fault recognition rate of 93.3%.
- Designed a new model that combined RF with PSO, facilitating hyperparameter searching of the classification model, and analysed the best combination of gases from the oil, based on a modified CNN encoder, which simplified the complexity of feature engineering.
- The improved failure analysis model achieved 8.86% better than other commonly used diagnostic models.

**Research internship in Deep Reinforcement Learning, and Image Segmentation at the University of Cambridge**

***(Under Prof Pietro Liò)***

- Studied the theory related to Reinforcement Learning and Image Segmentation in the latest cutting-edge approaches.
- Developed a deep learning model that combines the transformer and GNN to predict the relationship between various compound medicines based on the integration of multi-scale data, presenting the interpretability of the synthesis of a compound.
- Design a machine learning model that utilises Ensemble Learning and Reinforcement learning to classify the structural medicine data by step improvements, obtained 86% accuracy on the USP drug category.

**Artificial Intelligence Internship Programme in NTU Business AI Lab**

***(Under Dr Teoh Teik Toe)***

- Conducted image-based detection research of crop leaves disease with 94.5% accuracy of disease recognition.
- Designed and developed a Multi-feature fusion and Focus splitting model based on sparse CNN and identity shortcuts, promoting the use of larger kernels in the middle abstract layers for a more effective recognition area.
- Built and deployed a web-integrated (Flask backend), deep inference model on Heroku (cloud platform).
- Acquired an ESA (Excellent Student Award).

**Production and practice of self-navigable buggy based on ROS, SLAM, and Object Detection**

***(Under Mr Heng Wang)***

- Developed an omnidirectional-drive chassis by Mecanum wheels controlled by an STM32-F407 MCU with Hall encoders on the motors.
- Utilised a Raspberry Pi 4B as a hierarchical control centre running ROS and realised the auto-navigation depended on integrated information from a DTOF LD06 LIDAR, an IMU and other sensors.
- Deployed the SLAM algorithm relied on Cartographer ROS integration to build a static map of the surrounding environment with point clouds on the Raspberry Pi 4B.
- Navigated the buggy with the integrated location data from the tf (Transform Frame) and the speed from the Odometry by ROS Navigation Tool Kit.
- Detected the target person by CSI camera to identify his/her position and follow the movement by self-navigation.

**The research of Self-organised critical phase transformation of historical time sequences of power system based on Critical slowing down theory**

***(Under Dr Wenli Fan)***

- Explored the self-organised critical factors of existing power systems and transferred Catastrophe Theory to the historical and simulated patterns of power systems.
- Applied the Critical slowing down theory to sentence the bifurcation of each critical phase transformation with higher-order terms that reveal qualitative features of the new regime in the future.
- Developed an encoder-decoder structure based on Transformer to incorporate the abstract features and the time-scale data, and the obtained model could be adapted to other critical transformation problems.
- Achieved more than 90% accuracy in terms of prediction of self-organised critical points as well as the distance from collapse, and the type of bifurcations also acquired precision of 95% in the positive samples.

## *PUBLICATIONS* (* indicates equal contribution)

[1] **M, Song** et al., "Transformer Fault Diagnosis based on PSO-RF characterised by modified CNN-encoder," 2022 IEEE 11th Data Driven Control and Learning Systems Conference (DDCLS), accepted on March 28, 2022 **.**

[2] H. Wang*, S. Gao*, Y, Zhao*, **M, Song***, "The Mind Commands You: Combining Brain Computer Interactions with Augmented Reality to Control Internet of Things (IoT) tools, and Robotic Platforms," 2022 IEEE 5th International Conference on Electronics Technology (ICET), accepted on April 18th, 2022.

[3] **M, Song**, "FusionNet: a New Perspective of CNN for Image Classification," 2022 3rd International Conference on Big Data, Artificial Intelligence and Internet of Things Engineering (ICBAIE), accepted on June 12th, 2022.

## *AWARDS*

***May. 2021 –*** *The 11th National College E-Commerce "Innovation, Creativity and Entrepreneurship" Challenge* ***– First Provincial Prize (Top 10%)***

***Jun. 2021 –*** *U.S.-China Young Maker Contest* ***– Second National Prize (Top 5)***

***Jun. 2021 –*** *U.S.-China Young Maker Contest* ***– Winner of the U.S.-China Cooperation (Exclusive)***

***Sep. 2021 –*** *The 7th China International College Students 'Internet+' Innovation and Entrepreneurship Competition* ***– Third National Prize (Top 5%)***

***Oct. 2021 –*** *'Higher Education Society Cup' National Mathematical Modelling Competition for College Students* ***– Second Provincial Prize (Top 20%)***

***Feb. 2022 –*** *The 17th "Challenge Cup" National College Students Extracurricular Academic Science and Technology Works Competition* ***– "Black Technology" Challenge First Prize (Top 1%)***

## *RESEARCH INTEREST*

- Self-Supervised Learning
- Natural language processing
- Computer vision
- Reinforcement Learning

## *TECHNICAL SKILLS*

Python (Pytorch, TensorFlow, Keras, etc.); C\C++; MATLAB; Verilog FPGA