Yang Zhao

i@snowztail.com · yang-zhao · snowztail · 7747-390-777

Education

Imperial College London · PhD in Wireless Communications 2020 – 2024

- Modules: **Artificial intelligence** (machine learning, deep learning, pattern recognition, large-dimensional data processing, computational optimization), **data science** (hypothesis testing, regression modeling, data visualization, R, Pandas, Mathematica, SPSS), **research computing** (Linux, HPC, Docker, Julia, Fortran)
- Supervisor: Prof. Bruno Clerckx, IEEE Fellow, Head of Communications and Signal Processing Group
- Thesis: Reconfigurable intelligent surface: beamforming, modulation, and channel shaping [slides]

Imperial College London · MSc in Communications and Signal Processing 2018 – 2019

- Modules: **Communications** (wireless communications, information theory, coding theory, advanced communication theory), **signal processing** (DSP & filters, adaptive signal processing, wavelets, labs), **artificial intelligence** (probability & stochastic processes, computer vision)
- Grade: 78%, Distinction
- Thesis: Signal optimization for wireless information and power transmission [poster]

University of Liverpool & XJTLU · BEng in Communications and Electronics 2014 – 2018

- Modules: **RF** (antennas, circuits, electronics, electromagnetism, microwave engineering, EMC), **communications** (signal & systems, communication systems, digital & wireless communications), **signal processing** (DSP & filters, instrumentation & control), **programming** (C++, MATLAB, Python)
- Grade: 83%, Distinction
- Thesis: Cross-layer optimization for 4G broadband wireless communication networks [poster]

Expertise

- Focus: **Reconfigurable intelligent surface, ambient backscatter communications, wireless power transfer**
- Interests: Power/code-domain NOMA, multi-antenna techniques (hybrid beamforming, interference alignment, generalized spatial modulation, space-time coding), multiplicative interference channel, OTFS, semantic communications
- Skills: **Optimization** (surrogate, fractional, geometric, dynamic, manifold, ADMM), **signal processing** (estimation, detection, waveform design), **information theory** (modulation, coding, capacity), machine learning, compressed sensing, matrix analysis, tensor methods, system modeling, algorithms & simulations

Projects

1. **Channel Shaping Using Beyond-Diagonal RIS:** We investigate the capability of various passive RIS to redistribute the singular values of point-to-point MIMO channels for achieving power and rate gains. Results show that BD-RIS can help to attain full DoF at much lower SNR than conventional model thanks to its higher signal processing flexibility. Some results are also extended to MIMO interference channels for interference alignment and weighted sum-rate maximization.

2. **Capacity Region of RIS-Aided Broadcast Channel:** We derive an accurate and tractable expression to approximate the entropy of Gaussian mixture, which helps to characterize the achievable rate of generalized spatial modulation. Results show that RIS can significantly enlarge the capacity region by semi-randomly switching the reflection pattern and splitting the resulting free-ride information to different users.

3. **RIScatter:** We propose a batteryless cognitive radio that unifies backscatter communication and RIS from an input distribution perspective. It allows RFID tags to function as RIS elements with minimal hardware modifications at legacy receivers. Results show that active and passive transmission can share the same energy, spectrum, and infrastructure while still benefiting each other.

4. **RIS-Aided Wireless Information and Power Transfer:** We optimize waveform and beamforming to enlarge the rate-energy region under practical harvester model and receiver architectures. Results show that RIS beamforming provides a second-order array gain and fourth-order harvested power, both double than transmit beamforming.

Publications

- **Y. Zhao,** H. Li, M. Franceschetti, and B. Clerckx, "Channel Shaping Using Beyond-Diagonal Reconfigurable Intelligent Surface: Analysis, Optimization, and Enhanced Flexibility," under revision in *IEEE Transactions on Signal Processing.* [code]
- **Y. Zhao** and B. Clerckx, "RIScatter: Unifying Backscatter Communication and Reconfigurable Intelligent Surface," in *IEEE Journal on Selected Areas in Communications,* vol. 42, no. 6, pp. 1642-1655, Jun. 2024. [code, blog]
- **Y. Zhao,** B. Clerckx and Z. Feng, "IRS-Aided SWIPT: Joint Waveform, Active and Passive Beamforming Design Under Nonlinear Harvester Model," in *IEEE Transactions on Communications,* vol. 70, no. 2, pp. 1345-1359, Feb. 2022. [code]
- **Y. Zhao** and B. Clerckx, "Reconfigurable Intelligent Surfaces in Wireless Information and Power Transfer," in *Intelligent Surfaces Empowered 6G Wireless Network.* Hoboken, NJ, USA: Wiley, 2023, pp. 271-295.
- Z. Feng, B. Clerckx, and **Y. Zhao,** "Waveform and Beamforming Design for Intelligent Reflecting Surface Aided Wireless Power Transfer: Single-User and Multi-User Solutions," *IEEE Transactions on Wireless Communications,* vol. 21, no. 7, pp. 5346-5361, Jul. 2022.

Presentations

- RIScatter: Unifying backscatter communication and reconfigurable intelligent surface @ SAL Symposium on 6G, Nov. 2023.
- Semantic communications: An introduction @ internal group meeting, Dec. 2022.
- Symbiotic radio: Towards energy and spectrum efficient transmission @ internal group meeting, Dec. 2020.

Experience

Imperial College London · Teaching Assistant 2020 – 2024

- Wireless communications & optimization (Year 4 & MSc): Tutorial delivery, coursework design & marking, oral test
- Communications & signal processing lab (MSc): Material design & delivery, lab supervision, note & report marking
- Communications (Year 2): Slides & graphics making, tutorial delivery, forum Q&A, exam marking
- Probability and statistics for engineers (Year 2): Tutorial delivery, forum Q&A, exam marking
- Final year project (Year 4 & MSc): Research supervision, progress tracking, feedback & advice, viva examination

China Mobile Group (Guangzhou) · Summer Intern 2017 – 2018

- **Operations engineer** @ Optimization department: Network monitoring, outage identification, base station repair & upgrade, emergency communication vehicle deployment, MRO statistics analysis, network adjustment planning
- **Data analyst** @ Design institute: Commercial product (BBU, RRU, antenna, AAU, microcell, PSU) evaluation, 4G upgrade solution (GSM/TD → NB-IoT/FDD) summarization, site database management, network statistics (RSRP, SINR, CSFB) measurement, radio tower coverage simulation, press release writing, anniversary event organization

Training

- Public lectures: Statistical detection and estimation by Peyman Milanfar, information theory and network coding by Raymond Yeung, Lean for scientists and engineers by Tyler Josephson (in progress)
- ComSoc courses: OTFS and delay-doppler communications, introduction to deep learning for the physical layer, principles of satellite location and navigation, introduction to quantum communications, building the road to 6G
- Professional development: Research communication & grant applications, open access & public engagement, research integrity & data management, self-awareness & teamwork, teaching & assessment

Referees

- Prof. Bruno Clerckx, IEEE Fellow, Head of Communications and Signal Processing Group, Imperial College London [email]
- Prof. Geoffrey Ye Li, IEEE Fellow, Chair Professor of Wireless Systems, Imperial College London [email]

Awards

- **Featured Article** @ IEEE Journal on Selected Areas in Communications, Jun. 2024
- **IET Student Prize** @ University of Liverpool, 2018
- **Undergraduate Scholarship** @ University of Liverpool, 2017
- **University Achievement Award** @ Xi'an Jiaotong-Liverpool University, 2016