Xiangyu Cui

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EDUCATION

New York University Abu Dhabi Aug. 2025 – Present
PhD, supervised by Prof. Qurrat-Ul-Ain Nadeem *Abu Dhabi, UAE; New York, US*

King Abdullah University of Science and Technology (KAUST) Aug. 2023 – Jul. 2025
M.S. with Thesis, supervised by Prof. Mohamed-Slim Alouini | GPA: 4.00/4.00 *Thuwal, Saudi Arabia*

University of Electronic Science and Technology of China (UESTC) Sept. 2019 – Jul. 2023
B.Eng. in Communication Engineering | GPA: 3.93/4.00 *Chengdu, China*

RESEARCH EXPERIENCE

Channel Power Gain Analysis and Orientation Optimization for CAPA Systems Aug. 2025 – April. 2026
Advisor: Prof. Qurrat-Ul-Ain Nadeem *New York University Abu Dhabi*

- Studied point-to-point continuous aperture array (CAPA) systems, where the transmit and receive apertures were modeled as continuous current distributions rather than discrete antenna elements.
- Derived a semi-closed-form expression for the near-field channel power gain (CPG) under a dyadic Green's function based channel model with polarization effects.
- Used the derived CPG expression to analyze how CAPA orientation, aperture size, propagation distance, and transceiver misalignment affected the received channel gain.
- Showed that the optimal Tx/Rx aperture orientation was not always parallel, but depended on the relative geometry between the two CAPAs.
- Validated the proposed expression through numerical simulations and demonstrated substantially lower computational complexity compared with direct integral evaluation and densely sampled discrete MIMO approximation.

Channel Capacity Saturation and Beamforming Acceleration for Near-Field XL-MIMO Aug. 2024 – Jul. 2025
Advisor: Prof. Mohamed-Slim Alouini *CTL, KAUST*

- Investigated the capacity saturation phenomenon in near-field XL-MIMO multiuser communications, showing that excessively increasing the antenna array size may lead to marginal capacity improvement.
- Derived analytical criteria for determining the capacity saturation point, providing design insights for choosing practical array sizes in near-field communication systems.
- Proposed a low-complexity beamforming algorithm to reduce the computational burden caused by extremely large antenna arrays while maintaining near-optimal performance around the saturation point.
- Validated the theoretical analysis and beamforming design through numerical simulations for near-field multiuser XL-MIMO systems.
- Published the work in *IEEE Wireless Communications Letters*.

Near-Field Performance Analysis for XL-MIMO Aug. 2023 – Sept. 2024
Advisor: Prof. Mohamed-Slim Alouini *CTL, KAUST*

- Analyzed near-field performance of extremely large-scale MIMO systems, where conventional far-field assumptions may become inaccurate.
- Summarized existing analytical results on received signal-to-noise ratio for several near-field wave models.
- Derived a generalized received-power expression for different near-field channel models and antenna array structures.
- Derived closed-form approximations for the correlation between different users' channel vectors using the stationary phase method.
- Applied the received-power and correlation results to analyze the sum rate of multi-user XL-MIMO uplink systems.
- Modified a previous user-selection algorithm using the analytical results, achieving a significant speed-up while maintaining the same sum-rate performance.
- Published the work in *IEEE Open Journal of the Communications Society*.

Performance Analysis of OAM Communication under Random Misalignment Apr. 2022 – Jul. 2023
Advisor: Prof. Mohamed-Slim Alouini *CTL, KAUST*

- Analyzed millimeter-wave orbital angular momentum (OAM) communication systems under practical random transceiver misalignment.

- Derived closed-form intensity expressions for given misalignment values in both indoor and outdoor propagation scenarios.
- Evaluated the average channel capacity under two-dimensional Gaussian random misalignment and validated the analysis through numerical simulations.
- Used Gauss–Laguerre quadrature to reduce computational complexity in capacity evaluation under realistic misalignment distributions.
- Studied the effects of array radius, signal-to-noise ratio, and misalignment variance on OAM channel capacity, providing guidelines for practical RF OAM system design.
- Published the work in *IEEE Open Journal of the Communications Society*.

Specific Emitter Identification Using RF Hardware Impairments Jan. 2022 - Jun. 2022

Team Project *UESTC*

- Developed a specific emitter identification (SEI) system that distinguished transmitters using physical-layer hardware fingerprints, including IQ imbalance and carrier leakage.
- Built a signal processing pipeline including digital down-conversion, FIR low-pass filtering, Costas carrier synchronization, and Gardner timing synchronization.
- Modeled transmitter impairments through gain imbalance, quadrature phase error, and carrier leakage, and estimated these features using maximum-likelihood and statistical-property-based methods.
- Compared feature extraction methods under different data-size and SNR conditions, showing that maximum-likelihood estimation was more robust with limited data while statistical estimation was effective for carrier leakage extraction.
- Trained SVM classifiers with One-vs-One multi-class classification and grid-searched hyperparameters, achieving approximately 98% transmitter identification accuracy in testing.

PUBLICATIONS

[J1] X. Cui and Q.-U.-A. Nadeem, "Channel Power Gain Analysis and Orientation Optimization of a Point-to-Point Continuous Aperture Array (CAPA) System," *IEEE Communications Letters*, early access, 2026.

[J2] X. Cui, K.-H. Park, and M.-S. Alouini, "Channel Capacity Saturation Point and Beamforming Acceleration for Near-Field XL-MIMO Multiuser Communications," *IEEE Wireless Communications Letters*, vol. 15, pp. 1390–1394, 2026.

[J3] X. Cui, K.-H. Park, and M.-S. Alouini, "Near-Field Analysis of Extremely Large-Scale MIMO: Power, Correlation, and User Selection," *IEEE Open Journal of the Communications Society*, vol. 6, pp. 252–270, 2024.

[J4] X. Cui, K.-H. Park, and M.-S. Alouini, "Effect of Random Misalignment in the Capacity of Millimeter-Wave OAM," *IEEE Open Journal of the Communications Society*, vol. 5, pp. 1141–1154, 2024.

CONFERENCES

- 4th KAUST 6G Summit, Thuwal, Saudi Arabia, Nov. 27–29, 2023.
- 5th KAUST 6G Summit, Thuwal, Saudi Arabia, Nov. 4–5, 2024.
- Abu Dhabi 6G Summit, Abu Dhabi, UAE, Nov. 14–15, 2024.
- IEEE Communication Theory Workshop (CTW), Murano, Venice, Italy, May 4–7, 2025.

HONORS AND AWARDS

- National Scholarship of China (Top 1%), Dec. 2020 and Nov. 2021.
- Excellent Student Scholarship of UESTC, Dec. 2020 and Nov. 2021.
- First Prize, Electronic Design Contest of UESTC, Nov. 2019.
- Third Prize, National Electronic Design Contest, Sichuan Province, Oct. 2020.
- First Prize, National College Students Mobile Communication 5G Technology Contest, Sichuan Province, May 2020.
- Excellent Prize, National College Students Mobile Communication 5G Technology Contest, Jul. 2020.

TECHNICAL SKILLS

Languages	C, MATLAB, Python, LaTeX
Software	MATLAB, Keil5, Mathematica
Research Areas	wireless communication, near-field communication, XL-MIMO, continuous aperture arrays
ML framework	PyTorch