Navid Reyhanian

U.S. Lawful Permanent Resident
Wireless Systems Engineer in Cisco's Product Group of Enterprise Networking (Grade 8)

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Website

Background

- An expert in the advanced development of signal processing algorithms for wireless communications physical layer, with specialized focus on beamforming techniques, hybrid precoding, and optimization methods for next-generation wireless systems. Possesses mastery in designing sophisticated algorithms that address real-world challenges in multi-user MIMO-OFDM systems, satellite-terrestrial networks, and RIS-assisted cell-free massive MIMO architectures. Beyond theoretical contributions, has implemented practical solutions for precise localization using diverse technologies including GNSS, Wi-Fi, FTM, UWB, and AoA estimation through PDoA measurements. Expertise extends advanced signal processing techniques—including WMMSE-based block coordinate descent, digital predistortion (DPD), Kalman filtering, Riemannian gradient descent, and ADMM—while consistently achieving superior performance in complex communications environments where hardware constraints, interference management, and channel uncertainties present significant challenges.

Education

- **University of Minnesota, Twin-Cities** — MN, USA
  Ph.D. in Electrical Engineering (GPA: 3.96/4) — *2016 – 2022*
  Advisor: Prof. Zhi-Quan Luo, *Co-Advisor: Prof. Jarvis* Haupt
  Dissertation: New Large-Scale Optimization Methods
  with Applications in Communication Networks and Medical Imaging

- **University of Minnesota, Twin-Cities** — MN, USA
  M.Sc. in Electrical Engineering (GPA: 3.96/4) — *2016 – 2019*
  Advisor: Prof. Zhi-Quan Luo

- **University of Tehran** — Tehran, Iran
  M.Sc. in Electrical Engineering (GPA: 16.91/20) — *2012 – 2015*
  Advisor: Prof. Behrouz Maham, *Co-Advisor: Prof. Vahid* Shah-Mansouri

- **Technical University of Munich (TUM)** — Munich, Germany
  Visit for master thesis — *2014 – 2015*

- **Iran University of Science & Technology (IUST)** — Tehran, Iran
  B.Sc. in Electrical Engineering, Communications — *2008 – 2012*

Work Experience

- **Cisco Systems, Inc.** — June 2022 – present
  Wireless Systems Engineer in the Product Group of Enterprise Networking (Grade 8) — *Milpitas, CA*
  - **Topic**: Advanced Development of Signal Processing Algorithms for Wireless Networks
    - Designed and developed an advanced GNSS receiver leveraging a Kalman filter combined with raw pseudo-range measurements, employing Gauss-Newton optimization techniques for enhanced positioning accuracy and robustness.
    - Created and implemented novel algorithms for real-time localization of Access Points (APs) by jointly processing Fine Time Measurement (FTM) data and GNSS signals, enabling dynamic tracking and precise geolocation.
    - Developed a robust Angle of Arrival (AoA) estimation framework using Phase Difference of Arrival (PDoA) measurements on AP antennas, integrating sophisticated phase unwrapping methods with memory techniques and effective ambiguity resolution to significantly enhance client/tag localization accuracy.
    - Conducted detailed RF impairment analysis of transmit front-end modules, including systematic filtering, tuning, and adaptive power control strategies to ensure compliance with stringent FTM ranging accuracy and performance requirements.
    - Designed and implemented robust clustering algorithms for AP grouping, complemented by an Ultra-Wideband (UWB)-based client positioning engine optimized for downlink Time Difference of Arrival (TDoA) networks, enhancing scalability and localization precision.
    - Led the design and development of an uplink TDoA tag positioning system, integrating multiple synchronization techniques to address timing and drift challenges, substantially improving the reliability and accuracy of client localization.
    - Developed and optimized block coordinate descent algorithms tailored for solving large-scale, rank-constrained anchor-free optimization problems, significantly improving AP localization accuracy in GPS-denied network environments.
    - Hands-on performance testing on Wi-Fi and UWB-enabled devices, focusing on real-time throughput, coverage, and reliability metrics to ensure strict QoS and regulatory compliance.
  - **Implementations**: Code developed in C/C++ and Python, executed on Cisco Spaces (cloud).

Technical Skills

- **Technical Skills**: Channel estimation (MMSE, Zero forcing), equalization methods, OFDMA, transmit explicit and implicit beamforming, precoding, compressed beamforming report, channel sounding, space–time block code, LDPC, packet structure, data/ACK frame exchange, channel access techniques, interoperability, and spectrum management.

Internship

- **Sabre Corporation** May. 2019 – Aug. 2019
  Operations Research Analyst *Southlake, Texas*
  - **Topic**: Developing distributed and scalable large-scale optimization algorithms for airline scheduling
  - **Method**: ADMM algorithm with a warm start, where subproblems are linearized and solved via away-steps Frank-Wolfe

Research Experience

- Joint Spatial and Spectral Beamforming for Hybrid mmWave Multi-User MIMO-OFDM Systems See here
  - Hybrid Precoding Design: Integrated digital and analog precoding techniques to address hardware constraints in mmWave systems while balancing performance and cost
  - OFDM Signal Optimization: Developed joint spatial-spectral precoding methods with tailored constraints to mitigate high PAPR and reduce out-of-band emissions
  - TDD-Assisted Precoding Framework: Introduced a TDD-assisted strategy that jointly optimizes transmitter digital-analog precoders, user combiners, and incorporates true time-delay (TTD) lines to counteract beam squint effects
  - Advanced Optimization Techniques: Employed a weighted MMSE-based block coordinate descent (BCD) method enhanced with Riemannian gradient descent, ADMM, and bi-section search to efficiently solve the non-convex optimization problem
  - Performance Validation: Demonstrated superior downlink weighted sum-rate performance and interference mitigation through extensive simulation studies

- Coordinated Multipoint (CoMP) Transmission in Satellite-Terrestrial Networks
  - Integrated CoMP Framework: Leverages coordinated multipoint transmission combining a satellite and multiple terrestrial base stations (BSs) to serve multiple users
  - MMSE-Based Design: Adopts a Minimum Mean Square Error (MMSE) framework that rigorously incorporates transmit power limits, per-user interference constraints, and practical hardware limitations
  - Signal & Interference Modeling: Assumes complex Gaussian signal models and enforces strict interference constraints to maintain controlled interference at each user
  - Markov Satellite Channel Modeling with Memory: Models the wireless channel as a Markov multi-state process with memory, effectively capturing temporal variations in channel conditions
  - Kalman Filter CSI Estimation: Utilizes Kalman filtering to extract accurate channel state information (CSI) from noisy observations, enabling real-time channel tracking
  - CSI-Driven Beamforming: Implements adaptive beamforming based on the estimated CSI to optimize transmission performance and system reliability

- Uplink Sum-Rate Maximization in RIS-Assisted CF-mMIMO-OFDM Networks
  - Joint Optimization Framework: Simultaneously optimizes user transmit precoding, multiple reconfigurable intelligent surface (RIS) coefficients, and receive combining matrices to maximize the uplink sum-rate
  - IQI Considerations: Accounts for in-phase and quadrature-phase imbalance (IQI) at both user equipments (UEs) and access points (APs), ensuring realistic system performance
  - WMMSE-Based BCD Algorithm: Leverages a weighted minimum mean square error (WMMSE) framework with block coordinate descent (BCD) to effectively tackle the non-convex precoding problem
  - Efficient Subproblem Solutions:
    - Employs bisection-search methods and closed-form solutions for optimizing precoders at UEs and combiners at APs, respectively
    - Proposes multiple reformulations for the multi-RIS coefficient subproblem, which are globally solved using a cost-effective gradient projection method (GPM) with adaptive step-size
  - Theoretical and Empirical Validation: Provides convergence guarantees and demonstrates superior performance through extensive simulations compared to heuristic methods that decouple subproblems and overlook hardware impairments

- Data-Driven Adaptive Network Resource Slicing for Multi-Tenant Networks
  - Proposing a novel optimization-based network slice activation scheme for 5G and beyond networks

- Development of a distributed end-to-end network slice adaptation scheme to provide different QoS guarantees
- Exploitation of $\ell_p, 0 < p < 1$ regularization for promoting binary solution in the relaxed optimization
- Incorporation of non-smooth non-convex optimization techniques for sparsity-promoting slice adaptation
- Decomposition of non-convex slice adaptation subproblems and solving them to global optimality
- Deployment of recursive kernel estimators to derive user demand statistics

- Resource Reservation in Backhaul and Radio Access Network with Uncertain User Demands
  - Introduction of a novel distributed resource reservation scheme with multi-connectivity in networks
  - Proposing a distributed and scalable multi-path routing algorithm with link-level parallelization
  - Analysis of the convergence for the proposed optimization-based routing methods in the dual space
  - Proposing an expected outage minimizing reservation in RAN based on successive upper-bound minimization
  - Demonstrating robustness of the proposed resource reservation against two widely used methods
- Virtual Network Function Deployment with In-Subnetwork Processing
  - Proposing a joint virtual network function placement and traffic engineering in a network spanning multiple subnetworks
  - Development of a distributed ADMM algorithm with group LASSO regularization to provision networks
- Guided Joint Image and Field Map Optimization in the Presence of Field Inhomogeneity
  - Proposing a large-scale parallel block coordinate descent method to learn an image correcting transformation
  - Exploitation of golden-section-search method nested inside a grid search to optimize a non-convex problem
  - Introduction of an alternating optimization algorithm to identify the magnetic field from distorted images
  - Solving the joint image and field map estimation to global optimality despite very large field inhomogeneity
- Learning Linear Dynamical Systems from One Trajectory via Stochastic Gradient Descent
  - Derivation of complexity bounds for SGD methods to estimate Markov parameters
  - Introduction of a novel method based on the characteristic polynomial to identify linear systems
- A Linearly Convergent Doubly Stochastic Gauss-Seidel Algorithm for Solving Linear Equations and a Certain Class of Over-Parameterized Optimization Problems
  - Analysis of the convergence of a Gauss-Seidel algorithm for solving a general linear system of equations
  - Proposing iterative alternating projection algorithms for solving the linear feasibility problem
  - Extension for training over-parameterized models in machine learning
- Energy-Aware Scheduling for Broadcast Erasure Channels in Satellite Communications with Two Energy Harvesting Receivers
  - Maximization of throughputs for energy harvesting users via a probabilistic network-coded broadcast scheme
  - Solving a non-convex optimization to global optimality via several convexifications
- Game-Theoretic Approaches for Energy Cooperation in Energy Harvesting Small Cell Networks
  - Development of two novel approaches for energy trading in multi-tier networks with non-cooperative energy-harvesting base stations with the purpose of minimizing non-renewable energy consumption
  - Convergence analysis of proposed approaches and investigation of required message passing interfaces

Patents

- 10 internally approved, 1 granted

Accepted Journal Papers

- **N. Reyhanian** and Z.-Q. Luo, "Data-Driven Adaptive Network Slicing for Multi-Tenant Networks," in IEEE Journal of Selected Topics in Signal Processing, vol. 16, no. 1, pp. 113-128, Jan. 2022 Here
- **N. Reyhanian**, H. Farmanbar, and Z.-Q. Luo, "Resource Reservation in Backhaul and Radio Access Network with Uncertain User Demands," accepted in IEEE Transactions on Vehicular Technology, 2022 [Online] available: Here
- **N. Reyhanian**, B. Maham, "Energy-Aware Scheduling for Broadcast Erasure Channels With Two Energy Harvesting Receivers," in IEEE Transactions on Green Communications and Networking, vol. 4, no. 4, pp. 1174-1187, Dec. 2020 Here
- M. Razaviyayn, M. Hong, **N. Reyhanian**, and Z.-Q. Luo, "A linearly convergent doubly stochastic Gauss–Seidel algorithm for solving linear equations and a certain class of over-parameterized optimization problems," Mathematical Programming, Springer, 2019 Here
- **N. Reyhanian**, B. Maham, V. Shah-Mansouri, W. Tushar, and C. Yuen, "Game-Theoretic Approaches for Energy Cooperation in Energy Harvesting Small Cell Networks," IEEE Transactions on Vehicular Technology, vol. 66, no. 8, pp. 7178–7194, Aug. 2017 [Online] available: Here

Submitted and In-Preparation Journal Papers

- **N. Reyhanian**, R. Ghaderi and Z.-Q. Luo, "Joint Spatial and Spectral Hybrid Precoding For MU-MIMO-OFDM Systems with True Time Delays," to be submitted 2025

Conference Papers

- **N. Reyhanian**, M. Mullen, T. Froelich, M. Garwood and J. Haupt,"Guided Joint Image and Fieldmap Estimation in the Presence of Field Inhomogeneity", in Proc. International Society of Magnetic Resonance in Medicine Annual Meeting & Exhibition, Jun. 2023
- **N. Reyhanian** and Z.-Q. Luo, "Data-Driven Optimized Slice Activation in Multi-Tenant 5G Networks," in Proc. Asilomar Conference on Signals, Systems, and Computers, Nov. 2021
- **N. Reyhanian**, H. Farmanbar, and Z.-Q. Luo, "Data-Driven Adaptive Network Resource Slicing for Multi-Tenant Networks," in Proc. 2021 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)
- **N. Reyhanian**, and B. Maham, "Statistical Slice Selection in Multi-Tenant Networks with Maximum Isolation of Reserved Resources," in Proc. Asilomar Conference on Signals, Systems, and Computers, Nov. 2020
- **N. Reyhanian**, H. Farmanbar, and Z.-Q. Luo, "Resource reservation in backhaul and radio access network with uncertain user demands," in Proc. IEEE 21st International Workshop on Signal Processing Advances in Wireless Communications (IEEE SPAWC), May 2020
- **N. Reyhanian**, H. Farmanbar, S. Mohajer, and Z.-Q. Luo "Resource provisioning for virtual network function deployment with in-subnetwork processing," in Proc. IEEE 21st International Workshop on Signal Processing Advances in Wireless Communications (IEEE SPAWC), May 2020
- **N. Reyhanian**, H. Farmanbar, S. Mohajer, and Z.-Q. Luo, "Joint Resource Allocation and Routing for Service Function Chaining with In-Subnetwork Processing," in Proc. International Conference on Acoustics, Speech and Signal Processing (ICASSP), May 2020
- **N. Reyhanian**, B. Maham, and G. Nauryzbayev, "Energy-Aware Scheduling for Broadcast Erasure Channels with Three Energy Harvesting Receivers," in Proc. 12th International Symposium on Communication Systems, Networks and Digital Signal Processing (CSNDSP), Aug. 2020
- **N. Reyhanian**, B. Maham, V. Shah-Mansouri and C. Yuen, "Double-Auction-Based Energy Trading for Small Cell Networks with Energy Harvesting," in Proc. IEEE International Conference on Communications (IEEE ICC), Kuala Lumpur, Jun. 2016
- **N. Reyhanian**, B. Maham, V. Shah-Mansouri and C. Yuen, "A Matching-Game-Based Energy Trading for Small Cell Networks with Energy Harvesting," in Proc. IEEE 26th Personal, Indoor and Mobile Radio Communications Conference (IEEE PIMRC), Hong Kong, Sept. 2015
- **N. Reyhanian**, V. Shah-Mansouri, B. Maham and C. Yuen, "Renewable Energy Distribution in Cooperative Cellular Networks with Energy Harvesting," in Proc. IEEE 26th Personal, Indoor and Mobile Radio Communications Conference (IEEE PIMRC), Hong Kong, Sept. 2015
- **N. Reyhanian**, B. Maham and C. Yuen, "Optimal Scheduling for Broadcast Erasure Channels with Energy Harvesting Receivers," in Proc. IEEE International Conference on Communications (IEEE ICC), Workshop on Green Communications and Networks, London, UK, Jun. 2015
- M. Heindlmaier, **N. Reyhanian**, and S. Saeedi Bidokhti, "Capacity Regions of Two-Receiver Broadcast Packet Erasure Channels with Feedback and Memory," in Proc. Information Theory and Applications Workshop, Feb. 2015
- M. Heindlmaier, **N. Reyhanian**, and S. Saeedi Bidokhti, "On the Capacity Region of the Two-User Broadcast Packet Erasure Channel with Feedback and Memory," in Proc. IEEE 52nd Annual Communication, Control, and Computing (Allerton), Oct. 2014

Honors and Awards

- Department Fellowship of University of Minnesota, USA- Fall 2016-Spring 2017
- Honorary admission for Master's Degree studies in Iran University of Technology 2012
- Ranked 81st in the nationwide MS.c. entrance exam in electrical engineering, spring 2012

Graduate Courses

- **University of Minnesota, Twin-Cities**
  - Introduction to Nonlinear Optimization, Probability and Stochastic Process, Convex Optimization Theory, Detection and Estimation Theory, Matrix Theory, Linear Programming and Combinatorial Optimization, Artificial Intelligence II, Introduction to Machine Learning, Machine Learning, Optimization
- **University of Tehran**
  - Data Communication Networks, Coding Theory, Wireless Communications, Game Theory, Advanced Communication Networks, Optimal Control, Stochastic Processes, Digital Signal Processing, Advanced Communication Theory
- **Technical University of Munich**
  - Multi-User Information Theory

Licenses & Certifications

- **Coursera**
  - Neural Networks and Deep Learning
  - Improving Deep Neural Networks: Hyperparameter tuning, Regularization and Optimization
  - Structuring Machine Learning Projects
  - Natural Language Processing in TensorFlow
  - Convolutional Neural Networks
  - Sequence Models

Professional Services

- Session Chair for IEEE SPAWC 2020, IEEE Asilomar 2020
- Active reviewer for IEEE TCOM, IEEE TVT, IEEE ICC, IEEE ISIT

Skills Summary

- **Languages**: Python (Numpy, Scipy, Sklearn, and TensorFlow), C/C++, LaTeX, Assembly
- **Softwares**: MATLAB, CVX, Gurobi, Simulink, Multi-Threading, OpenMPI, CUDA, OrCAD schematic capture & PCB layout, and Microsoft Office (Word, Powerpoint, Visio, Excel
- **Operating Systems**: MacOS, Linux, Windows
- **Lab Skils**: Fixed-Point Arithmetic , Digital/Analog Scopes, Spectrum Analyzer, Function Generators
- **Soft Skills**: Leadership, strong verbal and written communication skills, excellent troubleshooting and debugging skills, excellent problem solving skills, excellent teams skills

References

Will be provided upon request.