# Pejman Ghasemzadeh

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## Research Interests

Wireless communications, machine/deep learning, Internet-of-things (IoT), cognitive radio & sensing, signal processing.

## Education

- **Ph.D. in Computer Engineering** — Lincoln, NE, USA
  *University of Nebraska-Lincoln – GPA: 4.00* — *Aug 2020 - May 2023*
  Dissertation: A Novel Graph Neural Network-based Framework for Automatic Modulation Classification in Mobile Environments
- **MS.c. in Telecommunications Engineering** — Lincoln, NE, USA
  *University of Nebraska-Lincoln – GPA: 3.98* — *May 2018 - May 2020*
  Thesis: Deep Learning and Polar Transformation to Achieve a Novel Adaptive Automatic Modulation Classification Framework
  (Awarded the best MSc thesis in the College of Engineering)

## Academic Positions

- **Assistant Professor** — Stillwater, OK, USA
  *Oklahoma State University – School of Electrical and Computer Engineering* — *Jul 2023 - Present*
- **Research Assistant** — Lincoln, NE, USA
  *University of Nebraska-Lincoln – Dept. ECE – TEL Lab* — *May 2018 - May 2023*

## Research Experience

- **Research Assistant** — Lincoln, NE, USA
  *University of Nebraska-Lincoln (UNL) – TEL Lab* — *May 2018 - May 2023*
  - **Automatic Modulation Classification (AMC) in Stationary & Mobile Environments [Published 12 Articles]**:
    - Determined the best instantaneous statistical feature (moment/cumulant of high-order, wavelet transformed- or cyclostationary-based feature) to be extracted from received signal that improves the performance of an SVM-based AMC model under Gaussian channel model
    - Through a mathematical derivation, the biasedness of high-order statistics estimator for low- and high-order modulation schemes was removed by one-pass/two-pass algorithms and joint cumulant computation, respectively, to provide more accurate statistical features to an SVM-based AMC model to improve its performance in low SNR environments
    - Stationary Environments: Under RadioML 2016.10A and 2018.01A datasets testing:
      - Proposed a CNN-based AMC model, operating upon deep belief network working principle, to increase an average 19.2% classification accuracy in low SNR environment compared to other models
      - Proposed a low computationally complex CNN-based AMC model, operating upon spiking neural network working principle, to decrease the execution latency by 34.31% with sacrificing only 4.2% in classification accuracy compared to previously proposed CNN-DBN-based model
      - Proposed an adaptive framework using CNN-DBN- and CNN-SNN-based models to improve AMC performance efficiency by intelligently balancing between classification accuracy and computational complexity in low SNR environments
    - Mobile Environments: Under MIMOSigRef-SD (Pedestrian A&B and Vehicular A&B) dataset testing:
      - Collected a real-world emulated dataset (MIMOSigRef-SD) via a communications setup using USRP B210s and B205-minis as transceivers, and Azimuth ACE 400WB as channel emulator for 4 mobile environments (Pedestrian-A/B and Vehicular-A/B)
      - Proposed a robust graph convolutional neural network (GCNN)-based AMC model for mobile environment
      - Addressed the two major challenges in the GCNN-based feature extraction module: 1) constellation points link assignment (determining adjacency matrix), and 2) graph-based feature abstraction over time to capture dynamic characteristics of the mobile environments
      - Optimized the proposed model for maximum efficiency, making it real-world implementable
      - Conducted SDR-based (USRP X310) field testing to analyze and validate the performance of the trained AMC classifier
  - **Exploring Railroad Requirements, Achieving Synergy, and Designing Wireless Digital Train Line (WiDTL) for Next-Generation Rail Services [Published 9 Articles]**:
    - Modeled a practical communication system in single- and multi-carrier (OFDM) transmission and reception mode, capable of combating real-world distortions (carrier frequency and phase offsets, etc) with maximum throughput while complying with FCC regulations, i.e., emission mask

- Modeled railroad propagation environments (rural, suburban and urban) via channel models of interest (Okumura, Hata, Winner2, etc) with relevant channel effects (attenuation, fast/slow fading, velocity/mobility impact, etc)
- Comprehensively analyzed the designed communications systems' performance in terms of: signal strength/SINR/BER/throughput vs distance, performance at different velocities and latency of Tx and Rx operations
- Conducted end-to-end performance analysis by implementing protocol stack, designed specifically for railroad applications with CSMA/CA channel access protocol, using the PHY layer results of the designed communications systems for: best-case performance/latency/packet loss/throughput, mid/long-rang performance and full/reduced contention scenarios
- GNU Radio implementation of the designed communication system for SDR-based field testing prototyping

◦ **Software-defined Radar for Railroad Applications** [**Published 2 Articles**]:

- Proposed a novel single- and multi-antenna coupled with beamforming for long-range reading of Automatic Equipment Identification (AEI) tags installed on dark cars in railroad operations
- Evaluated the effects of various railroad channel characteristics (attenuation, phase and frequency offsets, etc) in Two-Ray Ground-reflection, Rayleigh and Rician environments over the identification process
- Determined the antenna type capable of matching to any possible polarization of AEI tag in order to deliver the maximum transmitted power

## Peer-Reviewed Publications

Authored and co-authored **23** technical articles (6 journals and 17 conferences) with more than **240** citations, **h-index** and **i10-index** of **11** as of August 21, 2023. (Google Scholar profile: )

### Transactions & Journals

1. **P. Ghasemzadeh**, Michael Hempel, Honggang Wang, and Hamid Sharif. "GGCNN: An Efficiency-Maximizing Gated Graph Convolutional Neural Network Architecture for Automatic Modulation Identification" IEEE Transactions on Wireless Communications (2023). {Accepted}
2. **P. Ghasemzadeh**, Subharthi Banerjee, Michael Hempel, and Hamid Sharif. "A novel deep learning and polar transformation framework for an adaptive automatic modulation classification" IEEE Transactions on Vehicular Technology 69, no. 11 (2020): 13243-13258.
3. **P. Ghasemzadeh**, Michael Hempel, Subharthi Banerjee, and Hamid Sharif. "A spatial-diversity MIMO dataset for RF signal processing research" IEEE Transactions on Instrumentation and Measurement 70 (2021): 1-10.
4. **P. Ghasemzadeh**, Michael Hempel, and Hamid Sharif. "GS-QRNN: A high-efficiency automatic modulation classifier for cognitive radio IoT" IEEE Internet of Things Journal 9, no. 12 (2022): 9467-9477. **{Invited Paper}**
5. S. Banerjee, **P. Ghasemzadeh**, M. Hempel, and H. Sharif, "Topography Relaxation in determining Unsafe State Intersections for Uncertain CPS" IEEE Sensors Letters, vol. 4, no. 4, pp. 1–4, 2020.
6. S. Banerjee, J. Santos, M. Hempel, **P. Ghasemzadeh**, and H. Sharif,"A novel method of near-miss event detection with software defined RADAR in improving railyard safety" MDBI Safety, vol. 5, no. 3, p. 55, 2019.

### Conferences & Proceedings

7. **P. Ghasemzadeh**, M. Hempel, and H. Sharif, "A Robust Graph Convolutional Neural Network-Based Classifier for Automatic Modulation Recognition" in IEEE International Wireless Communications and Mobile Computing Conference (IWCMC), pp. 907–912, IEEE, 2022.
8. **P. Ghasemzadeh**, M. Hempel, and H. Sharif, "A Novel High-Accuracy Low-Execution Time Machine Learning-Driven Approach to Automatic Modulation Classification" in IEEE 18th Annual Consumer Communications & Networking Conference (CCNC), pp. 1–6, IEEE, 2021.
9. **P. Ghasemzadeh**, S. Banerjee, M. Hempel, A. Harms, and H. Sharif, "Detecting Dark Cars in Railroad Operations using Multi-Antenna Beamforming for Long-Distance Discovery and Identification of AEI Tags" in IEEE International Wireless Communications and Mobile Computing (IWCMC), pp. 1561–1566, IEEE, 2020.
10. **P. Ghasemzadeh**, S. Banerjee, M. Hempel, H. Sharif, and T. Omar, "Evaluation of machine learning-driven automatic modulation classifiers under various signal models" in IEEE/ASME Joint Rail Conference, vol. 83587, p.V001T11A007, American Society of Mechanical Engineers (ASME), 2020.
11. **P. Ghasemzadeh**, S. Banerjee, M. Hempel, A. Harms, and H. Sharif, "Detecting Dark Cars Using a Novel Multi-Antenna AEI Tag Reader Design for Increased Read Distance and Reliability" in IEEE/ASME Joint Rail Conference, vol. 83587, p.V001T11A006, American Society of Mechanical Engineers (ASME), 2020.

12. **P. Ghasemzadeh**, S. Banerjee, M. Hempel, and H. Sharif, "A new framework for automatic modulation classification using deep belief networks" in IEEE International Conference on Communications Workshops (ICC Workshops), pp. 1–6, IEEE, 2020.
13. **P. Ghasemzadeh**, S. Banerjee, M. Hempel, M. Alahmad, and H. Sharif, "Analysis of Distribution Test-based and Feature-based Approaches toward Automatic Modulation Classification" in IEEE 30th Annual International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC), pp. 1–6, IEEE, 2019.
14. **P. Ghasemzadeh**, S. Banerjee, M. Hempel, and H. Sharif, "Accuracy analysis of feature-based automatic modulation classification with blind modulation detection" in IEEE International Conference on Computing, Networking and Communications (ICNC), pp. 1000–1004, IEEE, 2019.
15. **P. Ghasemzadeh**, S. Banerjee, M. Hempel, and H. Sharif, "Performance evaluation of feature-based automatic modulation classification" in IEEE 12th International Conference on Signal Processing and Communication Systems (ICSPCS), pp. 1–5, IEEE, 2018.
16. **P. Ghasemzadeh**, M. Hempel, H. Sharif, and T. Omar, "Modeling and Performance Evaluation of an RF Transceiver System at 160 MHz for Railroad Environments" in IEEE/ASME Joint Rail Conference, vol. 85758, p.V001T03A005, American Society of Mechanical Engineers (ASME), 2022.
17. **P. Ghasemzadeh**, M. Hempel, H. Sharif, and T. Omar, "Maximizing RF Communications Throughput for Railroad Applications at 160 MHz" in IEEE/ASME Joint Rail Conference, vol. 85758, p.V001T03A004, American Society of Mechanical Engineers (ASME), 2022.
18. **P. Ghasemzadeh**, M. Hempel, H. Sharif, and T. Omar, "An OFDM-Based Transceiver Analysis for Railroad Applications" in IEEE International Wireless Communications and Mobile Computing Conference (IWCMC), pp. 748–753, IEEE, 2022.
19. S. Banerjee, M. Hempel, **P. Ghasemzadeh**, H. Sharif, and T. Omar, "Wireless Communication for High-Speed Passenger Rail Services: A Study on the Design and Evaluation of a Unified Architecture" in IEEE/ASME Joint Rail Conference, vol. 83587, p. V001T11A004, American Society of Mechanical Engineers (ASME), 2020.
20. S. Banerjee, M. Hempel, **P. Ghasemzadeh**, Y. Qian, and H. Sharif, "A novel approach to social-behavioral d2d trust associations using self-propelled voronoi" in IEEE 90th Vehicular Technology Conference (VTC2019-Fall), pp. 1–5, IEEE, 2019.
21. S. Banerjee, M. Hempel, **P. Ghasemzadeh**, and H. Sharif, "A Novel Biomimicry-based Analysis of D2D User Association Retention for Achieving Maximal Throughput" in IEEE 15th International Wireless Communications & Mobile Computing Conference (IWCMC), pp. 2036–2042, IEEE, 2019.
22. S. Banerjee, M. Hempel, N. Albakay, **P. Ghasemzadeh**, and H. Sharif, "A Framework for High-Speed Passenger Train Wireless Network Radio Evaluations" in IEEE/ASME Joint Rail Conference, p. V001T08A003, American Society of Mechanical Engineers (ASME), 2019.
23. S. Banerjee, M. Hempel, **P. Ghasemzadeh**, N. Albakay, and H. Sharif, "High Speed Train Wireless Communication: Handover Performance Analysis for Different Radio Access Technologies" in IEEE/ASME Joint Rail Conference, vol. 58523, p. V001T03A006, American Society of Mechanical Engineers (ASME), 2019.

**Datasets**

1. **P. Ghasemzadeh**, M. Hempel, S. Banerjee, and H. Sharif, "MIMOSigRef-SD," IEEE Dataport, 2021.

## Selected Fellowships, Honors and Awards

- Holling Family Excellency Teaching Fellowship ($16,000) — Aug 2019 – May 2023
- Nebraska Engineering Recruitment Fellowship ($10,000) — Aug 2021 – May 2023
- UNL ECE Depat. – Outstanding Teaching Assistant Award — May 2022
- UNL College of Engineering – Outstanding Masters Thesis Award — May 2020

## Teaching Experience

- **University of Nebraska-Lincoln** — Lincoln, NE, USA
  *Department of Electrical and Computer Engineering – Role: Lab Instructor* — *Aug 2018 - May 2023*
  - ECEN 106: Microprocessor Applications (Students Evaluation: **4.9/5**) — Aug 2019 – May 2023
  - ECEN 103: Computer & Electrical Eng Fundamentals (Students Evaluations: **4.8/5**) — Aug 2022 – Dec 2022
  - ECEN 345: Mobile Robotics (Students Evaluations: **4.6/5**) — Jan 2019 – May 2019
  - ECEN 123: Introduction to Engineering (Students Evaluations: **4.5/5**) — Jan 2019 – May 2019
  - ECEN 444: Linear Control System (Students Evaluations: **4.5/5**) — Aug 2018 – Dec 2018

## Professional Services

- **Technical Reviewer**
  *IEEE* *Since 2019*
  - IEEE Transactions on Wireless Communications
  - IEEE Transactions on Vehicular Technology
  - IEEE Transactions on Mobile Computing
  - IEEE Transactions on Cognitive Communications and Networking
  - IEEE Transactions on Aerospace and Electronic Systems
  - IEEE Wireless Communications Letter
  - IEEE Communications Letter
  - IEEE Microwave and Wireless technology Letter
  - IEEE Sensors Journal
  - IEEE Access