

Abolfazl Rahimnejad

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Research Profile. My research focuses on data-driven estimation, control, and optimization. I develop data-driven and ML-aided frameworks for uncertainty-aware and resilient operation and control, with applications in cyber-physical energy systems and smart building energy management.

Education

- **University of Guelph** (in collaboration with McMaster University) (09/2018–10/2022)
Ph.D. in Engineering Systems and Computing. Thesis: *Lattice Kalman Filters: Data-driven Dynamic State Estimation*. GPA: A
- **Babol University of Technology** (09/2009–09/2012)
M.Sc. in Electrical Power Engineering. Thesis: *Non-Intrusive Condition Monitoring of HV Transmission Lines*. GPA: 17.45/20 (Ranked 1/40, with honors)
- **University of Mazandaran** (09/2005–09/2009)
B.Sc. in Electrical Engineering. Project: *Challenges in the Power System with High Penetration of RESs*. GPA: 17.10/20 (Ranked 1/140, with honors)

Research Appointments

- **Research Associate**, Dept. of Mechanical Engineering, McMaster University (09/2022–Present)
Research: Data-driven resilient operation & control of smart systems.
- **Visiting Researcher**, Dept. of Engineering Systems and Computing, University of Guelph (06/2018–09/2018)
Research: Smart building energy management systems.
- **Graduate Visiting Researcher**, Dept. of EECS, Lamar University (Texas, USA) (04/2017–06/2018)
Research: Resilient cyber-physical power systems.
- **Graduate Researcher**, Dept. of ECE, Babol University of Technology (09/2013–04/2017)
Research: Multiple virtual power plants operation.
- **Graduate Researcher**, Dept. of ECE, Babol University of Technology (09/2012–09/2013)
Research: Optimal design of high voltage transmission lines & insulation coordination.

Selected Publications

- **A. Rahimnejad**, J. Khazaei, “Data-driven Model-free Dynamic State Estimation of Single Machine Infinite Bus System,” *IEEE Transactions on Power Systems*, Under Review.
- **A. Rahimnejad**, S. A. Gadsden, “Addressing Cybersecurity in Smart Power Systems Through Variants of Reinforcement Learning: Attacks, Defenses, and Trends,” *Expert Systems with Applications*, Under Review.
- E. Akbari, **A. Rahimnejad**, S. A. Gadsden, “Holistic Swarm Optimization: A Novel Metaphor-Less Algorithm Guided by Whole Population Information for Addressing Exploration-Exploitation Dilemma,” *Computer Methods in Applied Mechanics and Engineering*, vol. 445, 2025, Art. 118208. doi: [10.1016/j.cma.2025.118208](https://doi.org/10.1016/j.cma.2025.118208)
- **A. Rahimnejad**, L. Vanfretti, S. A. Gadsden, M. Al-Shabi, “Strengthening Lattice Kalman Filters: Introducing Strong Tracking Lattice Filtering for Enhanced Robustness,” *IEEE Access*, vol. 12, pp. 178552–178565, 2024. doi: [10.1109/ACCESS.2024.3504338](https://doi.org/10.1109/ACCESS.2024.3504338)
- **A. Rahimnejad**, J. Enayati, L. Vanfretti, S. A. Gadsden, M. Al-Shabi, “Reinforced Lattice Kalman Filters: A Robust Nonlinear Estimation Strategy,” *IEEE Open Journal of Signal Processing*, vol. 4, pp. 410–423, 2023. doi: [10.1109/OJSP.2023.3298555](https://doi.org/10.1109/OJSP.2023.3298555)
- J. Enayati, **A. Rahimnejad**, L. Vanfretti, S. A. Gadsden, M. Al-Shabi, “Dynamic Harmonic Estimation Using a Novel Robust Filtering Strategy: Iterated Sliding Innovation Cubature Filter,” *IEEE Transactions on Instrumentation and Measurement*, vol. 72, Art. 2502310, 2023. doi: [10.1109/TIM.2022.3218539](https://doi.org/10.1109/TIM.2022.3218539)
- A. Esmaeel Nezhad, **A. Rahimnejad**, P. H. J. Nardelli, S. A. Gadsden, S. Sahoo, “A Shrinking Horizon Model Predictive Controller for Daily Scheduling of Home Energy Management Systems,” *IEEE Access*, vol. 10, pp. 2169–3536, 2022. doi: [10.1109/ACCESS.2022.3158346](https://doi.org/10.1109/ACCESS.2022.3158346)
- **A. Rahimnejad**, S. A. Gadsden, M. Al-Shabi, “Lattice Kalman Filters,” *IEEE Signal Processing Letters*, vol. 28, pp. 1355–1359, 2021. doi: [10.1109/LSP.2021.3089935](https://doi.org/10.1109/LSP.2021.3089935)
- A. Esmaeel Nezhad, **A. Rahimnejad**, S. A. Gadsden, “Home Energy Management System for Smart Buildings with Inverter-Based Air Conditioning System,” *International Journal of Electrical Power & Energy Systems*, 133 (2021) 107230. doi:[10.1016/j.ijepes.2021.107230](https://doi.org/10.1016/j.ijepes.2021.107230).

Full publication list available via [Google Scholar](#).

Projects & Experiences

Research Experience

- **Intelligent Operation and Control of Cyber-Physical Systems**, Research Associate, McMaster University, Apr 2024 – Present.
 - Proposed *Strong Tracking Lattice Filters* to enhance robustness in nonlinear dynamic state estimation, improving resilience of control systems under modeling uncertainties.

- Co-developed *Holistic Swarm Optimization*, a novel metaphor-less algorithm addressing exploration–exploitation trade-offs in large-scale optimization, with applications to engineering design and intelligent automation.
 - Investigated reinforcement learning frameworks for cybersecurity in smart power systems, focusing on adversarial resilience and defense strategies for safety-critical cyber-physical infrastructures.
 - Conducted simulation and hardware-in-the-loop studies for validating estimation and optimization frameworks, with methods adaptable to complex smart systems.
- **Data-Driven Estimation and Control**, Research Associate, McMaster University, Oct 2022 – Mar 2024.
 - Introduced *Reinforced Lattice Kalman Filters*, a robust nonlinear estimation strategy designed to improve state estimation under high uncertainty and nonlinear dynamics.
 - Developed a *Data-driven dynamic state estimation framework* by integrating sparse identification of nonlinear dynamics (SINDy), deep neural networks for predicting unmeasurable states, and H-infinity lattice filters for real-time estimation.
 - Applied and validated these methods in complex power system and robotic environments, with approaches that are transferable to resilient estimation and control in networked platforms.
 - **Smart Buildings Energy Management in Presence of Renewable Energy Resources**, Graduate Researcher, University of Guelph, Jul 2018 – Sep 2020.
 - Developed a mixed-integer linear programming (MILP) model to optimally schedule shiftable household loads (e.g., air conditioner, dishwasher) considering solar PV availability and real-time pricing, reducing energy costs and improving power factor.
 - Designed a Home Energy Management System (HEMS) integrating inverter-based air conditioning with photovoltaics and electrical energy storage, applying time-of-use pricing and demand-response strategies to minimize daily energy costs while maintaining comfort.
 - Proposed a shrinking horizon model predictive control (MPC) approach for daily scheduling in smart buildings, achieving improved load management, cost savings, and operational flexibility.
 - Validated these demand-side and control-oriented strategies through simulation studies and data-driven modeling, demonstrating transferable expertise in real-time optimization and scheduling frameworks applicable to other systems.
 - **Non-Intrusive Prognosis of Power Components Faults**, Visiting Researcher, Lamar University, Apr 2017 – Jun 2018.
 - Developed a cyber-physical prognostic approach for microgrid components by detecting electromagnetic wave signatures and applying machine learning (classifiers), enabling early fault prognosis using minimally invasive measurements in microgrid environments.
 - Proposed a hybrid protection strategy for busbar systems combining hyperbolic S-Transform feature extraction with Extreme Learning Machines to reliably discriminate internal faults

from external faults and CT-saturation inrush currents, demonstrating resilience to noise and high fault resistance.

- Validated these data-driven fault detection and classification methods via HIL simulation studies, highlighting techniques that are transferable to predictive maintenance and fault-tolerant control in other systems.
- **Multiple Virtual Power Plants Operation**, BNUT & Mazandaran Distribution Utility, Sep 2013 – Mar 2017.
 - Generalized oligopolistic market equilibrium models to capture the participation of multiple Virtual Power Plants (VPPs), extending equilibrium problems with equilibrium constraints (EPEC) to include operational constraints such as generation limits, storage dynamics, and demand flexibility.
 - Formulated strategies for market participation where each VPP, composed of conventional generators, renewable energy sources, batteries, and responsible loads, optimizes its internal operation while competing in the electricity market.
 - Demonstrated how integrating storage and demand response within VPPs reduces the uncertainty of renewable generation, improves profitability, and enhances system reliability under competitive market conditions.
 - Highlighted the relevance of such equilibrium-based coordination frameworks for managing distributed and heterogeneous assets in other domains.
- **Assessment of Harmonic Effects on Measurement Devices**, BNUT & Mazandaran Distribution Utility, 2014.
 - Benchmarked metering susceptibility to harmonic distortions.
 - Recommended mitigation strategies for improved measurement accuracy.
- **Design of a Grading Ring for the 230 kV I-String Insulator & 400 kV V-String Insulator Transmission Line**, BNUT & Mazandaran Regional Electric Utility, Sep 2011 – Sep 2013.
 - Modeled electric field distribution and insulation coordination for high-voltage lines.
 - Designed and validated grading rings to optimize voltage distribution.
- **High-Voltage Research Lab Lead Coordinator**, BNUT, Sep 2010 – Sep 2013.
 - Directed the design and construction of high-voltage laboratory setups for academic and industrial use.
 - Supervised safety compliance, procurement, and technical training.
- **Internship, Design and Construction of High-Voltage Substations**, Nikan Niroo Sanat, Summer 2009.
 - Assisted in the design and assembly of high-voltage substation components.
 - Participated in layout planning and equipment specification.

- Internship, **Mazandaran Regional Electric Utility**, Summer 2008.
 - Participated in grid operation and maintenance activities.
 - Observed fault diagnosis and restoration procedures in high-voltage systems and prepared reports.

Teaching Experience

- **Lecturer**
 1. Linear Control Systems, System Analysis, Signal Processing, and Electric Circuits, Babol University of Technology & Mazandaran University of Science and Technology, Fall 2013–Winter 2017.
 2. Power Electronics, Electric Machines, Engineering Mathematics, and High Voltage Engineering, Mazandaran University of Science and Technology, Fall 2014–Winter 2017.
 - Designed syllabi, lectures, and problem sets; created and graded exams.
 - Built and supervised labs (hardware/software) and undergraduate projects.
 - Embedded real-world case studies.
- **ENGG*6140 – Optimization Techniques (Graduate)**, Graduate Teaching Assistant, University of Guelph, Fall 2022.
 - Assisted in delivering lectures and problem-solving sessions on linear/nonlinear programming, convex optimization, and metaheuristics.
 - Guided students on Simplex/MATLAB/Python implementations for optimization algorithms.
- **ENGG*2450 – Electric Circuits**, Graduate Teaching Assistant, University of Guelph, Winter 2021 and 2022.
 - Led labs on simulation and measurement (e.g., transient response, frequency response).
 - Guided students on MATLAB/Multisim analysis and lab reporting.
 - Provided office hours and targeted problem-solving support.
- **ENGG*3390 – Signal Processing**, Graduate Teaching Assistant, University of Guelph, Fall 2019, 2020, and 2021.
 - Ran hands-on MATLAB-based labs focused on signal fundamentals (convolution, Fourier analysis, digital filtering, FIR/IIR design).
 - Assisted students in implementing DSP algorithms, ensured proper use of lab platforms, and enforced safety and academic integrity protocols.
 - Managed CourseLink materials and announcements, supported quiz and exam administration and grading.
- **ENGG*41X – Engineering Design IV (Final Project Assessment)**, Graduate Teaching Assistant, University of Guelph, Fall 2019.

- Advised capstone student teams (3–4 per team) on project proposals, interim reports, and final design reports/practices.
- Administered deliverables through CourseLink, managed rubrics for grading proposal, interim and final reports.
- **ENGG*3410 – System and Control Theory**, Graduate Teaching Assistant, University of Guelph, Winter 2019.
 - Led MATLAB-based labs on modeling, transfer functions, state-space, root-locus, Bode, and Nyquist analysis.
 - Guided students in designing classical PID controllers and analyzing closed-loop behavior via simulations and lab experiments.
 - Managed lab manuals, pre-lab assignments, and rubrics via CourseLink; supported student learning in tutorials, office hours, and homework review.
- **ENGG*3450 – Electronic Devices**, Graduate Teaching Assistant, University of Guelph, Fall 2018.
 - Supervised MATLAB-based labs covering semiconductor fundamentals, diode/MOSFET behavior, biasing circuits, small-signal models, op-amps, and logic gate implementation.
 - Guided students in translating theoretical device models into circuit-level designs and real-world troubleshooting.
 - Assisted with lab logistics, including scheduling, safety protocols, and grading of lab reports and quizzes via CourseLink.

Academic and Professional Service

• Journal Reviewer

- Served as peer reviewer for leading journals, including: *IEEE Transactions on Instrumentation and Measurement*, *IEEE Signal Processing Letters*, *IEEE Open Journal of Signal Processing*, *IEEE Transactions on Geoscience and Remote Sensing*, *Soft Computing* (Springer), *IEEE Access*, *Energy* (Elsevier), and *Results in Engineering* (Elsevier).

• Canadian Union of Public Employees (CUPE), University of Guelph

Steward, Department of Physics (Apr 2020–Sep 2021)

- Represented departmental members in workplace matters, including conflict resolution and contract interpretation.
- Acted as the first point of contact for concerns, guiding members through grievance and resolution processes.

Member Representative (Sep 2021–Sep 2022)

- Served as liaison between CUPE membership and executive committee, voicing member concerns in decision-making forums.
- Supported union initiatives and coordinated communication on policy changes, benefits, and workplace rights.

Honors & Awards

- Research Fellowship, McMaster University, Ontario, Canada 2022
- IDTS Scholarship, University of Guelph, Ontario, Canada 2019
- Research Award, LAREM Lab., Lamar University, Texas, USA 2017
- Awarded Research Scholarship, Ranked 1st M.Sc. cohort 2009, BNUT 2013
- Distinguished M.Sc. Thesis Award, BNUT, Iran 2012
- Research Assistantship, High Voltage Laboratory, BNUT, Iran 2010
- Awarded Research Scholarship, Ranked 1st B.Sc. cohort 2005, Univ. of Mazandaran 2009

Technical & Language Skills

- **Programming & Scripting:** Python (NumPy, pandas, scikit-learn, TensorFlow, PyTorch), MATLAB, R, C++, GAMS, \LaTeX
- **Cloud Platforms & Services:** AWS (SageMaker, S3)
- **Engineering & Simulation Tools:** MATLAB Simulink, LabVIEW, PLC Programming, EMTP/ATP, DigSILENT PowerFactory, ANSYS, COMSOL Multiphysics
- **Data Science & Analytics Tools:** JupyterLab, RStudio, SQL, Git
- **Languages:** English (Fluent), French (Intermediate – B1), Persian (Native)

Certificates & Specializations

- Statistics and Data Science (Methods Track), MIT MicroMasters, In Progress
- Machine Learning, Stanford University, Coursera
- Deep Learning Specialization, Stanford University, Coursera
- Reinforcement Learning Specialization, University of Alberta, Coursera; In Progress
- Convex Optimization, Stanford University (edX)
- Optimization: Principles and Algorithms — Network and Discrete Optimization, Unconstrained Nonlinear Optimization, Linear Optimization, EPFLx
- AWS Cloud Technical Essentials, Amazon Web Services
- Microsoft Azure Data Scientist Associate (DP-100), Microsoft, Coursera; In progress

References

- Prof. Andrew Gadsden, McMaster University — gadsdesa@mcmaster.ca
- Prof. Luigi Vanfretti, Rensselaer Polytechnic Institute — vanfrl@rpi.edu
- Prof. Mohamad Abou El Nasr, University of Guelph — maboueln@uoguelph.ca