

AKHILESH RAJ

 [akhileshraj91.github.io](https://github.com/akhileshraj91)

 [Akhilesh-Raj](#)

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RESEARCH INTERESTS

- **Reinforcement Learning:** I worked on maximizing the performance parameters under a constrained power supply in HPC nodes. Beginning as a summer internship project, it is now mainstream research area. It can either be posed as an optimal control problem with or without the knowledge of the dynamics or as a reinforcement learning problem that solves the optimization heuristically.
- **HPC:** Design critical algorithms to propose power caps for the operation of HPC running application thereby pave way to green computing.
- **Advanced Test Beds:** Developing advanced test beds for testing Cyber-Security Reinforcement Learning Agents trained to tackle ongoing threats to the Operational Technology Networks.

RESEARCH EXPERIENCE

Graduate Research Assistant

Vanderbilt University

 Jan 2024 – Present

 Nashville, USA

- Designed and implemented a realistic cyber-physical testbed integrating GridLAB-D (for power distribution simulation), OpenPLC (for programmable logic control), and Mininet (for emulating operational technology (OT) networks).
- Developed and tested Modbus TCP-based communication between SCADA controllers and simulated field devices for real-time data acquisition and control.
- Enabled closed-loop interaction between GridLAB-D and physical control logic via OpenPLC using Python-based middleware for deterministic control and fault injection.
- Emulated cyber-attack vectors and tested their impacts on physical infrastructure to evaluate the resilience and responsiveness of control logic under adversarial scenarios.
- Contributed to the DARPA CASTLE (Cyber Agents for Security Testing and Learning Environments) project, which aims to advance AI-based defense mechanisms for critical infrastructure.
- Facilitated integration of AI agents for anomaly detection and automated mitigation strategies using the developed cyber-physical infrastructure.

W.J Cody Associate

Argonne National Lab

 May 2024 – Aug 2024

 Chicago, USA

- Worked on efficient utilization of edge computational devices while integrating with AI workflows on HPC.
- Developed a data processing algorithm, by designing controller to spawn edge resources based on the arrival speed of data.
- Published the proposed work to IPDPS PAISE-2025 workshop.

Student Sub Contractor

Argonne National Lab

 Jan 2023 – Sept 2023

 Remote Position

- Extended the internship works to multiple applications.
- Worked on bringing application agnostic nature to the research.
- Offline reinforcement learning was used to make improvement to power efficiency by incorporating application and hardware agnostic feature.

W.J Cody Associate

Argonne National Lab

 May 2022 – Aug 2022

 Chicago, USA

- Worked on optimizing the performance and power of High Performance Computing (HPC) node.

- A Reinforcement Learning based method implemented using PyTorch with the help of Stable-Baselines-3 was proposed, over the existing Control Theory based approach which yielded results better or equal to the benchmark.
 - The RL agent trained using mathematical models of the HPC node was tested on a skylake processor hosted by **Chameleon Cloud**, where the actuation was facilitated with the help of intel RAPL technology.
 - The results and the code were tabulated and were made available for publications.
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Project Associate

Indian Institute of Science

📅 March 2021 – July 2021

📍 Bangalore, India

- Worked on the development of an intersection management algorithm in unguarded traffic intersections by using **Reinforcement Learning** methods. The approach was an alternative to the expensive combined optimization problem that was involved before.
 - The constraints were comprised of collision avoidance, passenger safety, intersection safety and a demand factor.
 - An important breakthrough that came out of this research was parallelizing the existing python simulations for multi-core processors.
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Lead Project Engineer

DROPVault Tech. Pvt. Ltd.

📅 Oct 2020 – Feb 2021

📍 Bangalore, India

- Worked on creating a functional prototype of a secure package collection system.
 - Designed, built and tested a Raspberry Pi based model.
 - Lead the team for designing the back-end support.
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Research Consultant

BAYESIAN WAYS LLP

📅 Aug 2020 – Oct 2020

📍 Kerala, India

- Developed MATLAB and Python based programs for an **optimal event scheduler**.
 - The initial prototype development was done in MATLAB using GUROBI and MOSEK (licensed cvx solvers).
 - The solver for the event scheduler (a **mixed integer problem**), was then developed in Python using CVXPY and OR-TOOLS.
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Research Associate

Missouri University of Science and Technology

📅 Jan 2017 – Dec 2019

📍 Rolla, USA

- Worked on developing a **distributed state estimation architecture for multi-agent systems** with applications to **target tracking** using MATLAB.
 - With the use of Model Predictive Control (MPC), formulated a control strategy to track the dynamics.
 - The project, funded by **Dynamic data driven applications of air force office of scientific research**, required the detection and tracking of an enemy aircraft, where the dynamics and inputs were considered unknown.
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Project Engineer

IDEA Lab, IIT Kanpur

📅 May 2016 – Nov 2016

📍 Kanpur, India

- Worked on this Boeing company funded project for developing **computer-vision based automated guided vehicles** capable of material handling. This work was able to achieve reduced cost of sensors installed on such a system.
 - Worked on designing test bed environments using **ROS2** for simulating Robotic xArm manipulator.
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LEADERSHIP AND MENTORING

- Research Mentor – Student Inquiry and Research (SIR) Program Illinois Mathematics and Science Academy (IMSA), Oct 2024 – Apr 2025
- Mentored Laksh Patel, a high school researcher, on a cyber-physical systems project integrating OpenPLC, GridLAB-D, and Modbus TCP.
- Guided the development and presentation of "Adversarial Attack Mitigation in Formation Control of Multi-Agent Systems" at the 2025 IMSAloquium, IMSA's flagship research symposium.

- The project introduced Second-Order State Hallucination (SOSH) – a novel technique using second-order Taylor expansions to estimate the state of compromised agents in multi-agent systems (MAS). SOSH enables continued stability and formation control under adversarial conditions by disconnecting attacked nodes and substituting their dynamics with hallucinated estimates.
- Demonstrated that hallucinated dynamics preserve exponential stability, mitigating cascading errors in MAS scenarios such as search and rescue, platooning, and disaster response.

EDUCATION

Ph.D in Electrical Engineering (Specialization: Control Systems)

Vanderbilt University - CGPA (4.0/4.0)

📅 July 2021 – Dec 2024

📍 Nashville, USA

- **Optimal control of HPC devices** - a Reinforcement Learning based approach.
- **Control of Cyber-Physical-Systems** with applications to surrogate models.
- **Optimal resource allocation** for reducing transmission load using Reinforcement Learning.

M.Tech in Electrical Engineering

IIT Kanpur - CGPA (8.5/10)

📅 2014 – 2016

📍 Kanpur, India

- Specialisation in **control and automation**.
- Completed my thesis in computer vision aided Automated Guided Vehicle (AGV).

B.Tech in Electronics and Instrumentation

CET Trivandrum - CGPA (6.56/10)

📅 2009 – 2013

📍 Trivandrum, India

- Completed my graduation in Applied Electronics and Instrumentation Engineering

PUBLICATIONS

📖 Books

- **Raj, Akhilesh, Gandhi, K., Nalla, B. T., & Verma, N. K. (2019).** Object detection and recognition using small labeled datasets. In *Computational intelligence: Theories, applications and future directions* (pp. 407–419). Springer.

📄 Journal Articles

- **Raj, Akhilesh, Jagannathan, S. [Sarangapani], & Yucelen, T. (2020).** Distributed adaptive state estimation and tracking by using active-passive sensor networks. *International Journal of Adaptive Control and Signal Processing*, 34(3), 330–353.

👥 Conference Proceedings

- **Raj, Akhilesh, Das, S., Vardhan, H., Neema, H., Chhokra, A., & Balasubramanian, D. (2025).** Autonomous cybersecurity testbed for operational technology networks. In *Proceedings of the 7th workshop on design automation for cps and iot*. doi:10.1145/3722573.3727830
- **Raj, Akhilesh, Swann, P., & Gokhale, A. (2025).** An offline reinforcement learning based approach for performance aware power reduction. In *[under review at hpdc]*. ACM.
- **Raj, Akhilesh, Swann, P., & Gokhale, A. (2023a).** Controlling the energy efficiency of hpc nodes - a reinforcement learning based approach. In *Ic2e*. IEEE.
- **Raj, Akhilesh, Swann, P., & Gokhale, A. (2023b).** Performance-aware power reduction in exascale computing: Leveraging reinforcement learning for unified control of diverse application. In *Ipdps* (to be submitted). IEEE.
- **Raj, Akhilesh, Jagannathan, S., & Yucelen, T. (2020).** Distributed adaptive state estimation and tracking scheme for nonlinear systems using active passive sensor networks. In *2020 american control conference (acc)* (pp. 2587–2592). IEEE.
- **Raj, Akhilesh, Jagannathan, S., & Yucelen, T. (2019a).** Distributed state estimation by using active-passive sensor networks. In *2019 american control conference (acc)* (pp. 4689–4694). IEEE.
- **Raj, Akhilesh, Jagannathan, S., & Yucelen, T. (2019b).** Event-triggered adaptive distributed state estimation by using active-passive sensor networks. In *2019 american control conference (acc)* (pp. 4695–4700). IEEE.
- **Raj, Akhilesh, Gupta, S., & Verma, N. K. (2016).** Face detection and recognition based on skin segmentation and cnn. In *2016 11th international conference on industrial and information systems (iciis)* (pp. 54–59). IEEE.

- **Raj, Akhilesh**, Sivaraman, A., Bhowmick, C., & Verma, N. K. (2016). Object tracking with movement prediction algorithms. In *2016 11th international conference on industrial and information systems (iciis)* (pp. 285–290). IEEE.
- Verma, N. K., Kumar, G., Siddhant, A., Nama, P., **Raj, Akhilesh**, Mustafa, A., ... Salour, A. (2015). Vision based obstacle avoidance and recognition system. In *2015 IEEE Workshop on Computational Intelligence: Theories, Applications and Future Directions (WCI)* (pp. 1–7). IEEE.
- Verma, N. K., Nama, P., Kumar, G., Siddhant, A., **Raj, Akhilesh**, Dhar, N. K., & Salour, A. (2015). Vision based object follower automated guided vehicle using compressive tracking and stereo-vision. In *2015 IEEE Bombay Section Symposium (IBSS)* (pp. 1–6). IEEE.

Workshops

- Kim, Y., Park, S., Perarnau, S., & **Raj, Akhilesh**. (2025). *Charon: An end-to-end infrastructure for connecting ai@edge to hpc*. ACM.
- **Raj, Akhilesh**, & Swann, P. (2023). *Energy efficient computing*. 15th Joint Laboratory for Extreme-Scale Computing (JLESC)-2023 INRIA, University of Bordeaux, France-March 2023.

Posters

- **Raj, Akhilesh**, Canady, R. E., Das, S., Gokhale, A., & Perarnau, S. (2024). *Reinforcement learning-based performance-aware energy management in 5g base stations*. doi:10.1109/COMSNETS59351.2024.10427091
- **Raj, Akhilesh**, Perarnau, S., & Gokhale, A. (2024). *Application-architecture agnostic efficiency optimization using reinforcement learning*. Community Workshop on Practical Reproducibility in HPC.

TRAVEL GRANTS RECEIVED

- Super Computing 2024, Atlanta, GA-November 2024
- CCGRID 2024, Philadelphia, PA-May 2024
- Super Computing 2023, Denver, CO-November 2023
- Colosseum Young Gladiators-2023, Institute for the Wireless Internet-of-Things, Northeastern University, Boston, MA-June 2023.
- IC2E Reproducibility Hackathon-2023, 11th IEEE International Conference on Cloud Engineering, Boston University, Boston, MA-September 2023.

RELEVANT COURSES

- Computer Networks
- Social Network Analysis
- Adaptive Control
- Robust Control
- Model Integrated Computing
- Hybrid and Embedded Systems
- Linear Control
- Nonlinear Control
- Deep Learning
- Reinforcement Learning
- Combinatorics and Graph Theory
- Distributed Systems
- Modern Control Systems
- Optimal Control

STRENGTHS

Technical

- **Python**: Relevant projects include the Reinforcement Learning based control problem solved at ANL, Distributed Systems and Social Network Analysis course projects etc. [available on GitHub]
- **Shell Script**: Experiments related to the HPC node optimization problems (ANL research), performed on Chameleon cloud, which required multiple executions with different configurations used shell scripting. [available on GitHub]
- **MATLAB**: Formulated and implemented the adaptive control and estimation algorithms, published in American Control Conferences and Journals.
- **WebGME**: Developed a PetriNet framework for modeling processes which is also hosted on Github.

Personal

- **Team Player**: Worked with different project groups across the globe where I got significant publications and rather, experience. Notable projects include works with Drop Vault Tech. and Bayesian ways.
- **Enthusiastic**: Eager to learn new subjects through self study and hard-work.
- **Vigilant driver** with experience over 16 years of driving both in the USA and India.

ACHIEVEMENTS

- **3-MT finalist** 2023 organised by GSC at Vanderbilt University.
- Obtained a grant with **Argonne National Lab** for the year 2023 as the **student sub-contractor** (graduate).
- Cleared **GATE** Examination in 2014 with an **All India Rank 29**.
- **Convener/ Coordinator** Dhvani'12 (Annual Cultural Fest of CET)
- **Sponsorship Committee Convener**, Dhrishti'12 (Annual Tech Fest of CET)
- **Convener**, IEEE WCI-2015 (IEEE conference in computational intelligence, IIT Kanpur)
- **Member** of adventure sports club, IIT Kanpur, in clearing the Kanchenjunga base camp at an altitude of 4000m.
- **Winners** Intramural Doubles Badminton tournament, Missouri University of Science and Technology.
- **Runners-up** in Badminton doubles tournament organized by Missouri S&T CGS.

LANGUAGES

English
Malayalam
Hindi
Spanish

