AKHILESH RAJ

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RESEARCH INTERESTS

- **Reinforcement Learning**: Maximizing the performance parameters under a constrained power supply in High Performance Computing (HPC) devices. Beginning as a summer internship during the Summer 2022, it became a part of my research area and thereby thesis. 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. Research collaboration with Argonne National Lab is oriented towards this topic.
- **Distributed Systems**: Distributed state estimation and control. Design and develop algorithms to estimate the states of a decentralized process and mimic its working. The generated model can be used to design control laws that can guide the process to run through a desired state trajectory.
- **Surrogate Model Design and Development**: Use novel physics based machine learning techniques to estimate underlying dynamics in a given data-set. It can replicate the behaviour of a model with the limited data provided and can even model the underlying uncertainties. At Vanderbilt University my research focus is on this area dealing with the design and development of the training algorithms in a composition of surrogates.

EDUCATION

Ph.D in Electrical Engineering (Specialization: Control Systems)
Vanderbilt University - CGPA (4.0/4.0)

📅 July 2021 – Present   📍 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).
- Designed and developed the 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

EXPERIENCE

W.J Cody Associate - Summer Internship
Argonne National Lab

📅 May 2022 – Aug 2022   📍 Chicago, USA

- Worked on optimizing the performance and power of High Performance Computing (HPC).
- The work focused on controlling the supplied power to the HPCs without any compromise on its performance.
- A Reinforcement Learning based method was proposed over the existing Control Theory approach which yielded results better or equal to the benchmark.
- The RAPL actuator/sensors developed by intel deployed on a skylake processor was used to test the algorithm by hosting on a **Chameleon Cloud**.
- The results and the code were tabulated and were made available for publications.

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. c
- Parallelizing the python simulations for multi-core processors was an important accomplishment.

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.

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.

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.

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.

PUBLICATIONS

📕 Books

- Raj, A., 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, A., 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, A., Swann, P., & Gokhale, A. (2023). Controlling the energy efficiency of hpc nodes - a reinforcement learning based approach. In *Iccps* (Under Review). ACM.

- Raj, A., 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, A., 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, A., 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, A., 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, A., 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, A., 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, A., 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.

CONFERENCES ATTENDED

- Smart and Connected Communities, NSF PI meet 2022, Arlington, VA, USA (volunteer).
- Cyber-Physical-Systems, NSF PI meet 2022, Arlington, VA, USA (volunteer).
- American Control Conference (ACC 2019), Philadelphia, PA, USA.
- IEEE Workshop On Computational Intelligence (WCI 2015), IIT Kanpur, UP, India.
- American Control Conference (ACC 2020), Denver, CO, USA.

RELEVANT COURSES

Adaptive Control | Digital Control | Discrete Neural 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**: Devised learning based algorithms (Deep Learning and Reinforcement Learning) and distributed algorithms (Distributed Systems course project) using Pytorch and ZeroMQ packages respectively.
- **Shell Script**: Experiments related to the HPC node optimization problems performed on Chameleon cloud, which required multiple executions with different configurations, were automated using shell scripting.
- **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.
- **HTML**: Developed my own personal website hosted on Git-pages.

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.
- **Self-motivated and Determined**: My journey so far starting from a small town.
- **Vigilant driver** with experience over 13 years of driving both in the USA and India.

ACHIEVEMENTS

- Cleared **GATE** Examination in 2014 with an **All India Rank 29**.
- **Convener/ Coordinator** Dhwani'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
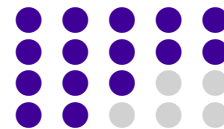
REFEREES

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