Akhilesh Raj

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Professional Summary

A motivated researcher in the field of control systems and reinforcement learning with hands on experience in problem solving - theory and application, using math and MATLAB. The knowledge seeker and the team player in me helped gain experience in electronic assembly and Python coding.

Education

2021 – Present **Ph.D, Department of Electrical Engineering** Vanderbilt University, Nashville, Tennessee, USA.
(Ongoing)

2014–2016 **M.Tech** - **Control Systems** IIT Kanpur, UP, India.
Grade:8.5/10 (Average CGPA of 4 semesters)

2009–2013 **B.Tech** - **Applied Elecrtonics and Instrumentation** College of Engineering, Trivandrum.
Grade: 6.5/10 (Average CGPA of 8 semesters)

Work Experience

March 2021 - July 2021 **Project Associate** *Indian Institute of Science, Bangalore, India.*
- Worked on the research aiming at development of an intersection management algorithm in unguarded traffic intersections.
- The non-linear optimization problem formulated by the Control and Network System lab at IISc was simulated and reformulated using an RL approach.
- Parallelising the simulation program in python on multicore processors was an important accomplishment.
- The hardware implementation of the theory was initiated on the m3pi pololu robots using raspberry pi.

Oct 2020 - Feb 2021 **Lead Project Engineer** *DROPVAULT TECH. PVT. LTD. .*
- Worked on creating a functional prototype of a secure package collection system.
- Designed the circuit for the prototype and chose the appropriate peripherals for it.
- A Raspberry Pi based prototype model was built by integrating the chosen components.
- The back-end software for the functioning of the prototype was built using Python.
- The main features include:
  - All weather hardware,
  - ID based package delivering and monitoring system,
  - App support.
- The following Python packages were used:
  - socket (conventional TCPIP)
  - socketio (event based TCPIP)
  - asyncio (asynchronous concurrent execution)
  - GPIO (Rpi Pin control)
  - cv2 (Open Computer Vision)
  - aiohttp (WebRTC)

Aug 2020 -
Oct 2020

Research Consultant *BAYESIAN WAYS LLP* .
- 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.

Jan 2017 -
Dec 2019

Research Associate *Missouri University of Science and Technology* .
- Worked on developing a distributed state estimation architecture for multi-agent systems with applications to target tracking applications.
- The project, funded by **Dynamic data driven applications of air force office of scientific research**, demanded the detection and tracking of an enemy air-craft in practical scenarios.
- Delivered the project on time with test and simulation results. The results were accounted as publications in well known journals and conferences. Briefing:
  - Estimation and control architecture to accurately determine the position as well as velocity.
  - The algorithm works even in the environment where target dynamics as well as the inputs are unknown.
  - Tested for a linear, non linear and event-triggered cases using MATLAB.
- Responsibilities,
  - Propose new control theories/ techniques.
  - Prove the proposed theorem using mathematical tools like Lyapunov analysis.
  - Validate the results through simulations using MATLAB.
  - Perform control system experiments with Quanser interfaces using MATLAB/ LabVIEW and relate the inferences with the control theory.
  - Trained and mentored the disciplines of control system.

May 2016 -
Nov 2016

Project Engineer *Idea Lab,* IIT Kanpur.
- Worked as a Project Engineer in a Boeing funded experiment in developing automated guided vehicles capable of material handling.
- Responsibilities
  - Design the hardware.
  - Ensure smooth software hardware integration.
  - Coding various control algorithms using C++.
  - Validate the results.

July 2014 -
June 2016

Teaching/ Research Assistant *IIT Kanpur*.
- Experiment on various control algorithms and utilize the idea in vision based trajectory tracking in automated guided vehicles, after simulations in MATLAB.
- Use image processing techniques to extract data and use learning techniques for imparting intelligence to the vehicle.
- Instructing the disciples of the Control Systems lab and also the Electrical Machines and drives lab.

Technical Skills

Languages	**Python, C++, HTML, VAL 32, 8051 assembly, Julia**.
Softwares/ Libraries	**MATLAB, SIMULINK, LATEX, LabVIEW, ROS, PSPICE, OpenCV, SocketIO, WebRTC, cvxpy, Gurobi, MOSEK**.
OS	**Unix, Windows, iOS**.

Publications

Journal Articles.

1. Akhilesh Raj, Jagannathan Sarangapani and Tansel Yucelen: *Distributed Adaptive State Estimation and Tracking by Using Active-Passive Sensor Networks*, International Journal for Adaptive Control and Signal Processing, *[DOP: 01/13/2020, Article DOI: 10.1002/acs.3088]*
2. Akhilesh Raj, Jagannathan Sarangapani and Tansel Yucelen: *Event-triggered Adaptive Distributed State Estimation and Control by Using Active-Passive Sensor Networks*, *[to be submitted]*.
3. Akhilesh Raj, Jagannathan Sarangapani and Tansel Yucelen: *Distributed Adaptive State Estimation and Tracking Scheme for Nonlinear Systems using Active Passive Sensor Networks*, *[to be submitted]*.

Conference Papers.

1. Akhilesh Raj, Jagannathan Sarangapani and Tansel Yucelen: *Distributed State Estimation by Using Active-Passive Sensor Networks*, American Control Conference [2019], *[Published & Presented]*
2. Akhilesh Raj, Jagannathan Sarangapani and Tansel Yucelen *Event-triggered Adaptive Distributed State Estimation by Using Active-Passive Sensor Networks*, American Control Conference [2019], *[Published & Presented]*.
3. Akhilesh Raj, Jagannathan Sarangapani and Tansel Yucelen: *Distributed Adaptive State Estimation and Tracking Scheme for Nonlinear Systems using Active Passive Sensor Networks*, *[Accepted for presentation at American Control Conference-2020 Denver, Colorado]*
4. Nishchal K. Verma , Pranay Nama, Gaurav Kumar, Aditya Siddhant, Ocean, Akhilesh Raj, Narendra Kumar Dhar and Al Salour: *Vision based Object Follower using Compressive Tracking and Stereo-vision*, IEEE Bombay Section Symposium 2015, Mumbai, September 10- 11, 2015, *[Published]*.
5. Nishchal K. Verma, Gaurav Kumar, Aditya Siddhant, Pranay Nama, Akhilesh Raj, Aquib Mustafa, Narendra Kumar Dhar and Al Salour: *Vision Based Obstacle Avoidance and Recognition System*, IEEE Workshop On Computational Intelligence: Theories, Applications and Future Directions (IEEE WCI 2015), Kanpur, December 14-17, 2015, *[Published & Presented]*
6. Akhilesh Raj, Abishalini Sivaraman, Chandreyee Bhowmick and Nishchal K.Verma: *Object Tracking With Movement Prediction Algorithms*, 2016, 11th International Conference on Industrial and Information Systems, *[Published]*.
7. Akhilesh Raj, Soumay Gupta and Nishchal K.Verma: *Face Detection and Recognition based on Skin Color and Geometric Properties of Face*, $2016, 11^{th}$ International Conference on Industrial and Information Systems. *[Published]*.

Book Chapter.

1. Akhilesh Raj, Kanishk Gandhi and Nishchal K.Verma: *Object Detection and Recognition for Small Labeled Datasets*, Computational Intelligence: Computational Intelligence: Theories, Applications and Future Directions-Volume II [2019], *[Published]*.

KEY ACADEMIC PROJECTS

Controllability of Complex Networks, *Instructor: Dr. Jagannathan Sarangapani, Professor, MST Rolla, MO*.
- Determine the possibility of controlling a complex network.
- Determine the locations of control to attain full controllability.
- Study the structural controllability of a network.
- Simulate the proposed idea using MATLAB.

H_∞ - **Optimal Actuator Location,** *Instructor: Dr. Hamidreza Modares, Assistant Professor, MSU, East Lansing, MI.*
- Determine the optimal locations of control in a system.
- Design the input matrix so that the H_∞ control effort is optimal.
- The entire experiment was simulates using MATLAB.

Optimal Control of Affine Nonlinear Continuous Time Systems with Unknonw Internal Dynamics, *Instructor: Dr. Jagannathan Sarangapani, Professor, MST Rolla, MO.*
- Control a nonlinear affine continuous time system provided the internal dynamics are unknown.
- Design a Neural Network based observer inorder to estimate the dynamics and thereby the states.
- Use the estimated states for the design of an optimal control.
- The simulations were performed using MATLAB.

Event Triggered Distributed State Estimation by Using Consensus Based Adaptive Observers, *Instructor: Dr. Jagannathan Sarangapani, Professor, MST Rolla, MO.*
- Design of an event based observer to estimate the position of a moving target.
- Use the estimated states to communicate among a network of sensors to assure consensus.
- The results were validated using MATLAB.

Distributed State Estimation of Linear/ Non-Linear Moving Target using Adaptive Observers, *Instructor: Dr. Jagannathan Sarangapani, Professor, MST Rolla, MO.*
- Design an adaptive observer for estimating the states of a moving target with unknown dynamics.
- Using the designed observer co-estimate the position of a moving target in a heterogeneous sensor network.
- Simulate the same using MATLAB to support the theoretical claims.

Cyber Physical Mobile Robot, *Instructor: Dr. Laxmidhar Behera, Professor, IIT Kanpur.*
- Android controlled vehicle capable of traversing free space.
- Ultrasonic range sensors incorporated to avoid obstacles and reach the defined destination without hindrance.
- Free flow of information packets through Bluetooth and Wi-Fi implemented as the processes were interfaced between android phone, laptop and Arduino.

Smart homes in the smart grid, *Instructor: Dr. Laxmidhar Behera, Professor, IIT Kanpur.*
- A study based on the IEEE transaction Smart Homes in the Smart Grid.
- The chances of the same in India has been analysed and feasibility studied.
- The simulations were perfomed using MATLAB and the results were analyzed.

AGV (Automated Guided Vehicle,) *Instructor: Dr. Nishchal K Verma, Assistant Professor, IIT Kanpur..*
- The milestone term paper for my M-Tech thesis.
- The literature survey regarding the possibility of this AGV within the campus was studied and analysed and was implemented as a part of the M-Tech thesis.
- The prototype is working perfectly.
- Tools used: Arduino, OpenCV, C++, MATLAB

Conferences Attended/ Expected to Attend

- **Akhilesh Raj** (2019), American Control Conference-2019, Philadelphia, PA.
- **Akhilesh Raj** 2015, IEEE WCI, IIT Kanpur, UP, India.
- **Akhilesh Raj** (2020) Expected: American Control Conference-2020, Denver, CO.

Entrepreneurship

- Worked in setting up a start up firm with mobile networking and android programming for efficient queue management systems.
- Motivated by the trends in the field of technology, I along with four of my friends started up a mobile network based efficient queue management system which we tried to implement in various dispensaries and hospitals. The propositions under the projects were:
  - A main server capable of receiving the appointment request from the patients/customers and sending an SMS based on the vacancy and priority.
  - Accounts for registered authorities (Doctors in case of a hospital OP) for updating their personal schedule and routines.
  - Registered users for continued performance.
- The SMS based queue management system was somehow unacceptable by the dispensaries at that time because of the lack of confidence in us. But the server is working fine under the name 'ROCKETQ'.

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** of the Intramural Doubles Badminton tournament, organized by Missouri University of Science and Technology and Runners up in Badminton doubles tournament organized by Missouri S&T Council of Graduate studies.

References

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