Network Control Systems using Reinforcement Learning

.....

Overview

Significant advancements in theoretical and practical research have been made in the last ten years at the intersection of computation, communication, and control. A feedback controller's function is to alter the system's behaviour to bring it up to the desired performance level. A communication network was most recently inserted into the feedback loop to create a networked control system (NCS). An NCS increases system agility while reducing system wiring and making diagnostics and maintenance more accessible than traditional control systems. These benefits have led to the implementation of the NCS in the manufacturing and power sectors, and it is still used in other industries today despite growing system complexity. Existing feedback design strategies have been severely constrained by the complexity of such man-made systems. In the face of system uncertainties and unknown environments like a communication network inside the control loop, more demanding performance standards in terms of both speed and accuracy have pushed the limits of modern control. The controller must be intelligent with adaptive and learning capabilities in the presence of unknown disturbances, un-modeled dynamics, and unstructured uncertainties in order to operate a complex system in various regimes with an imperfect communication network made up of random delays, packet losses, and quantization errors inside its feedback control loop. Reinforcement learning (RL), one of the most significant disciplines of Artificial intelligence (AI), has gained more attention recently. Finding the optimal decision or control strategies for dynamic environments is the main goal of reinforcement learning (RL), a learning strategy that draws inspiration from biology. RL is an interdisciplinary discipline that combines trial-and-error learning with optimal control, and it claims to be able to offer the best options for decision-making or control in large-scale and complex dynamic processes. This course introduces the learning controller design for NCSs in discrete time. The design of intelligent controllers for such NCSs will be dis-cussed in this course using RL-based control approaches. Several case studies will be demonstrated with MATLAB simulations with step-by step design approaches. Some open research problems will be discussed, which will pave the way for future research in the field of NCS.

Course Information	**Duration: 03rd March 2025– 13th March 2025** **Place: NIT Rourkela, Odisha, India** **Total Contact Hours: 28 hrs in 10 days**
Modules	▪ Introduction to Networked Control Systems: Overview, challenges and current research trends, Course Layout. ▪ Background on Lyapunov Stability and Stochastic Optimal Control : for Discete-time Systems ▪ Optimal Adaptive Control of Uncertain Linear Network Control Systems: for finite and infinite horizons ▪ Optimal Control of Unknown Quantized Network Control Systems (QNCSs): for linear and nonlinear systems ▪ Optimal Control of Uncertain Nonlinear Network Control Systems via Neurodynamic Programming: for finite and infinte horizons ▪ Event-Sampled Distributed Networked Control Systems ▪ Problem solving session and simulation using MATLAB
You Should Attend If…	▪ you are students (B.Tech./M.Sc./M.Tech./Ph.D.) , researchers and faculty members in all areas of engineering and applied sciences working on control and control applications. ▪ you are practicing engineers working on control and control related applications in aerospace, automobile, space-sciences, structural dynamics, manufacturing, robotics, power systems and many others. ▪ you are engineers from industries from all areas of engineering working on control and control applications including R&D laboratories. ▪ you are computational mathematicians and other scientists
Fees	▪ Participants from abroad: USD 500 ▪ Industry/ Research Organizations: Rs. 10000/-

	▪ Academic Institutions ○ Faculty: Rs. 5000/- ○ External Students: Rs. 1000/- ○ Internal PG & PhD Students: Rs. 500/- ○ Internal UG Students: Nil The above registration fee is towards instructional materials, computer use for tutorials, 24 hr free internet facility, light refreshments etc. The outstation participants will be provided accommodation and food on payment basis. **Number of participants for the course will be limited to fifty**.

The Faculty

Dr. Jagannathan Sarangapani (or S. Jagannathan) is at the Missouri University of Science and Technology (former University of Missouri-Rolla) where he is at present a Rutledge-Emerson Distinguished Professor. He served as the Site Director for the graduated NSF Industry/University Cooperative Research Center on Intelligent Maintenance Systems for over 13 years. He has a joint appointment with the Department of Computer Science and the Department of Engineering Management and Systems Engineering. Prior to joining the Missouri S&T, he was employed at the University of Texas at San Antonio and Caterpillar Inc. His research interests include adaptive and neural network control, networked control systems/cyber-physical systems, sensor networks, prognostics, and autonomous systems/robotics.

He has co-authored 163 peer-reviewed journal articles, 277 refereed IEEE conference articles, several book chapters, and six books. He holds 21 patents with several pending. He so far supervised the completion of 29 doctoral students and 30 M.S. students. He received research funding from NSF, NASA, AFRL, Sandia and industries such as Boeing, Caterpillar, Honeywell, and others. He served as the co-editor for the IET Book Series on Control from 2010-2012 and on a number of IEEE Conference Organizing Committees including Chair of IEEE CSS Tech Committee on Intelligent Control. He is a Fellow of IEEE, US National Academy of Inventors, IET (UK), and Institute of Measurement and Control, UK. He received NSF Career Award in 2000, Caterpillar Research Excellence Award in 2001, Presidential Award for Research Excellence at the University of Texas in 2001, Boeing Pride Achievement Award in 2007, several Faculty Excellence and Teaching Excellence Awards at Missouri S&T and many others.

Dr. Manas Kumar Bera is an Associate Professor in the department of Electrical Engineering, NIT Rourkela, Rourkela, India. His research interest is robust control theory, sliding mode control and its applications, learning based control, network control system, and control of multi-agent systems.

Course Coordinator

Dr. Manas Kumar Bera
Associate Professor,
Department of Electrical Engineering, NIT, Rourkela, Rourkela, Odisha-769008

Phone: +919775693776/+919476696804
E-mail: beramk@nitrkl.ac.in

.....

Course website:
https://www.nitrkl.ac.in/Research/Workshops

For more details visit link:
https://gian.iith.ac.in/