AUTONOMOUS VEHICLES – CONTROL AND LEARNING SYSTEM

Course Objectives:

The objectives of this course is to

1. Control of autonomous vehicles; path following, model predictive control (MPC), and control of path velocity.
2. Cooperating autonomous vehicles, including ground vehicles and flying vehicles, and the required communication.
3. Learning systems within autonomous vehicles: reinforcement learning, machine learning using deep neural networks, and Markov decision processes (MDP).

I. Ground Vehicle Motion Control - I

Basic motion controller, Control architecture, Path vs trajectory, Pure-pursuit control, Formulating path tracking as a stabilization problem, Linearized error dynamics, Linear controller, Stability of non-linear systems, path follower.

II. Ground Vehicle Motion Control - II

Closed Loop Rapidly-Exploring Random Tree, Sampling strategies, Heuristic, The controller, Replanning, Model Predictive Control, Model Predictive Control, Applications.

III. Collaborative control

Networked Mobile Robots, Swarm Robots, Multi-agent Formation Control Problems, Position-based formation control, Double-integrator modeled agent, Displacement-based formation control, Directed graphs, Undirected graphs, Graph rigidity , Distance-based formation control, Gradient based control.

IV. Modeling of flying and water vehicles

Aerial Vehicles, Modeling and Control of Quadrotors, Underwater Vehicles, Sensor systems, Actuating Systems, Modeling Deformable Terrain for Robots, Legged robots.

V. Learning for autonomous vehicles

Short introduction to machine learning, Learning using neural networks, Learning using Gaussian processes, Introduction to Reinforcement Learning.

Course Outcome:

1. Use different machine learning techniques to design Autonomous vehicles.
2. Understand the control system of AGVS.
3. Program the path planning for Autonomous vehicles.

Text Books

1. New Advances in AI Autonomous Driverless Self-Driving Cars: Artificial Intelligence and Machine Learning by Dr. Lance B. Eliot, LBE Press Publishing, 2017, ISBN: 9780692048351
2. Creating Autonomous Vehicle Systems By Shaoshan Liu, Liyun Li, Jie Tang, Shuang Wu, Jean-Luc Gaudiot, morgan & claypool publishers , 2018, ISBN: 9781681730073.

Reference Books

1. Rasmussen, C. E., & C. K. I. Williams: Gaussian Processes for Machine Learning. MIT Press, 2006.
2. Sutton, R. S., & A. G. Barto: Reinforcement learning: An introduction. MIT Press, 2018.
3. Hastie, T., R. Tibshirani, J. Friedman, & J. Franklin: The Elements of Statistical Learning: Data Mining, Inference and Prediction. 2nd Edition, Springer, 2005.