Model Predictive Control (MPC) based projects

Project 1: MPC based controller for electric drive of EV
Focus: Speed control while maximizing efficiency and respecting limits of voltage, current, etc through modeling and validation of dynamics with EV data, controller design for MPC for EV, and implementation in actual hardware.
Tasks: Complex control design, modeling, linearization requirements.
Relevant Courses: Electrical Engineering (6-1)
Applicable Skills (Any one or combination): Controls systems, Motor Control

Project 2: MPC for active steering in autonomous vehicle
Focus: Stabilizing a vehicle along a desired path while fulfilling the physical constraints.
Tasks: Vehicle dynamical model including the steering mechanism, MPC based Controller design, simulation results and analysis under various scenarios.
Relevant Courses: Mechanical Engineering (2), Electrical Engineering (6-1)
Applicable Skills (Any one or combination): Controls Systems, Motor Control, Mechatronics

Project 3: MPC in Battery Management System (BMS) of EV/HEV
Focus: Optimal operation of BMS through battery model and validation against practical battery data, MPC based controller design and simulation results and analysis under various operating scenarios.
Background: A BMs requires several functionalities, including monitoring vital parameters and protecting the battery. For EV/HEV, it also controls the recharge of the battery. MPC can be employed in the BMS to ensure that all the operations are done in an optimal manner based on the weightages give to different parameters of interest, which will try to feedback the maximum energy possible, while safe-guarding the battery's health in the best possible manner. Under different fault conditions it will further charge the scheme to maintain at least partial functionality.
Tasks: Complex battery model: all dynamics including temperature, model simplification and validation, creating practical scenarios.
Relevant Courses: Electrical Engineering (6-1)
Applicable Skills (Any one or combination): Controls Systems, Power Electronics, Battery Management Systems

Battery Projects

Project: KPIT High Fidelity Battery Model
Focus: Using existing KPIT High fidelity battery model to do various tasks
Background: Using a high fidelity battery model can save a lot of time and expenses when trying to understand the dynamic characteristics for prediction of SOC/SOH dynamics, conduct analysis for diagnostics, predict the range of vehicles under various operating/driving conditions, battery characteristics, etc.
Tasks: Parameterization of battery model, rigorous analysis of battery model to study behavior under various normal and abnormal operating conditions, diagnostic schemes under various fault conditions and monitoring parameter degradation, offline simulation and analysis of battery model when integrated with a validated EV/HEV model under different vehicle driving conditions.
Relevant Courses: Electrical Engineering (6-1)
Applicable Skills (Any one or combination): Controls Systems, Power Electronics, Battery Management Systems, Mathematical Modeling & Simulation

Autonomous Vehicle/ADAS Projects

Project 1: Deep Learning for L3 to L5 level functions for Autonomous Vehicles
Focus: Deep Learning platform development to process video input for Free Space Calculation including steering angle prediction, accelerator pedal and brake pedal control, training open source machine learning libraries like Torch 7, Theano, Paddle, etc. to process video feed to compute free space on the road.
Tasks: Feasibility analysis, design simulation, prototype development.
Relevant Courses: Electrical Engineering (6-1), Computer Science (6-3)
Applicable Skills (Any one or combination): Image Processing, Neural Networks, Machine Learning, Mathematical Modeling & Simulation

Project 2: Sensor Fusion platform for autonomous vehicles based on Convolutional Neural Networks
Focus: Sensor Fusion platform for autonomous vehicles based on Convolutional Neural Networks (CNN) through data processing of typical sensors like ultrasound, Radar, LiDar, and Camera. Also involves use of CNN for data fusion from these sensors to re-create 360 degree view of surroundings around the vehicle.
Tasks: Feasibility analysis, design simulation, prototype development.
Relevant Courses: Electrical Engineering (6-1), Computer Science (6-3)
Applicable Skills (Any one or combination): Image Processing, Neural Networks, Machine Learning, Mathematical Modeling & Simulation, Signal Processing, Sensor Technology

Cybersecurity Projects

Project 1: CyberSecurity for Automotive Applications: Embedded Anomaly detection on In-Vehicle networks
Focus: Developing algorithms capable of running in real-time and using minimal computing power and memory resources.
Tasks: Feasibility analysis, design by simulation, prototype development
Relevant Courses: Computer Science (6-3)
Applicable Skills (Any one or combination): Pattern Recognition, Algorithm Development, Machine Learning, Mathematical Modeling & Simulation

Project 2: CyberSecurity for Automotive Applications: Embedded Firewall on In-Vehicle network traffic
Focus: Developing algorithms capable of running in real-time and using minimal computing power and memory resources.
Tasks: Feasibility analysis, design by simulation, prototype development
Relevant Courses: Computer Science (6-3)
Applicable Skills (Any one or combination): Pattern Recognition, Algorithm Development, Machine Learning, Mathematical Modeling & Simulation

Project 3: CyberSecurity for Automotive Applications: Embedded Public-Private key management software
Focus: Developing algorithms capable of running in real-time and using minimal computing power and memory resources.
Tasks: Feasibility analysis, design by simulation, prototype development
Relevant Courses: Computer Science (6-3)
Applicable Skills (Any one or combination): Pattern Recognition, Algorithm Development, Machine Learning, Mathematical Modeling & Simulation

Urban Transportation Planning Projects

Project 1: Traffic flow modeling with simulation for traffic flow optimization
Focus: The purpose of this project is to model people movement within urban environment using cell-phone data.
Tasks: Applying infrastructure attributes like road types, no. of signals, rush hours, etc. on the model as well as applying dynamic traffic rules, modify signal timings to optimize traffic flow with minimum time required for travel between various nodes of the model.
Relevant Courses: Computer Science (6-3), Mathematics (18)
Applicable Skills (Any one or combination): Data Analytics, Pattern Recognition, Algorithm Development, Machine Learning, Mathematical Modeling & Simulation

Project 2: Urban transport scheduling for EV buses
Focus: Preparing optimized schedules for EV public transport bus routes based on battery capacity, no. stops, charging stations availability, etc.
Tasks: Feasibility analysis, design by simulation.
Relevant Courses: Computer Science (6-3), Mathematics (18)
Applicable Skills (Any one or combination): Data Analytics, Pattern Recognition, Algorithm Development, Machine Learning, Mathematical Modeling & Simulation

Advanced Computing Projects

Project: Automated Code Migration/Re-Architecture to AUTOSAR
Focus: Automated analysis of code involving static code analysis and identifying rules/patterns, rule based automated code migration/conversion/re-architecture and validating the output model/code after migration.
Tasks: Complex static analysis (pointers, arrays, function pointers, etc.), validation of the migrated code/ model.
Relevant Courses: Computer Science (6-3)
Applicable Skills (Any one or combination): Algorithm Development, Expertise in software development in languages like C, C++, Python, etc.

Miscellaneous Projects

Project 1: Underground water table mapping
Focus: Detection of water levels in bore wells by using sound and radar signals. The purpose of this project is to accurately estimate the underground water level and conduct water table mapping through a smart phone based app for end users.
Tasks: Feasibility analysis, design by stimulation, prototype development.
Relevant Courses: Electrical Engineering (6-1)
Applicable Skills (Any one or combination): Image Processing, Mathematical Modeling & Simulation, Signal Processing, Sensor Technology

Project 2: Using knowledge graph for enhancing Machine Learning algorithms

Focus: To create a knowledge graph generated out of system design data to eliminate the need for system experts to validate data models for future predictions.

Tasks: Generate a machine learning algorithm to make use of the knowledge graph to validate the data model per the illustration below:

Relevant Courses: Computer Science (6-3), Mathematics (18)

Applicable Skills (Any one or combination): Pattern Recognition, Algorithm Development, Machine Learning, Mathematical/Graph based Modeling & Simulation, Database knowledge