SAKET ADHAU

Machine Learning and Optimization
✉ Department of Chemical Engineering (IKP),
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RESEARCH INTERESTS

1. Machine learning for MPC
2. Nonlinear model predictive control
3. Embedded systems
4. Optimization

EDUCATION

Machine Learning Research Assistant ***Sep'19–Ongoing***

- Norwegian University of Science and Technology (NTNU), Norway
  - Part of the project "*Intelligent use of data to build optimization tools for cyber-physical systems in the process industry*" funded by the Research Council of Norway.
  - By leveraging big data and machine-learning algorithms, task is to utilize process data to develop machine-learning based models (also known as digital-twins), that can be used for developing optimization tools. This will enable to address the challenges with respect to developing models for optimization.

Master of Technology, Instrumentation and Control ***Aug'17–June'19***

- College of Engineering Pune, India
  - Thesis Title: *Learning Based Model Predictive Control*
  - Supervisor: Prof. Dayaram Sonawane
  - CGPA: 8.16

Bachelor of Engineering, Instrumentation and Control ***Aug'13–June'17***

- University of Pune, India
  - Project Title: *System Identification and PID Control of PMDC Motor using* MATLAB *and LabVIEW*
  - Supervisor: Dr. Milind Bongulwar
  - Mention: First Class with Distinction | Percentage: 69.67

WORK EXPERIENCE

Trainee Engineer ***June'19–August'19***

- Aker Solution, Pune, India.
  - Post Graduate Trainee Engineer in the Application Engineering department.
  - Developed automated method for testing of the subsea module used in offshore oil fields.

PUBLICATIONS

Articles in international conferences
2021

- **Adhau S.**, Naik Vihang, and Skogestad S., "Constrained Neural Networks for Approximate Nonlinear Model Predictive Control", *submitted to* 60^{th} *IEEE conference on Decision and Control (CDC).*
- Mohanty N. R., **Adhau S.**, Ingole D., and Sonawane D., "Hardware Implementation of Low-complexity Deep Learning-based Model Predictive Controller", *accepted for presentation and publication in the proceedings of the* 2021 *European Control Conference (ECC).*

2019

- **Adhau S.**, Patil S., Ingole D., Sonawane D., "Embedded Implementation of Deep Learning-Based Linear Model Predictive Control", *in Proceedings of* 6^{th} *Indian Control Conference*, IEEE, Hyderabad, India, 2019.
- **Adhau S.**, Patil S., Ingole D., and Sonawane D., "Implementation and Analysis of Nonlinear Model Predictive Controller on Embedded Systems for Real-Time Applications", *in Proceedings of the* 17^{th} *European Control Conference (ECC'*19*)*, IFAC and IEEE, Naples, Italy, 2019.

2018

- **Adhau S.**, Phalke K., Nalawade A., Ingole D., Patil S., Sonawane D., "Implementation and Analysis of Offset-Free Explicit Model Predictive Controller on FPGA", *in Proceedings of* 5^{th} *Indian Control Conference*, IEEE, Delhi, India, 2018.

THEORETICAL BACKGROUND

- **Machine Learning:** physics-informed ML, deep learning, classification and regression trees, clustering
- **Systems Modeling:** differential equations, linear, nonlinear, hybrid systems, data-driven
- **Control Design:** model predictive control (MPC), learning-based control
- **Optimisation:** linear (LP), quadratic (QP), nonlinear programming (NLP)

INTERNSHIP EXPERIENCE

Bosch Chassis Systems India Pvt. Limited, Chakan, Pune. ***June'15 - July'15***

- Worked with the TeF department towards maintenance and predictive safety standards.
- Carried out analysis of Mean Time To Repair (MTTR) and Mean Time Between Repair (MTBR) on the assembly lines (NOAH, Line 51, TMC line).

POSITIONS OF RESPONSIBILITY

- **Co–supervisor for master's theses student at the Department of Chemical Engineering, NTNU.** ***Autumn 2020***
- **Coordinator for 3^{rd} Winter School.** ***Dec'18***
  - Served as convener and co–ordinator of 3^{rd} **Winter School on Optimization and Optimal Control – A Data–based Approach** at Embedded Systems Lab, COEP.
- **Teaching Assistant.** ***July'18–Dec'18***
  - Served as TA for **Microcontroller Techniques and Its Applications** fand **Embedded System Design** which was a special course.

AWARDS AND FUNDING

- Project accepted for oral presentation in **MATLAB Expo'19.** ***May'19***
- Student support program for Indian Control Conference – IIT Delhi. ***Jan'19***
- Xilinx University Program for researchers – Pynq development board and software. ***Sep'18***

TECHNICAL SKILLS

- **Programming languages:** Python, MATLAB, C, LaTeX.
- **Data Science Tools:** PyTorch, TensorFlow, NumPy, Pandas, SciPy, Matplotlib, Scikit-learn, Matlab Statistics and Machine Learning Toolbox
- **Control Tools:** Matlab toolboxes (Simulink, Stateflow, System Identification, MPT3, MPC, Control Systems), CasADi.
- **Development:** Atmel Studio, Vivado, MPLAB X, HDL coder, LabView, Arduino IDE, Linux.
- **Toolboxes:** Protoip, MPT toolbox, ACADO Toolkit, CasADi, FORCES, GRAMPC.
- **Version Control and Code Management:** GitHub, GitLab, Google Colab, Jupyter notebooks.

PROJECTS

- **Deep Neural Networks based Linear MPC**
  - Trained highly nonlinear and linear models using neural networks, to mimic the original model.
  - Neural networks were trained to behave as Linear model predictive controller to reduce the online optimization and guarantee safety.
  - The designed neural network was also implemented on ARM Cortex-M3 to prove the usability in embedded devices.
- **Implementation of nonlinear MPC on ARM Cortex-M3 and FPGA**
  - Successfully implemented nonlinear MPC on for the first time ARM Cortex-M3 and FPGA using GRAMPC and ACADO toolkit

  - The performance of NMPC controller was rigorously tested using HIL simulations in MATLAB
  - Designed framework for easy implementation of NMPC on micro-controllers and FPGA.

- **Linear and explicit MPC on ARM Cortex-M3 and FPGA**
  - Implemented Interior Point Method, Active Set Method and KWIK Algorithm for linear MPC on Arm Cortex-M3
  - Validated the designed MPC on DC motor using HIL simulation for real-time using Simulink coder.
  - Implemented Explicit MPC using MPT toolbox, Hybrid toolbox and MATLAB based toolbox on micro-controllers and validated the same on actual plant
  - The same framework was also validated and detailed analysis were carried out on FPGA Zedboard.

- **Auto-tuning of PID controller using optimization method**
  - Evaluated optimization algorithm SQP for auto-tuning of PID controller
  - Verified values of K_p, K_i and K_d parameters using run-time optimization in MATLAB/Simulink.

- **Parameter Estimation and Position control of PMDC motor**
  - Validated PMDC motor model using parameter estimation
  - Implemented SQP algorithm in MATLAB for parameter estimation
  - Implemented and tested PID controller for position and speed control on ARM Cortex-M3 micro-controller

- **System Identification and PID Control**
  - System identification for an unknown DC motor was done using System Identification toolbox of MATLAB
  - Verified the system by passing through various linear and non-linear signals for accurate system model
  - PID tuning using Zeigler Nicholas and Cohen-Coon methods for speed control of the DC motor using identified state-space model
  - Implemented PID controller on 8-bit micro-controller using plain C code, MATLAB based embedded coder and in LabVIEW using toolbox for VISA protocol.

CERTIFICATES

- Hands-on CasADi course on Optimal Control, Hasselt, Belgium [Link] ***Nov'19***
- Winter School on Optimization and Optimal Control - A Data-based Approach. ***Dec'18***

PERSONAL DETAILS

- Citizenship: Indian
- Current Residence: Trondheim, Norway
- Languages: English - Fluent, Norwegian - Level 1
- Date of Birth: 29 May 1995