Satadru Dey, Ph.D.
Postdoctoral Researcher
Energy, Controls, and Applications Lab
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RESEARCH AND TEACHING INTEREST

- **Research Interest:** *Theory:* Control, Estimation and Fault Diagnosis of Dynamic Systems
  Applications: Energy Systems, Transportation Systems

  Current Focus:
  - Estimation, Control and Fault Diagnosis of Batteries and Ultracapacitors
  - Fault Diagnosis of Connected Vehicles
  - Fault Diagnosis of PDE Systems
- **Teaching Interest:** Linear Systems, Nonlinear Control, Fault Diagnosis of Dynamic Systems

SKILLS

Technical Skills	Modeling, Control Design, Estimation and Diagnostics Algorithms
Tools	MATLAB/Simulink, dSPACE, Microsoft Office

CURRENT POSITION

Postdoctoral Researcher in Civil and Environmental Engineering
University of California, Berkeley, U.S.A. Present
Topics: Advanced Battery Management Algorithms, Connected Vehicles, Fault Diagnosis of PDEs
Advisor: Prof. Scott Moura

EDUCATION

Doctor of Philosophy in Automotive Engineering, GPA: 3.9/4.0
Clemson University, U.S.A. August 2015
Dissertation: "Estimation and Diagnostics of Lithium-ion Batteries"
Advisor: Prof. Beshah Ayalew
Committee: Prof. Beshah Ayalew, Prof. Zoran Filipi, Prof. Pierluigi Pisu, Prof. Ardalan Vahidi
Relevant Coursework: Automotive Control Systems, Vehicle Diagnostics, Alternative Energy Sources, Advanced Process Control, Nonlinear Control, Hybrid Powertrain Control

Master of Technology in Control System Engineering, GPA: 9.1/10
Indian Institute of Technology Kharagpur, India May 2010
Thesis: "Fault-tolerant Controller Design for an Independent Four-wheel Drive Electric Vehicle"
Advisors: Prof. Sidhhartha Mukhopadhyay, Prof. Chandan Chakraborty
Relevant Coursework: Linear Control Theory, Optimal Control, Digital Signal Processing

Bachelor of Technology in Electronics & Instrumentation Engineering, First Division (87%)
University of Kalyani, West Bengal, India June 2008

PUBLICATIONS

Peer-reviewed Journal Publications (published and under review)

[J1] **S. Dey**, B. Ayalew, and P. Pisu, "Nonlinear Robust Observers for State-of-Charge Estimation of Lithium-Ion Cells Based on a Reduced Electrochemical Model," *IEEE Transactions on Control Systems Technology*, vol.23, no.5, pp.1935-1942, 2015.

[J2] **S. Dey**, P. Pisu, and B. Ayalew, "A Comparative Study of Three Fault Diagnosis Schemes for Wind Turbines," *IEEE Transactions on Control Systems Technology*, vol.23, no.5, pp.1853-1868, 2015.

[J3] **S. Dey**, B. Ayalew, and P. Pisu, "Nonlinear Adaptive Observer for a Lithium-ion Battery Cell based on Coupled Electrochemical-Thermal Model," *ASME Journal of Dynamic Systems, Measurement and Control*, vol. 137, no. 11, pp. 111005, 2015.

[J4] **S. Dey**, S. Mohon, P. Pisu, B. Ayalew, "Sensor Fault Detection, Isolation and Estimation in Li-ion Batteries," accepted in *IEEE Transactions on Control Systems Technology***,** available online, DOI 10.1109/TCST.2016.2538200, 2016.

[J5] **S. Dey,** Z. Abdollahi, S. Tatipamula, N. Das, S. Mohon, P. Pisu, and B. Ayalew, "Model-based Real-time Thermal Fault Diagnosis of Lithium-ion Batteries," *Control Engineering Practice*, vol. 56, pp. 37-48, 2016.

[J6] **S. Dey**, B. Ayalew, "Real-time Estimation of Lithium-ion Concentration in Both Electrodes of a Lithium-ion Battery Cell," accepted in *ASME Journal of Dynamic Systems, Measurement and Control*, 2016.

[J7] H. E. Perez, X. Hu, **S. Dey**, S. J. Moura, "Optimal Charging of Li-Ion Batteries with Coupled Electro-Thermal-Aging Dynamics," under revision in *IEEE Transactions on Vehicular Technology*.

[J8] **S. Dey**, S. Mohon, H. Arunachalam, S. Onori, "Real-time Algorithm for Combined State and Parameter Estimation of a Battery-Double Layer Capacitor Hybrid Energy Storage System," under review.

[J9] H. E. Perez, **S. Dey**, X. Hu, and S. J. Moura, "Optimal Charging of Li-Ion Batteries via a Single Particle Model with Electrolyte and Thermal Dynamics".

[J10] H. E. Perez, **S. Dey**, and S. J. Moura, "Sensitivity-Based Interval PDE Observers for Lithium-Ion Battery SOC Estimation".

Peer-reviewed Conference Proceedings (published)

[C1] **S. Dey**, and B. Ayalew, "Nonlinear Observer Designs for State-of-Charge Estimation of Lithium-ion Batteries," in Proceedings of the *American Control Conference 2014*, Portland, OR, June 2014.

[C2] **S. Dey**, B. Ayalew, and P. Pisu, "Combined Estimation of State-of-Charge and State-of-Health of Li-ion Battery Cells Using Sliding Mode Observers on Electrochemical Model," in Proceedings of the *13th International Workshop on Variable Structure Systems*, Nantes, France, June 2014.

[C3] S. Mohon, **S. Dey**, P. Pisu and B. Ayalew, "A Hardware-In-the-Loop Platform for a Series Hybrid Powertrain Featuring Two Equivalent Consumption Minimization Strategies," in Proceedings of the *16th International Conference on Advanced Vehicle Technologies*, ASME /IDETC 2014, Buffalo, NY, August 2014.

[C4] **S. Dey**, B. Ayalew, and P. Pisu, "Adaptive Observer Design for a Li-ion Cell based on Coupled Electrochemical-Thermal Model," in Proceedings of the *ASME 2014 Dynamic System and Control Conference***,** San Antonio, TX, October 2014.

[C5] A. Yebi, **S. Dey** and B. Ayalew, "Observer Design for State Estimation for UV Curing Processes," in Proceedings of the *ASME 2014 Dynamic System and Control Conference***,** San Antonio, TX, Oct. 2014.

[C6] **S. Dey**, Z. Abdollahi, S. Tatipamula, N. Das, S. Mohon, P. Pisu, and B. Ayalew, "Online Thermal Diagnostics of Lithium-ion Batteries," in Proceedings of *IFAC Workshop on Engine and Powertrain Control, Simulation and Modeling***,** Columbus, OH, August 2015.

[C7] S. Mohon, **S. Dey**, P. Pisu, B. Ayalew, "A Quantized Stochastic Modeling Approach for Fault Diagnosis of Lithium-ion Batteries," in Proceedings of the *IFAC Symposium on Fault Detection, Supervision and Safety for Technical Processes*, Paris, France. September 2015.

[C8] **S. Dey**, B. Ayalew, and P. Pisu, "Estimation of Lithium-ion Concentrations in Both Electrodes of a Lithium-ion Battery Cell," in Proceedings of *ASME 2015 Dynamic System and Control Conference***,** Columbus, OH, October 2015.

[C9] **S. Dey**, and B. Ayalew, "A Diagnostic Scheme for Detection, Isolation and Estimation of Electrochemical Faults in Lithium-ion Cells," in Proceedings of *ASME 2015 Dynamic System and Control Conference***,** Columbus, OH, October 2015.

[C10] **S. Dey**, S. Mohon, P. Pisu, B. Ayalew, S. Onori, "Online State and Parameter Estimation of a Battery-Dual Layer Capacitor Hybrid Energy Storage System," in Proceedings of *IEEE 2015 Conference on Decision and Control*, Japan, December 2015.

[C11] **S. Dey**, Y. Wang, B. Ayalew, "A Distributed Computation Scheme for Real-time Control and Estimation of PDEs," in Proceedings of the *American Control Conference 2016,* Boston, MA, July 2016.

[C12] **S. Dey**, S. Mohon, S. Onori, "Model-based Sensor Fault Diagnostics of Double-Layer Capacitors," in Proceedings of the *American Control Conference 2016,* Boston, MA, July 2016.

[C13] Z. Abdollahi, **S. Dey**, P. Pisu, "Sensor Fault Diagnosis of Connected Vehicles Under Imperfect Communication Network," accepted in *ASME 2016 Dynamic System and Control Conference***,** Minneapolis, MN, October 2016.

AWARDS/ACHIEVEMENTS

- Best Presentation in 'Energy Storage and Hybrid Electric Vehicle Controls' session, American Control Conference 2016
- Outstanding Automotive Engineering Ph.D. Student Award, Department of Automotive Engineering, Clemson University, 2015
- Graduate Automotive Technology Education Fellowship from U.S. Department of Energy, 2012
- Recipient, National Merit Scholarship, Government of India, 2004

ACADEMIC RESEARCH EXPERIENCE

Postdoctoral Researcher, **University of California, Berkeley, U.S.A.** September 2015 – Present

Modeling and Control of Batteries

- Developing reduced order PDE electrochemical models for real-time implementation utilizing the tools of parametric and observability analysis, and projection-based discretization approaches
- Developing optimal control algorithms for enhancing the performance of batteries with respect to charge time, usable power and energy and life-time

Aging Prognostics of Batteries based on Data-driven Learning Techniques

- Developing data-driven learning algorithms for battery aging prognostics

Thermal Diagnostics of Battery Pack

- Developing diagnostics algorithms for thermal failures in battery pack

Fault Diagnosis of PDE Systems

- Developing diagnostics algorithms for systems modelled by partial differential equations (PDEs)

Fault Diagnosis of Connected Vehicles

- Developing fault diagnosis schemes for connected vehicles to diagnose physical and cyber failures under unreliable network

Graduate Research Assistant, **Clemson University, U.S.A.** August 2012 – August 2015

Real-time Estimation and Diagnostics of Li-ion Batteries

(1) Electrochemical Model-based State-of-Charge (SOC) Estimation

- Designed an SOC estimation algorithm based on reduced order uncertain electrochemical model and nonlinear observer
- The SOC estimation is done by estimating the Li-ion concentration inside the cell electrodes
- The observer is a combination of Luenberger observer for nominal estimation error convergence and sliding mode observer for uncertainty handling

(2) Electrochemical Model-based Combined Estimation of State-of-Charge (SOC) and State-of-Health (SOH)

- Designed a combined SOC-SOH estimation algorithm based on reduced order electrochemical-thermal model and nonlinear observers
- SOC estimation is done by estimating Li-ion concentration inside the electrodes and SOH estimation is done by estimating electrochemical parameters that carry battery health information
- The design uses nonlinear adaptive observer framework

(3) Equivalent Circuit Model-based Detection and Estimation of Sensor Faults

- Designed a diagnostic algorithm to detect, isolate and estimate the sensor faults in the battery
- The design is based on a set of filters that extract the fault information from the sliding mode observers

The afore-mentioned algorithms are validated by extensive simulation and experimental studies.

(4) Detection, Isolation and Estimation of Electrochemical Faults

- Designed and validated via simulation studies a sliding-mode observer-based diagnostic algorithm to detect, isolate and estimate the battery electrochemical faults

(5) Thermal Fault Diagnosis

- Developed a nonlinear observer-based fault diagnosis strategy to diagnose several thermal faults
- Experimental validation is ongoing

Real-time Estimation and Diagnostics of Ultracapacitors

(1) Combined State and Parameter Estimation of Ultracapacitor

- Designed estimation algorithms for real-time combined estimation of states and parameters of ultracapacitor
- Validated the algorithms by extensive simulation studies and experimental validation is ongoing

(2) Model-based Sensor Fault Diagnostics of Ultracapacitor

- Designed observer-based sensor fault detection and isolation algorithm
- Developed adaptive threshold-based scheme to incorporate passive robustness in the algorithm

Fault Diagnosis of Wind Turbine Drivetrain System

- Developed two diagnosis schemes (Kalman filter based and dedicated observer based) for horizontal axis wind turbine drivetrain faults

Energy Management Strategy for Series Hybrid Vehicle

- Developed a natural gas powered series hybrid vehicle simulator and implemented an energy management strategy on MATLAB/Simulink platform

Graduate Research Assistant, **IIT Kharagpur**, **India** May 2009- May 2010

Fault-tolerant Control System Design for Four-wheel Drive Electric Vehicle

- Designed a sliding-mode theory based control algorithm for vehicle lateral & longitudinal motion
- Developed an observer based fault-tolerant control strategy for robust performance

INDUSTRIAL RESEARCH EXPERIENCE

Control Engineer, **General Electric, India** June 2010- July 2012

Control Implementation for Emission Control in Gas Turbine

- Implemented control algorithm in dedicated gas turbine control system application software

Reduced Order Modeling and Control of GE Tier 4 Diesel Engine

- Applied model order reduction techniques to simplify hi-fidelity first principles model to support implementation in Hardware-in-The-Loop simulator
- Designed an emission control algorithm for diesel engine

Technical Reports

[1] "Control Solutions for Non-minimum Phase Behavior in Diesel Engine", *GE Internal Report*, 2011.
[2] "Reduced Order Modeling of Diesel Engine for Implementation in HILS", *GE Internal Report*, 2011.

TEACHING AND MENTORING EXPERIENCE

Guest Lecture in Energy Systems and Control Course, UC Berkeley, 2016

- Guest lecture on dynamic programming

Teaching Assistant/Grader in Hybrid Powertrain Control Lab Course, CU, 2012

- Along with other two teaching assistants, built various laboratory setups used for following experiments: Battery modeling, Electrochemical Impedance Spectroscopy of batteries, Fuel cell polarization curve characterization, throttle motor drive control using Pulse Width Modulation.

Teaching Assistant in Control System Design Course, IIT Kharagpur, 2010

- Developed and graded control design related assignments

Mentoring Experience, CU, 2012-2015

- Mentored groups of graduate students in developing battery balancing circuits and thermal models

Mentoring Experience, UC Berkeley, 2015

- Mentoring two Ph.D. students in theoretical/experimental studies on battery control algorithms
- Mentored an undergraduate student in experimental studies on battery pack failures

HANDS-ON EXPERIENCE

- Data acquisition from Li-ion cells and electrochemical-thermal model identification, CU, 2014
- Design and implementation of a step-down (buck) DC-DC converter, CU, 2013
- Implementation of an HIL setup for series hybrid electric vehicle, CU, 2013
- Design and implementation of active and passive circuits for Li-ion cell balancing, CU, 2012
- Turbine Teardown Training in GE Energy Learning Centre, Schenectady, NY 2012

OTHER SERVICES

Reviewer

IEEE Transactions on Control System Technology; IEEE Transactions on Power Systems; ASME Journal of Dynamic Systems, Measurement and Control; International Journal of Powertrain; American Control Conference; ASME Dynamic Systems and Control Conference; IEEE Conference on Decision and Control

Invited Session Organizer

Battery and Oil & Gas Systems, ASME 2016 Dynamic Systems and Controls Conference

PROFESSIONAL DEVELOPMENT/TRAININGS

- Six Sigma Green-Belt Certification (GE), DMAIC, 2012
- Edison Engineering Development Program (EEDP)-GE, 2010-2012

PROFESSIONAL MEMBERSHIPS

- IEEE, Professional Member
  - Societies: IEEE Control Systems Society, IEEE Vehicular Technology Society
- ASME, Professional Member
- IEEE Technical Committee on Automotive Controls
- ASME Energy Systems Technical Committee