Curriculum Vitae

Dr. Somnath Buriuly

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Profile

- I bring expertise in modeling and solving both continuous and discrete optimization problems, complemented by a solid foundation in systems and control, which allows me to design hybrid solutions tailored to practical applications. I am a fast learner, quick at grasping mathematical fundamentals, and very quick at prototyping software and hardware solutions. I am deeply passionate about research and development and highly committed to the tasks I take on, consistently striving to meet responsibilities despite the challenges.
- My research interests are: *Optimization - Offline Trajectory Estimation, Trajectory Optimization, Dynamic Programming, Column Generation, Branch-and-cut, Benders' decomposition, Deep Reinforcement Learning; and Control - Extended Kalman Filter, Constrained Optimal Control.*
- Systems/setups of interest: *Strapdown Inertial Navigation System (considering Earth's manifold and rotation), Multi-agent time-dependent network, Quadruped, Robotic Arm, Inverted-cart pendulum, Fixed-wing and rotary-wing drones, Unicycle (differential-drive).*

Publications

- **S. Buriuly**, L. Vachhani, Self-calibrating Offline Trajectory Estimation Technique for Sporadically Observable Systems, Accepted in *Indian Control Conference*, 2024.
- **S. Buriuly**, L. Vachhani, A. Sinha, S. Ravitharan, S. Chauhan, Route planning for capacity restricted agents over railway network, without disrupting train schedules, In *IFAC-PapersOnLine*, Volume 55, Issue 1, 2022, pp. 38-45, https://doi.org/10.1016/j.ifacol.2022.04.007.
- **S. Buriuly**, L. Vachhani, A. Sinha, S. Chauhan, S. Ravitharan, Optimal routing and scheduling in a time-dependent and directed multi-graph: a multi-agent temporal rural postman problem, In *arXiv preprint arXiv:2101.04950*, 2021, https://doi.org/10.48550/arXiv.2101.04950.
- S.C. Nagavarapu, L. Vachhani, A. Sinha, **S. Buriuly**, Generalizing Multi-agent Graph Exploration Techniques, In *International Journal of Control, Automation and Systems*, 2020, pp. 1-14, https://doi.org/10.1007/s12555-019-0067-8.

Manuscripts in progress

- **S. Buriuly**, L. Vachhani, A. Sinha, S. Ravitharan, S. Chauhan, Moving Horizon Capacitated Arc Routing Problem, Under second review in *Journal of Combinatorial Optimization*, 2023.
- **S. Buriuly**, L. Vachhani, A. Sinha, S. Ravitharan, S. Chauhan, A novel branch-and-cut algorithm for Rural Postman Problem with Temporal Unavailabilities: Routing and scheduling in railway network., Submitted to *To be submitted soon*, 2024.
- **S. Buriuly**, V. Yogi, An LQR guidance law with range feedback for state and control constrained problems., *To be submitted*, 2024.
- **S. Buriuly**, L. Vachhani, A patent is in progress from the pipeline estimation post-doctoral work, *Prior-art review with the IP Team, Indian Institute of Technology Bombay*, 2024.
- **S. Buriuly**, et. al., EKTOpt - A robust framework for self-calibrating offline trajectory estimation, *Work in progress*.
- I. Jaiswal, **S. Buriuly**, A. Sinha, Effect of frequency shaping cost on trajectory planner for mitigation of motion sickness, *Work in progress*.

Education

2016–present *PhD in Systems and Control (IITB) & Mechanical and Aerospace (Monash)*
IITB-Monash Research Academy Mumbai, India

» CGPA: 9.22/10 (Percentage: 92.2)
» **Supervisors:** Prof. Leena Vachhani (IITB), Prof. Arpita Sinha (IITB), Prof. Sunita Chauhan (Monash), Prof. of practice (Monash, IRT) Sivapragasam Ravitharan.
» **Thesis Title:** Multi-agent routing and scheduling for railway track inspection.

2014–2016 *M.tech in Electrical Engineering (Control systems)*
IIT Kharagpur Kharagpur, India
» CGPA: 8.24/10 (Percentage: 82.4)
» **Thesis Title:** A simple interval type-2 fuzzy PI and PD controller.

2009–2013 *B.tech in Electrical Engineering*
NIT Durgapur Durgapur, India
» CGPA: 7.88/10 (Percentage: 73.8)
» **Project Title:** Designing PID controller for pressure control system.

Work

Nov 2022-present *Postdoctoral Fellow and Research Associateship*
CoEOGE, IIT Bombay Mumbai, India
» **Principal Investigator:** Prof. Leena Vachhani, *leena.vachhani.sc@gmail.com*
» **Industry Collaboration:** Indian Oil Corporation Ltd (`https://iocl.com`)
» **Collaborators:** Mr. Shubham Sharma (Asst. Research Manager, IOCL), Mr Siddhesh Girase (Project Research Engineer, IITB), Mr. Jaivardhan Shukla (Intern)
» **Objective:** Estimating trajectory of pipeline inspection gauge from large-scale IMU readings, odometer readings, and sporadic GPS readings (available once per kilometer of pipeline).

Jul 2017-Jun 2021 *Teaching Assistant (during PhD)*
IIT Bombay Mumbai, India
» Intelligent Feedback and Control (Spring 2020, online), Advanced Topics in Mobile Robotics (Autumn 2019), Linear and Nonlinear Systems Minor (Spring 2018 & 2017), Adaptive Control Theory (Autumn 2018)

Jul 2015-Jun 2016 *Teaching Assistant for Electrical lab 101 (during M. Tech.)*
IIT Kharagpur Kharagpur, India

Sep 2013-Dec 2013 *Senior Engineer (under training)*
GAIL India Limited India
» Trainee - learning the gas pipeline processes

Technical proficiency

Topics explored for research

Optimization + estimation	
Formulate trajectory estimation as an optimization problem	●●●●●●●●●●
Extended Kalman Filter (+ Rauch-Tung-Striebel smoothing)	●●●●●●●●●○
State-costate approach for computing state and parameter gradients	●●●●●●●●○○
Lagrangian approach for gradient comutation of discrete-time and continuous-time optimization problem	●●●●●●●●○○
Formulating barrier-based optimization for state and control constrained problems	●●●●●●●○○○

Optimization + planning over network	
Formulating integer decision problems/ combinatorial optimization problems (Capacitated, Time-window, and Temproral problems)	●●●●●●●●●●
Benders' and Danzig-Wolfe decomposition for solving combinatorial optimization problems	●●●●●●●●●○
Polyhedral study for finding dimension and facets of combinatorial optimization problems	●●●●●●●●●○
Dual feasible solution from Lagrangian in routing problems	●●●●●●●●○○
Branch-price-and-cut algorithm	●●●●●●●●○○
Dynamic programming	●●●●●●●○○○

Optimization + control	
Unconstrained optimal control problem	●●●●●●●●●○
Type-I and Type-II Mamdani Fuzzy Controller	●●●●●●●●●○
Model predictive control/ moving horizon approach	●●●●●●●●○○
Barrier-based optimal control problem	●●●●●●●○○○
Trajectory optimization using direct collocation - trapezoidal method	●●●●●●○○○○
Control Barrier Function	●●●●●○○○○○

Optimization (heuristics)	
Genetic Algorithm	●●●●●●●○○○

Systems	
Inverted cart pendulum	●●●●●●●●●●
Strapdown Inertial Navigation Systems with/without Earth's rotation in the Earth's navigation frame coordinate system (North-East-Up)	●●●●●●●●●○
Unicycle and bicycle model in t-domain and s-domain (Frenet-Serret frame)	●●●●●●●●●○
Reduced Inertial Sensor Systems in the Earth's navigation frame coordinate system (North-East-Up)	●●●●●●○○○○

ADDITIONAL TOPICS EXPLORED

Learning + planning + control	
Trajectory optimization using polynomial basis	●●●●●●●●○○
MDP and reinforcement learning	●●●●●●●●○○
Deep reinforcement learning algorithms - Value iteration, Q-learning, SARSA, Reinforce, Actor-Critic, and DDPG (`https://t.ly/RUGd_`)	●●●●●●○○○○
Laplacian based consensus in multi-agent systems	●●●●○○○○○○

Self development	
Framework for consistent coding and testing features in matlab and python (ipynb)	●●●●●●○○○○
Framework for prototyping optimization problems and compiling into C (matlab + matlab-coder, in progress)	●●●●●●○○○○
Framework for creating well-structured drafts (`https://t.ly/9KC9l`)	●●●●○○○○○○

Systems
Robotic Arm
Quadruped robot (`https://t.ly/nu9SC`)
Double inverted pendulum
Linear Inverted Pendulum Model for walking gait generation

Embedded + hardware
Microcontroller (ATmega series) programming using Embedded C and Arduino + Identifying registers from datasheet and editing for interface with TIMER/COUNTER/UART
Circuit design and simulation - Proximity sensor, Impedence-matching circuits, Pulse with modulation for servo/speed control, DC-DC converter
Server-client setup for hosting pages + network control (Worked with Remote runtime for colab, Apache-server, VNC, SSH)

» **More:** `https://somnath3112.github.io/portfolio/`

Programming languages and software skills

MATLAB (oop)		Simulink	
Latex		Python	
Embedded C - firmware		Microcontroller interface	
ROS-Gazebo		URDF	
3D modelling - Blender		C++/C# (CPLEX & XNA)	
Tensorflow		MuJoCo	

Awards

» Qualified Gate in Electrical Engineering with an *All India Rank of 177* in 2014.
» Participated in the National level robotics competition Robocon-2011-13 held in Pune.
» Participated in the robotics competition in Kshitij-2011, organized by IIT-Kharagpur.

Referee

» **Prof. Leena Vachhani**, Systems and Control, Indian Institute of Technology Bombay,
  » Contact: *leena.vachhani@iitb.ac.in*
» **Prof. Arpita Sinha**, Systems and Control, Indian Institute of Technology Bombay,
  » Contact: *arpita.sinha@iitb.ac.in*
» **Prof. Sunita Chauhan**, Director at Center for Equitable & Personalized Health, Plaksha University,
  » Contact: *sunplaksha@gmail.com*