Curriculum Vitae

Name: Somnath Buriuly

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Profile

- I am deeply passionate about research and development and highly committed to the tasks I take on, consistently striving to meet responsibilities even when faced with technical or personal challenges. I love to have technical discussions with fellow researchers and brainstorm on problems to the best of my abilities. I aim to grow as an elite-level researcher and developer if provided with the opportunity.
- 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, 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, 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, Moving Horizon Capacitated Arc Routing Problem, *Under 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* ———, 2024.
- **S. Buriuly**, V. Yogi, An LQR guidance law with range feedback for state and control constrained problems., *Submitted to* ———, 2024.

Projects undertaken

Academic projects with thesis/report

Mar 2024-Jan 2025 *Determining GPS coordinates at odometer locations (Bridge-the-Gap project).*

Postdoctoral fellow, IIT Bombay Mumbai, India

- **Principal Investigator:** Prof. Leena Vachhani, *leena.vachhani.sc@gmail.com*
- **Industry Collaboration:** Indian Oil Corporation Ltd
- **Co-researchers:** Mr Siddhesh Girase (B-Tech with 4 years experience), Mr. Jaivardhan Shukla (Undergraduate)

» **Objective:** Estimating trajectory of pipeline inspection gauge from large-scale IMU readings, odometer readings, and sporadic GPS readings (available once per kilometer of pipeline).

» **Details:**

- Analysing the results over 100km pipeline dataset. Improving the accuracy and speed of the software plugin using a hybrid approach of gradient methods and heuristics.
- Communicating the novel aspects of the investigation as manuscripts.
- Upgrading the software plugin in collaboration with a software engineer and a research intern.

» **Concepts:** Strapdown Inertial Navigation System (considering Earth's manifold and rotation), Reduced Inertial Navigation System, Constrained optimization, Offline trajectory estimation, indirect approach for optimization, direct gradient-based search, heuristic optimization, etc.

» test.

» **Language:** Matlab, Python

Oct 2023-Jan 2024 *Determining GPS coordinates at odometer locations (Seed project).*

Research Associate, IIT Bombay Mumbai, India

» **Principal Investigator:** Prof. Leena Vachhani, *leena.vachhani.sc@gmail.com*

» **Industry Collaboration:** Indian Oil Corporation Ltd

» **Objective:** Estimating trajectory of pipeline inspection gauge from large-scale IMU readings, odometer readings, and sporadic GPS readings (available once per kilometer of pipeline).

» **Details:**

- Investigating for improvement in computation speed of the algorithm and the accuracy of pipeline sections with bents.

» **Concepts:** Strapdown Inertial Navigation System (considering Earth's manifold and rotation), Offline trajectory estimation, heuristic optimization, etc.

» **Language:** Matlab, Python

Nov 2022-Aug 2023 *Determining GPS coordinates at odometer locations (Seed project).*

Additional project, IIT Bombay Mumbai, India

» **Principal Investigator:** Prof. Leena Vachhani, *leena.vachhani.sc@gmail.com*

» **Industry Collaboration:** Indian Oil Corporation Ltd

» **Objective:** Estimating trajectory of pipeline inspection gauge from large-scale IMU readings, odometer readings, and sporadic GPS readings (available once per kilometer of pipeline).

» **Details:**

- Studying the rigid body dynamics for modeling the pipeline inspection gauge.
- Investigating estimation and optimization algorithms. Comparing the estimation against the benchmark (16 km pipeline) data available with the industrial partner.

» **Concepts:** Strapdown Inertial Navigation System (considering Earth's manifold and rotation), Offline trajectory estimation, heuristic optimization, etc.

» **Language:** Matlab, Python

Jul 2016-Feb 2024 *Multi-agent routing and scheduling for railway track inspection.*

PhD, IITB-Monash Research Academy India & Australia

- **Supervisors:** Prof. Leena Vachhani (IITB), Prof. Arpita Sinha (IITB), Prof. Sunita Chauhan (Monash), Prof. of practice (Monash, IRT) Sivapragasam Ravitharan.
- **Objective:** Planning the routes and schedules of heterogeneous agents/instrumented wagons on railway network.
- **Details:**
  - Modeling routing and scheduling problem of instrumented wagons that doesn't disrupt the train schedules. Designing novel algorithms for the same.
  - Moving horizon planning for railway track inspection.
- **Concepts:** Mixed integer linear programming, Column generation, Lagrangian and duality based derivations, Dynamic Programming, MPC, Branch-and-cut, polyhedral study, graph theoretic derivations.
- **Language:** Matlab, C++

Jul 2015-Jun 2016 *Interval type-2 fuzzy controllers.*

M.tech, IIT Kharagpur Kharagpur, India

- Design of Two Input Interval Type-II Fuzzy Logic PI/PD Controller.
- **Supervisor:** Prof. B. M. Mohan, *mohan@ee.iitkgp.ac.in*
- **Objective:** Calibration of fuzzy logic controllers using genetic algorithm.
- **Concepts:** Interval type-2 fuzzy control, Genetic Algorithm, DC motor control.
- **Language:** Matlab (GA toolbox + Fuzzy toolbox + Simulink)

Jul 2012-Mar 2013 *Designing PID controller for pressure control system.*

B.tech, NIT Durgapur Durgapur, India

- **Supervisor:** Prof. C. Koley, *ckoley@ee.nitdgp.ac.in*
- **Objective:** System identification + design of Two Input Interval Type-II Fuzzy Logic PI/PD Controller.
- **Concepts:** Interval type-2 fuzzy control, Genetic Algorithm, DC motor control.
- **Language:** Matlab (Simulink)

Additional learning projects

Since Mar 2021 *Implementation of A.Winkler's Work on Simultaneous CoP and Footstep Planner.*

IIT Bombay Mumbai, India

- **Objective:** Whole body controller and planner for a quadruped robot.
- **Details:**
  - Matlab-controlled ROS-Gazebo simulation for XPP quadrupedal robot. Alexander Winkler's simplified path planner implementation using linear programming.
  - Walking robot from a double pendulum dynamics - `https://youtu.be/aQi40NrY7So`.
  - **To-do** Task space controller based path plan implementation for XPP quadruped robot
- **Concepts:** Trajectory optimization, spline, quadratic and linear programming, Matlab-ROS- Gazebo interface, LIPM, Task space controller, Blender and URDF

» **Language:** Matlab, Python, URDF

Since Mar 2021 *Learning to Walk - ANYbot Walking Using SAC.*

During PhD, IIT Bombay Mumbai, India

» **Objective:** Walking controller for quadruped using deep reinforcement learning.

» **Details:**

- MuJoCo-based ANYmal robot interface for DRL training. MuJoCo-based ANYmal and SpotMicro inverse kinematics integration for OL control of the feet. Development of Q-learning, DQN, and DDPG algorithms from scratch. Stable baseline integration for MuJoCo-based gym models and custom created models.
- **To-do** Training ANYmal using the stable baseline library for movement between two points. Training ANYmal using custom made DDPG algorithm. Task space controller-based path plan implementation for ANYmal.

» **Concepts:** Trajectory optimization, spline, MuJoCo (dm-control), stable baseline (pytorch), tensorflow

» **Language:** Python

Since Mar 2021 *More small projects on ROS-Gazebo.*

IIT Bombay Mumbai, India

» **Objective:** Learn and implement tasks on ROS-Gazebo.

» **Details:**

- Pluto quadcopter in ROS-Gazebo and hardware. `https://github.com/somnath3112/pluto-ros-package`
- ROS-Gazebo simulation for the journal paper mentioned earlier (2020). `https://youtu.be/zDn6QxqzTAY`.

» **Concepts:** ROS-Gazebo

» **Language:** Python

SUPPORTING PROJECTS FOR EASE OF RESEARCH

Since Mar 2021 *LaTeX framework.*

During PhD, IIT Bombay Mumbai, India

» **Objective:** Create manuscript quickly with extra descriptions (key questions and bullet-point descriptions for each paragraph) that can be hidden easily.

» Link to my overleaf and github project.

» **Details:**

- Single boolean variable to switch on/off the paragraph descriptions. Converts manuscript into a bullet point format.
- Most needed libraries includes.
- Compilation of individual LaTeX files/section/chapter for fast building during drafting.

» **Language:** LaTeX

Since Mar 2021 *Matlab framework.*

During PhD, IIT Bombay Mumbai, India

» **Objective:** Create classes and functions with consistent structure, test codes, methods with naming conventions, etc.

» **Details:**

- Button to create a basic code structure with some variable and method names unique to the class name.
- functions in the same file to store basic syntax for instantiating the class.
- Script to generalize and store the upgraded framework.

» **Language:** Matlab

Since Mar 2021 *Optimization Framework for Robotics Applications.*

During PostDoc, IIT Bombay Mumbai, India

» **Objective:** Test variety of estimation and planning algorithms on different systems. Add new algorithms and systems and compare the results.

» **Details:**

- Unified framework for defining all system descriptions - dynamics, measurements, parameters, Jacobians (for states, control, and parameters), etc.
- EKF, TrajOpt, Parameter estimation/optimization, etc. algorithms with gradient computations.

» **Language:** Matlab

Since Mar 2021 *Control Framework.*

During PostDoc, IIT Bombay Mumbai, India

» **Objective:** Test variety of control algorithms on different systems. Add new algorithms and systems and compare the results.

» **Details:**

- Unified framework for defining all system descriptions - dynamics, measurements, parameters, Jacobians (for states, control, and parameters), etc.
- EKF, TrajOpt, Parameter estimation/optimization, etc. algorithms with gradient computations.

» **Language:** Matlab

FUN PROJECTS

Since Jun 2009 *Electronics and hardware robotics projects.*

Hobby. Robocon team member. India

» **Objective:** Real-time visualization of sensor data in PC.

» **Details:**

- Demonstration of IMU data, and visualizing it in a 3D virtual object. https://youtu.be/mNLPQUqB4xA and https://youtu.be/zPtgC2oQ3io.
- Load cell data visualization. https://youtu.be/mNLPQUqB4x.
- GPS + GSM tracking of device
- Smooth (ease-in) motion of the grid follower using custom made wheel encoders using PI controller, on an ATmega 128 developemnt board. Developed for [Robocon-2012]. https://youtu.be/zJr05-qt4zw.
- Interfacing with ultrasound sensor for distance measurement. Developed [in the year 2011]. https://youtu.be/fpqqW_jL-Ko
- Line follower without microcontroller - logic gates only. Developed [in the year 2010]. https://youtu.be/iqXU_BkhAk4.

» **Concepts:** Serial interface with Matlab, IMU interface using I2C control, Embedded C (no Arduino).

Since Mar 2007 — *Fun software projects.*

Hobby. — Kharagpur, India

» **Objective:** For self-learning and assistance in robotics projects.

» **Details:**

- A matchstick puzzle game. https://github.com/somnath3112/matchstick_puzzle.
- Blender donut design from an online course. https://somnath3112.github.io/portfolio/.
- Matlab simulation to show the open loop dynamics of double pendulum setup. Developed [in the year 2019]. https://youtu.be/SRQThrU1BL0.
- Applying Fuzzy Logic on line-follower robot. Developed [in IIT Kharagpur, Year-2014]. https://youtu.be/dybRLsO6OtI
- Sample website developed from scratch - CSS + HTML + Flask (a python backend). Developed [in the year 2021]. https://youtu.be/WdqNpHVyKqY.

» **Concepts:** Matchstick puzzle game in Macromedia Flash, Donut and whale modeling in Blender, etc.

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

2014–2016 — *M.tech in Electrical Engineering (Control systems)*

IIT Kharagpur — Kharagpur, India

» CGPA: 8.24/10

» Percentage: 82.4

2009–2013 — *B.tech in Electrical Engineering*

NIT Durgapur — Durgapur, India
- CGPA: 7.88/10
- Percentage: 73.8

2007–2009 — *ISC (XII)*
Sunrise (E. M.) School — Howrah, India
- Percentage: 83.23

2007 — *ICSE (X)*
Sunrise (E. M.) School — Howrah, India
- Percentage: 85.43

Work

Mar 2024-present — *Postdoctoral Fellow*
CoEOGE, IIT Bombay — Mumbai, India

Oct 2023-Jan 2024 — *Research Associateship*
IIT Bombay — Mumbai, India

Nov 2022-Aug 2023 — *Researcher*
CoEOGE, IIT Bombay — Mumbai, India

Jul 2020-Jun 2021 — *Teaching Assistant (online)*
IIT Bombay — Mumbai, India

Jul 2017-Jun 2019 — *Teaching Assistant*
IIT Bombay — Mumbai, India

Jul 2015-Jun 2016 — *Teaching Assistant*
IIT Kharagpur — Kharagpur, India

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

Technical proficiency

MATLAB object oriented programming	●●●●●●●●●●
Simulink	●●●●●●●●●●
Latex	●●●●●●●●●○
Embedded C - firmware	●●●●●●●●●○
Python	●●●●●●●●○○
Roboitcs Operating System (ROS)	●●●●●●●●○○
XML for Gazebo modeling	●●●●●●○○○○
3D modelling - Blender	●●●●●○○○○○
Tensorflow	●●●●●○○○○○
MuJoCo	●●●○○○○○○○

Languages

Hindi English

Awards

- Qualified Gate in Electrical Engineering with an All India Rank of 177 in 2014.
- Participated in the National level robotics competition Robocon-2013 held in Pune.
- Participated in the National level robotics competition Robocon-2012 held in Pune.
- Participated in the National level robotics competition Robocon-2011 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.sc@gmail.com*
- **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*