

# Curriculum Vitae

Name: Somnath Buriuly

📍 Lab 301, Systems and Control · IIT Bombay · Powai - 400076 ✉ somnath3112@google.com 📞 +919163107203

## PROFILE

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- » 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, Quadrupe, Robotic Arm, Inverted-cart pendulum, Fixed-wing and rotary-wing drones, Unicycle (differential-drive).*

## PUBLICATIONS

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- » **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

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- » **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

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### ACADEMIC PROJECTS WITH THESIS/REPORT

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📅 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](mailto: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](mailto: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](mailto: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](mailto: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](mailto: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

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- 📅 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. Planning and Control link: <https://www.youtube.com/playlist?list=PLeSCFB3ScayliH88QdEOWEA-8GdDj-G6t> & <https://www.youtube.com/playlist?list=PLeSCFB3Scayl5d13Q9SgN08hZuESpzMK3>.
  - Walking robot from a double pendulum dynamics. Link: <https://youtu.be/aQi40NrY7So>.
  - **Ongoing:** 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. Link: <https://www.youtube.com/playlist?list=PLeSCFB3ScayksgDsXM790253w18kFyePm>.
- **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

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📅 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

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📅 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 development 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](https://youtu.be/fpqqW_jL-Ko)
- Line follower without microcontroller - logic gates only. Developed [in the year 2010]. [https://youtu.be/iqXU\\_BkhAk4](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](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 back-end). Developed [in the year 2021]. <https://youtu.be/WdqNpHVyKqY>.

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

## EDUCATION

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📅 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*

	<b>NIT Durgapur</b> » CGPA: 7.88/10 » Percentage: 73.8	📍 Durgapur, India
📅 2007–2009	<i>ISC (XII)</i> <b>Sunrise (E. M.) School</b> » Percentage: 83.23	📍 Howrah, India
📅 2007	<i>ICSE (X)</i> <b>Sunrise (E. M.) School</b> » Percentage: 85.43	📍 Howrah, India

## WORK

📅 Mar 2024-present	<i>Postdoctoral Fellow</i> <b>CoEOGE, IIT Bombay</b>	📍 Mumbai, India
📅 Oct 2023-Jan 2024	<i>Research Associateship</i> <b>IIT Bombay</b>	📍 Mumbai, India
📅 Nov 2022-Aug 2023	<i>Researcher</i> <b>CoEOGE, IIT Bombay</b>	📍 Mumbai, India
📅 Jul 2020-Jun 2021	<i>Teaching Assistant (online)</i> <b>IIT Bombay</b>	📍 Mumbai, India
📅 Jul 2017-Jun 2019	<i>Teaching Assistant</i> <b>IIT Bombay</b>	📍 Mumbai, India
📅 Jul 2015-Jun 2016	<i>Teaching Assistant</i> <b>IIT Kharagpur</b>	📍 Kharagpur, India
📅 Sep 2013-Dec 2013	<i>Senior Engineer (under training)</i> <b>GAIL India Limited</b> » Trainee - learning the gas pipeline processes	📍 India

## TECHNICAL PROFICIENCY

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

## LANGUAGES

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Hindi

English

## AWARDS

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- » 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

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- » **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*
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