Dvij Kalaria

✉ dvijk@berkeley.edu · ⌨ dvij542 · in Linkedin · 🌐 Website · G Scholar ☎ 2067468702

Academics

EECS Ph.D.	**2024 -**
BAIR lab, UC Berkeley, **Advisor:** Shankar Sastry	GPA: -/4
Masters in Robotics (MSR)	**2022 - 2024**
Robotics Institute, Carnegie Mellon University (CMU), **Advisors:** John M. Dolan, Qin Lin, Guanya Shi	GPA: 4.08/4
B. Tech in Computer Science and Engineering	**2018 - 2022**
Indian Institute of Technology Kharagpur (IIT KGP), **Thesis Advisors:** Partha Prathim Chakraborty, Aritra Hazra	GPA: 9.16/10

Publications (**Recent focus)

1. **Dvij Kalaria**, Haoru Xue, Wenli Xiao, Tony Tao, Guanya Shi, and John M. Dolan. Agile Mobility with Rapid Online Adaptation via Meta-learning and Uncertainty-aware MPPI. ICRA 2025 [Website]
2. **Dvij Kalaria**, Qin Lin, and John M. Dolan. Disturbance Observer-based Control Barrier Functions with Residual Model Learning for Safe Reinforcement Learning. ICRA 2025 [Website]
3. ** **Dvij Kalaria**, Chinmay Maheshwari, and Shankar Sastry. Real-Time Algorithms for Game-Theoretic Motion Planning and Control in Autonomous Racing using Near-Potential Function. L4DC 2025 [Website]
4. ** Daniel Etaat, **Dvij Kalaria**, Nima Rahmanian, and Shankar Sastry. Learning to Anticipate Table Tennis Hits from Monocular Video. CVPR 2025 [Website, dataset coming soon!]
5. Wenli Xiao, Haoru Xue, Tony Tao, **Dvij Kalaria**, John M. Dolan, and Guanya Shi. AnyCar to Anywhere: Learning Universal Dynamics Model for Agile and Adaptive Mobility. ICRA 2025 [Website]
6. **Dvij Kalaria**, Qin Lin, and John M. Dolan. Adaptive planning and control with time-varying tire models for autonomous racing using extreme learning machine. Accepted, ICRA 2024 [PDF]
7. **Dvij Kalaria**, Q. Lin, and J. Dolan. Delay-aware robust control for safe autonomous driving. [**Oral**, 10% of accepted] IEEE-IV 2022 [PDF]
8. D. Kalaria, Q. Lin, J. Dolan. Towards safety assured end-to-end vision based control for autonomous racing. IFAC Congress 2023 [PDF]
9. **Dvij Kalaria**, Qin Lin, and John Dolan. Delay-aware robust control for safe autonomous driving and racing. T-ITS journal [PDF]
10. Emanuel Munoz, **Dvij Kalaria**, Qin Lin, and John M. Dolan. Online adaptive compensation for model uncertainty using extreme learning machine-based control barrier functions. IROS 2022 [PDF]
11. **Dvij Kalaria**, Qin Lin, and John M. Dolan. Towards optimal head-to-head autonomous racing with curriculum reinforcement learning. Presented at MADGames workshop, IROS 2023 and Under review, RLC 2024

Technical Skills

Languages: Python | C | C++ | MATLAB | JAVA | SQL | LaTeX
Libraries & Tools: ROS | PyTorch | OpenCV | Gazebo | Casadi | Blender | VRXPERIENCE | Unity
Relevant Coursework: F1Tenth | Learnning for 3D Vision (3 class choice awards) | Computer Vision | Safe robotics | Deep Learning | Robot Learning | SLAM | Reinforcement Learning | Machine Learning | Algorithms-1&2 | Operating Systems | SDM | Probability and Statistics | Software Development Engineering (SDE) | Game development | Operating Systems | Networks | FLAT | Natural Language Processing

Research Experience (**Recent focus)

BAIR lab, UC Berkeley *Guide: Shankar Sastry*   *July '24 - Present*
- ** **Game-theoretic planning and control for multi-car racing**: Working on using potential functions to compute online nash equilibrium within parameterized set of policies.
- ** **Game-theoretic planning and control for robotic table tennis**: Trained large transformer to learn strategies and anticipation for large human videos. Working on game-theoretic strategy planner based on learning potential function from skills learned from humans.

DRIVE lab, Robotics Institute, CMU *Guide: John M. Dolan, Qin Lin, Guanya Shi*   *June '21 - Present*
- **Robotics Institute Summer Scholar (RISS)** ⌨ [paper] [poster] [video] : Implemented a **delay aware Tube-MPC** which compensates for delays due to computation, actuator command processing and actuator dynamics for autonomous driving and racing scenarios
- ⌨ Formulated a control plan to compensate for delays in deploying a **learning enabled** controller and with CBFs for obstacle avoidance
- ⌨ Worked on learning a **safety assured end-to-end controller** policy using trainable **CBFs** with only camera image sensor used as input
- ⌨ [Website] Developed a **learning-enabled online model identification and adaptation**; and adaptive raceline planning for autonomous racing to compensate for time-varying aerodynamic and friction parameters from wear and tear of the tires, weather etc.
- ⌨ [Website] Formulated a **Multi-Agent Reinforcement Learning (MARL)** framework to train for Head-to-Head autonomous racing
- **OffTerSim** ⌨ : Developed offroad driving simulator for RL-based trail following. Currently working on deploying it on real buggy car
- ** **Towards foundation model for car controller** [Website 1] [Website 2]: Designed 1) a meta-learning approach to quickly learn model dynamics of any car with few seconds of online data 2) large transformer model enabling in-context adaptation to control any car on any surface. More details in the websites

AI Racing Tech team, Indy Autonomous Challenge (IAC) [Website] ⌨   *July '22 - Present*
- ⌨ Implemented Model Predictive Control (**MPC**) control with a more complex vehicle model suitable at high speeds to consider objectives for overtaking, optimal racing line keeping and use of drafting.
- ⌨ Implemented **Adaptive LQG** control that considers lateral tire dynamics followed by a controller agnostic **CBF** layer for track constraints
- ⌨ Implemented **online parameter estimator** that can adapt controllers to changing surface friction, aerodynamic parameters
- All contributions tested on GoKart and actual Indy Racing Car. Our team finished **3rd** on the IAC, **CES 2023** at Las Vegas

Autonomous Ground Vehicles, IIT Kharagpur *Guide : Dr. Debashish Chakravarty*   *Apr'19 - Dec'20*
- **Eklavya 7.0 (IGVC 2019)** : Worked on implementing EKF, UKF based localization, sensor integration, path planning and ramp detection
- **Hybrid A* Motion Planner** ⌨ : Fully implemented, tested on Gazebo sim, industrial prototype Husky, Mahindra e2o
- **Deep Learning based trajectory prediction** ⌨ : used Graph convolution layers on top of the State of the Art (SOTA) GRIP++ architecture and outperformed the SOTA model on Apolloscape and NGSIM dataset by 10% on WSADE loss

Industrial Experience

Pratt Miller - *Research intern* *May'23-July'23*
- Proposed **ML** models for opponents to predict their pit strategy, driver and vehicle limit parameters
- Developed an **optimization** framework to get an optimal pit stop choice given the opponent ML models and trained statistics
- Used **RL** to optimize ego agent race strategy against other trained racing agents based off previous races
- Deployed the whole framework on **flask** as a demo during a live **IMSA race** by efficiently managing online compute resource

PreImage - *Deep Learning intern* *Dec'20-Feb'21, Jan'22-May'22*
- Incorporated a **conditional generative DL model** to generate different 3D shapes conditioned on a specific class of objects like chairs
- Worked on **DL based auto-calibration** of raw images to correct barrel and pincushion distortion, **DL based image matching**
- Worked on parallelizing **DEM** and **DTM** calculation from sparse point clouds using **CUDA programming**. Sped up by about **7** times

Oracle Cloud Infrastructure (OCI) - *Deep Learning research intern* *Apr'21-Jun'21*
- Simulated an **uncertainty aware active learning** workflow to assist manual labelers on image detection task. Used a modified YOLOv5 network to consider epistemic uncertainty in the confidence score. Extended the framework to NLP tasks like **NER**
- Implemented **image clustering** to present images in clusters with common features to reduce fatigue

Teaching/Mentoring Positions

- **F1Tenth course head TA, CMU** ⦿ : Involved significantly high efforts as was introduced for first time in CMU. Tutored **2 lectures** based on my research, **8 tutorials** including hardware as part of the course. Mentored course projects of **4 teams**, organized **3 races**. Also organized demo presentation races in **Safety21**. Fully designed component arrangement which included **laser-cut** of platform deck, **3d-print** for mounts to accommodate new hardware changes for Spring'24
- **IEEE Winter Workshop, IIT Kharagpur** : Mentored a week long IEEE certified IP Workshop attended by more than 100 students on topics related to image processing
- **Unity Gaming Workshop, CGS, IIT Kharagpur** : Tutored for a week long Unity-certified workshop with about 50 attendees on developing a fully functional arcade game in Unity game engine
- **Kharagpur Winter of Codes (KWoC), IIT Kharagpur** : Mentored for a pygame project with 5 first year mentees involved
- **Oracle coding workshop** : Tutored a 3-day workshop conducted to teach high school students from various social backgrounds the basics of programming

Other Projects

Single View Scene Generation [Report] ⦿ *Term Project | Learning for 3D, CMU* *Mar'23 – Apr'23*
- Employed **YOLOv5** and **SAM** for object detection and segmentation along with **CubeRCNN** for 3D pose estimation
- Leveraged **PixelNeRF** & **Vision Transformer** for single image to NeRF predictions and **iNeRF** for object localization in 3D scene
- Demonstrated the approach on blender generated & KITTI dataset scenes and proposed method as a data labelling technique

CBFs for autonomous racing [Report] ⦿ *Term Project | Provably Safe Robotics, CMU* *Feb'23 – Apr'23*
- Proposed 2nd order CBFs for stability and track boundary constraints in the context of autonomous racing
- Leveraged model residual learning to improve the accuracy of CBFs at high speeds

Age and Gender Statistics calculator from CCTV cameras ⦿ *Team lead, InterIIT, Bosch Research* *Feb'22-Mar'22*
- Led a team on a month problem industry-associated competition to win a solo gold medal for IIT Kharagpur
- Implemented novel Frequency-aware super-resolution followed by age and gender detection from a low resolution CCTV camera

SpaceMania Android game ⦿ *Computer Graphics Society, IIT Kharagpur* *Jan'20-Feb'20*
- Completely developed the game including most of the graphics from scratch using Unity Game Engine
- Used various path planning strategies for enemy attacks. Used opencv library to generate maps, and graphics development in Blender.

EasyDataLabeler Android App ⦿ *Guide: Prof. Debasis Samanta* *Apr'20-May'20*
- Developed fully functional android app developed for easily adding bounding box and polygon labels, free line semantic segmentation on a dataset which can be accessed through a central database by any user.
- Employed industrial software development techniques like preparing SRS, DFD, Class diagrams.

Achievements

- **JEE Advanced, All India Rank 245 (Top 0.1% of 0.2 million selected candidates),** *Indian Institute of Technology (IITs), 2018*
- **JEE Mains, All India Rank 393 (Top 0.03% of 1.3 million candidates)** *Central Board For Secondary Education (CBSE), 2018*
- **Bosch MidPrep InterIIT tech 2022** : Head of the solo gold winning team
- **JOSAA 2021** : Was part of the committee responsible for for the largest pan India entrance exam with 1.2 million candidates. Prepared automated scorecard and ranklist creation scripts taking into consideration complicated reservation rules