

# Dvij Kalaria

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## Research Interests

**Robotics & AI:** Humanoids, Learning from videos, Agile robots, Game theory, Reinforcement Learning

**Current research focus:** Leveraging internet scale human video data to train humanoids for everyday tasks, and enable robots to play competitive games like table tennis, autonomous racing etc.

## Academics

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

- \*\* Dvij Kalaria, Sudarshan Harithas, Pushkal Katara, Sangkyung Kwak, Sarthak Bhagat, S. Shankar Sastry, Srinath Sridhar, Sai Vemprala, Ashish Kapoor, and Jonathan Huang. Dreamcontrol: Human-inspired whole-body humanoid control for scene interaction via guided diffusion. ICRA 2026 [\[Website\]](#)
- \*\* 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 [\[Website\]](#)
- \*\* Daniel Etaat, Dvij Kalaria, Nima Rahamanian, and Shankar Sastry. Learning to Anticipate Table Tennis Hits from Monocular Video. CVPR 2025 [\[Website\]](#)
- 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 [\[Website\]](#)
- Dvij Kalaria, Qin Lin, and John M. Dolan. Disturbance Observer-based Control Barrier Functions with Residual Model Learning for Safe Reinforcement Learning. ICRA 2025 [\[Website\]](#).
- 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 [\[Website\]](#)
- 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 [\[PDF\]](#)
- Dvij Kalaria, Q. Lin, and J. Dolan. Delay-aware robust control for safe autonomous driving. [Oral, 10% of accepted] IEEE-IV 2022 [\[PDF\]](#)
- D. Kalaria, Q. Lin, J. Dolan. Towards safety assured end-to-end vision based control for autonomous racing. IFAC Congress 2023 [\[PDF\]](#)
- Dvij Kalaria, Qin Lin, and John Dolan. Delay-aware robust control for safe autonomous driving and racing. T-ITS journal [\[PDF\]](#)
- 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 [\[PDF\]](#)
- 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)

### General Robotics *Guide: Jonathan Huang*

June '25 - Aug '25

- [Website]\*\* **DreamControl:** Used generative model trained on human motion paired with text prompts to generate diverse human task-specific trajectories that are re-targeted to humanoid. Closed loop task-specific RL policy is trained using reference motions as prior to deploy on unitree G1.

### BAIR lab, UC Berkeley *Guide: Shankar Sastry*

July '24 - Present

- [Website]\*\* **Game-theoretic planning and control for multi-car racing:** Worked on using potential functions to compute online nash equilibrium within parameterized set of policies.
- [Website] \*\* **Learning to play table tennis by observing expert human videos:** 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
- IOSAA 2021 : Was part of the committee responsible 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