Dvij Kalaria

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Research Interests

Robotics & AI: Motion Planning, Controls, Machine Learning, Computer Vision, Autonomous Driving

Academics

B. Tech in Computer Science and Engineering **2018 - 2022**
Indian Institute of Technology, Kharagpur 9.05/10

Publications Under Review

1. **Dvij Kalaria**, Qin Lin, and John M. Dolan. Delay-aware robust control for safe autonomous driving. [Submitted to ICRA 2022] [PDF]
2. **Dvij Kalaria**, Aritra Hazra, and Partha Pratim Chakrabarti. Detecting Adversaries, yet Faltering to Noise? Leveraging Conditional Variational AutoEncoders forAdversary Detection in the Presence of Noisy Images . 2022 [PDF]

Peer-Reviewed Workshop Papers

1. **Dvij Kalaria**, Parv Maheshwari, Animesh Jha, Arnesh Kumar Issar, Debashish Chakravarty, Sohel Anwar, and Andres Towar. Local NMPC on Global Optimised Path for Autonomous Racing. In *OCAR Workshop*, ICRA 2021 [PDF]

Research Experience

Robotics Institute Summer Scholar (RISS) *Guide: Dr. John M. Dolan, Dr. Qin Lin* *June '21 -*
Carnegie Mellon University [paper] [poster] [video]

- Implemented a delay aware Model Predictive Control which compensates for delays observed in autonomous vehicles due to computation, actuator command processing and actuator dynamics
- Formulated a control plan to compensate for delays in deploying a blackbox learning based controller
- Used Control Barrier Functions (CBFs) in Frenet frame for obstacle avoidance and lane keeping

Autonomous Ground Vehicles, IIT Kharagpur *Guide : Dr. Debashish Chakravarty* *Apr'19 - Dec'20*

- **Eklavya 7.0 for IGVC 2019, May'19-July'19**
  - Incorporated Localization module on ROS using EKF (Extended Kalman Filter) and UKF (Uncentred Kalman Filter) techniques taking as input from odometry, IMU and GPS sensors.
  - Worked under Path Planning module, costmap generation, waypoint generation, ramp detection, pothole detection, sensor integration.
- **Hybrid A* Motion Planner, Aug'19-Dec'19**
  - Implemented the conventional path planner on ROS C++ to run on Gazebo simulation software with planned path visualized on RviZ.
  - Installed voronoi field into heuristic cost to plan safer path while not compromising admissibility
  - Tested the code on Husky industrial prototype, Mahindra e2o for static obstacle course.
- **Deep Learning based trajectory prediction, Mar'20-Dec'20**
  - Reproduced results for state of the art methods like SGAN, CS-LSTM, GRIP++, TraPHic
  - Experimented with using Graph convolution layers and outperformed the state of the art model on Apolloscape and NGSIM dataset by 10% on WSADE loss (custom MSE loss defined by apolloscape).

IUPUI-IITKGP-USB team, Indy Autonomous Challenge (IAC) *July'20 - Mar'21*
Guide : Dr. Sohel Anwar, Dr. Andres Tovar, Dr. Debashish Chakravarty

- 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.
- Successfully completed all virtual hackathons and simulation race

Adversary detection and purification *Guide: Dr. Partha Chakravarty, Dr. Aritra Hazra* *Mar'21 -*

- Implemented a novel Conditional-VAE network for detecting white box adversarial attacks
- Comparable results on Cifar10, MNIST dataset with the state of the art methods with added advantage of not detecting an image with random noise as an adversary
- Implemented Variational AutoEncoder (VAE) for purification of adversaries after getting detected

Industrial Experience

PreImage *DL engineer* *Dec'21-Feb'21*

- Incorporated a generative DL model to generate different 3D shapes of a particular class
- Worked on DL based auto-calibration of raw images to correct barrel and pincushion distortion
- Worked on DL based image matching and clustering to get clusters of images capturing common scene with different views

Oracle Cloud Infrastructure (OCI) *DL engineer* *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
- Implemented image clustering to present images in clusters with common features to reduce fatigue
- Touched upon extending the active learning workflow to NLP Named Entity Recognition (NER) task

Other Projects

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.
- Employed industrial software development techniques like preparing SRS, DFD, Class diagrams.

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 and graphics development in Blender 3d, Photoshop.
- Used various path planning strategies for enemy attacks. Used opencv library to generate maps.

Teaching Positions

- **IEEE Winter Workshop, IIT Kharagpur** : Mentored a week long IEEE certified IP Workshop attended by more than 100 first years on topics related to image processing
- **Kharagpur Winter of Codes (KWoC), IIT Kharagpur** : Mentored for a pygame project with 5 first year mentees involved, conducted by KOSS, IIT Kharagpur
- **Oracle coding workshop** : Tutored a 3-day workshop conducted to teach high school students from various social backgrounds the basics of programming

Technical Skills

Languages: Python | C | C++ | MATLAB | JAVA | SQL | LaTeX
Libraries & Tools: ROS | PyTorch | OpenCV | Gazebo | Casadi | Blender | VRXPERIENCE | Unity | MuJoCo
Relevant Coursework: Deep Learning | Reinforcement Learning | Machine Learning | Algorithms-1 &2 | Operating Systems | Scalable Data Mining | Artificial Intelligence | Image Processing | Probability and Statistics | Formal Language and Automata Theory (FLAT)

Achievements

- **JEE Advanced, All India Rank 245 (Top 0.1%),** *Indian Institute of Technology (IITs), 2018*
- **JEE Mains, All India Rank 393 (Top 0.01%)** *Central Board For Secondary Education (CBSE), 2018*

Positions of Responsibility

- **Joint Seat Allocation Authority (JOSAA)** : Part of the technical team involved in calculating score, generating ranklist, seat allocation into IITs and NITs through the prestigious JEE examination
- **CodeClub, IIT Kharagpur** : Organized a series of events and talks in the university, including Up.AI, departmental coding competitions.