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Kartik Paigwar

Education

Visvesvaraya National Institute of Technology, Nagpur, India — *Jul' 15 - Jun' 19*
Bachelor of Technology, Computer Science and Engineering

Hislop College, Nagpur, India — *May' 13 - May' 15*
Higher Secondary School Certificate, Science Stream

Experience

Indian Institute of Science, Bangalore, India — *Jun '19 - Present*
Project Assistant, Robert Bosch Centre for Cyber-Physical Systems — *(Prof. Shishir K., Prof. Shalabh B.)*

Learning Agile Locomotion for a Low Cost Quadruped Robot - Stoch2

- Designed a linear policy control framework for robust quadruped locomotion on sloped terrain using proprioceptive feedback.
- Generated stable foot trajectories for Omni-directional quadruped motion and learnt smooth transitions between these trajectories using expert demonstration.
- Worked on generating a library of walking gaits, namely trot, side-step, and turn by learning the optimal control points of cubic spline trajectories using Augmented Random Search.

State Estimation and Localization for Autonomous Staircase Climbing

- Detected and performed 3D modeling of the staircase to estimate physical dimensions like height, width and inclination of the steps using onboard stereo camera on Stoch2.
- Installed electronic image stabilization and used MLS surface reconstruction method to smoothen the noisy point cloud data .

Politecnico di Milano, Milan, Italy — *Jun '18 - Aug '18*
Undergraduate Summer Research Fellow, AIRLab — *(Prof. Andrea Bonarini)*

- Worked on a Inverse Reinforcement Learning problem to find the reward function behind the 'Search Strategy' of humans tele-operating a holonomic mobile robot during a search and rescue operation.
- Created a tele-operated setup to perform expert's demonstration to search for an object in a partially observable environment.
- Reduced the high dimensionality of robot's state space by encoding 2D Laser Scans (majorly accountable) using a 1D convolution autoencoders with a compression ratio of 7:1 and reconstruction accuracy of 93%.

Research Interests

Robot Learning, Human-Robot Interactions, Computer Vision, Control, Navigation

Publications

K. Paigwar, L. Krishna, S. Tirumula et al. "Robust Quadrupedal Locomotion on Sloped Terrains: A Linear Policy Approach". *Submitted to Conference on Robot Learning (**CoRL**), 2020.* (Video)

S. Tirumula, S. Gubbi, **K. Paigwar** et al. "Learning Stable Manoeuvres in Quadruped Robots from Expert Demonstrations". In: *29th IEEE International Conference on Robot & Human Interactive Communication (**Ro-Man**).* (Video)

S. Tirumula, A. Sagi, **K. Paigwar** et al. "Gait Library Synthesis for Quadruped Robots via Augmented Random Search". *arXiv preprint arXiv:1912.12907, 2019.* (Video)

U. Patil et al. "Deep Learning Based Stair Detection and Statistical Image Filtering for Autonomous Stair Climbing". In: *2019 Third IEEE International Conference on Robotic Computing (**IRC**).*

Y. Phalak, G. Charpe, **K. Paigwar**. "Omnidirectional Visual Navigation System for TurtleBot Using Paraboloid Catadioptric Cameras". In: *2018 International Conference on Robotics and Smart Manufacturing (**RoSMa**).* (Video)

Research Projects

Human Gameplay Imitation Through Deep-RL (B.Tech. Thesis) *Aug '18 - Apr '19*
Computer Science Department, VNIT, Nagpur, India | Dataset, Codes, Video *(Prof. M. Dhabu)*

- Designed a Deep RL framework for autonomous skills acquisition in which an agent learns from expert's gameplays to exhibit a repertoire of skills in an adaptive game environment.
- Demonstrated results over the Atari game, Breakout, where the agent mimics some of the intelligent skills in the game, namely, tunnelling, corner hitting and ball tracking to beat the average high score of human-players.

Autonmous Multi-Storey Survelliance Robot (More Info) *Aug '18 - Jan '19*
IvLabs, VNIT, Nagpur | Dataset, Video *(Prof. Shital Chiddarwar*

- Designed and built a bio-inspired robot with continuous caterpillar tracks capable to traverse over the rough terrains including staircase of standard dimensions.
- Enabled multi-floor exploration via real time staircase detection and localization to autonomously climb over the staircase.
- Created a annotated staircase dataset with more than 2000 images to train a YOLO-v3 object detection model for robust detection over traditional methods of manually tuning the edge detector.
- Processed region of interest around the staircase using statistical gradient filters to find the heading offset of the robot with respect to stair's edges.

Multi-Focus Image Fusion with Deep CNNs (More Info) *Nov '17 - Mar '18*
IvLabs, VNIT, Nagpur, India *(Prof. Shital Chiddarwar)*

- Aim of the project is to capture fully focused images with a minimal specification smartphone camera by fusing multiple images of the same scene taken with different focal settings of the camera.
- Trained a Siamese CNN as a classifier using high definition images and their corresponding Gaussian blurred versions to obtain an all-in-focus image as described in the paper by Yu Liu.

Course Projects

Autonomous Ground Control Points Detection and Localization *Feb '19 - Apr '19*
Course: Computer Vision | Github Link, Report *(Prof. Praveen Kumar)*

- For Photogrammetry operations like precision drone mapping, GCP markers are detected and marked in the 4k resolution drone images autonomously for true global accuracy.
- Designed a pipeline consisting of image processing and deep learning techniques to segment L-shaped GCPs and mark their centre, which has the maximum convexity defect.
- Estimated real-time 6-DOF pose of the drone with respect to GCP markers using SolvePnP method.

Relevant Coursework

Academic Courses: Data Structures & Program Design, Design & Analysis of Algorithms, Linear Algebra, Neural Networks & Fuzzy Techniques, Artificial Intelligence, Image & Video Processing, Computer Vision, Machine Learning

MOOCs: Introduction to Machine Learning, Andrew Ng; Deep Learning Specialization, Andrew Ng— Coursera, Reinforcement Learning, David Silver; Introduction to Computer Vision— Udacity

Computer Skills

Languages: C, C++, Python, Java
Research Tools and Libraries: ROS, OpenCV, PCL, PyTorch, TensorFlow, Matlab, PyBullet
Misc. Tools: LaTeX, Android, Photoshop

Service

Core-Coordinator, IvLabs May'18 - May'19
- Managed lab website, conducted weekly knowledge sharing sessions and key involvement to setup alumni funds.

Project Mentor, IvLabs Jun'17 - Present
- Projects: Wizards Chess, Rapid Prototyping Educational Robotic Platform, AutoExMap

Commitee, ACM Programming Club, VNIT Jun'17 - Jun'18
- Conducted online coding competitions on Hackerearth and CodeChef for encouraging the programming culture in college.

Achievements

Selected for Deep Learning Reinforcement Learning Summer School, 2020 hosted by CIFAR, Mila, Alberta Machine Intelligence Institute (Amii), and Vector Institute among more than 1000 applicants across the world.

Recieved highest grades for outstanding performance in Bachelor's thesis project, Computer Science Department, VNIT

Qualified for Quarterfinals, DST & Texas Instrument India Innovation Challenge 2017