Kunal Nandanwar

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Education

Worcester Polytechnic Institute - USA | *MS Robotics* *Aug 2021 - May 2023*

Birla Institute of Technology & Science, Pilani - India | *Bachelor in Engineering(Hons.)* *Aug 2015 - Jul 2019*

Relevant Skills & Course Modules

- **Programming Languages**: Python, C, C++, MATLAB
- **Tools**: ROS (Noetic, Foxy), Gazebo, Rviz, Git, Docker, OpenCV
- **Framework/Packages**: Numpy, Pandas, Matplotlib, Scikit-learn, PyTorch, AWS
- **Courses**: Artificial Intelligence, Computer Vision, Robot Control, Deep Learning, Motion Planning, Machine Learning

Patent

- **Nandanwar, K**. Javed, H. Jamali, N. 2023. *SYSTEM AND METHOD FOR COMPLETING THREE DIMENSIONAL FACE RECONSTRUCTION.* Submitted Jan 13, 2023. (Status: With IP Lawyers)

Innovation Disclosure, Publications & Conferences

- **[Innovation Disclosure] Nandanwar, K**. Pant, A. 2020. *Auto Cleaning Feature for Radiator.* Submitted Aug 06, 2020. (Under review with John Deere)
- **[Publication] Nandanwar, K.** Rout, B.K. "Design and Trajectory Optimization of Delta Robot." *Advances in Industrial Machines and Mechanisms, Springer.* 2021. ISSN: 2195-4356
- **[Publication]** Jain, A. Bhaskar, S. **Nandanwar, K.** Bansal, H.O. "Self-Balancing of Bike Using Gyroscope and Data Driven PID Controller." *Advances in Intelligent Systems & Computing (AISC), Springer.* 2020. ISSN: 2194-5357. v989: 807-817
- **[Conference] Nandanwar, K.** et. al. "Design & Modeling of Spanwise Adaptive Wings for a Reconfigurable VTOL." Paper at *11th National Conf. & Exhibition on Aerospace & Defence Related Mechanisms* by *APJ Abdul Kalam Missile Complex, ISRO & INSARM*. Nov 2018

Work Experience

Vecros Aerial Robotics - *Computer Vision Intern* *Jan 2023 - Present*

- Designing & evaluating deep learning algorithms for Athera's Visual SLAM system to improve autonomous navigation efficiency
- Investigating visual sensing methods to attain precision in landmark detection & to simplify the indoor mapping procedure

Worcester Polytechnic Institute - *NSF Graduate Research Fellow* *Jan 2023 - Present*

- Working with Eversource Energy on autonomous robot that can patrol cables for deterring birds from congregating near utility assets
- Implementing efficient computer vision & deep learning techniques for real-time bird detection and identification

Honda Research Institute, San José - *Research Intern* *Sept 2022 - Jan 2023*

- Applied machine learning & deep learning techniques to analyze CK+ dataset, achieving 95.8% effective emotion classification
- Implemented advanced models to enhance Avatar robot's responses to mirror human states, resulting in 13% increased accuracy

Brain Corporation, San Diego - *Robotics Intern* *May 2022 - Aug 2022*

- Estimated homography between image pairs using feature correspondences for image stitching of warehouse shelves
- Used adaptive non-maximal suppression for uniform features & RANSAC for removing the outliers among the feature matches

Manipulation & Environmental Robotics Labs, WPI - *Research Assistant* *Jan 2022 - May 2022*

- Designed a parallel variable friction gripper model for improved object manipulation with precision control along object-surface
- Implemented A* algorithm to dynamically optimize navigation parameters, resulting in increased accuracy from 34% to 82%

John Deere, India - *Engineer II* *Jul 2019 - Jul 2021*

- Collaborated with American markets to streamline design of sheet metal parts, oil lines, and hoses for autonomous sprayers & tractors
- Automated design process for 32 rear-wheel-configurations by creating CREO program using C++, reducing design time by 20x

Centre for Robotics & Intelligent Systems, India - *Research Assistant* *Jan 2018 - May 2018*

- Developed mobile manipulation-based path-planner using weighted A* algorithm, enabling autonomous multi-object clean-up ops
- Incorporated vision-based navigation approaches to identify obstacles & classify them based on type, position & spatial measurements

Key Projects

MultiNet-2: Joint Semantic, Depth, & Normal Estimation *PyTorch, VGG16, ResNet*

- Developed unified encoder-decoder architecture using PyTorch to perform depth & surface estimation with semantic segmentation
- Performed experiments using VGG16 & ResNet versions as encoders with ResNet offering better performance, but longer runtime

Zhang Camera Calibration *Python, OpenCV*

- Rebuilt Zhang Camera Calibration Method to implement 8-parameter camera calibration, achieving mean re-projection error of 0.5 px
- Combined Eigen Decomposition & MLE to solve homogenous systems of linear equations for optimization of calibration parameter

Probability-based edge detection *Python, OpenCV*

- Developed simplified version of Pb(Probability of boundary) to find boundaries by examining brightness, texture & colour information
- Outperformed Canny and Sobel by suppressing false positives produced by classical methods in textured regions that show up as noise

3D reconstruction from 2D image sequence *Python, OpenCV*

- Reconstructed 3D image of Dinosaur using 10 2D-image sequence acquired from multiple angles with same camera calibration
- Gained a holistic understanding of structure from motion (SfM) technique by developing 3D image representation from 2D images

Vehicle Detection & Tracking *DeepSort, YOLO, OpenCV*

- Explored object recognition capabilities by comparing HoG based detection & YOLOv5, to maximize IoU & minimize false positives
- Evaluated a YOLOv5 model fusion with DeepSORT tracker, boosting custom tracking accuracy scores to approx. 92%

Integration of Lip Movement Recognition & Sign Language *LipNet, Inception-V4, Python*

- Implemented LipNet & Inception v4 to read the movement of lips for controlled utterances, achieving around 98% precision
- Integrated AI-driven ASL gesture recognition & Lip recognition to further enhance lip movement recognition, reaching 74% accuracy

Autonomous Valet Parking Planning *Python*

- Developed kinematic planning using nonholonomic constraints for di-wheeled robot, car & truck with trailer for autonomous parking
- Created graphical outputs of path by implementing built-in python functions resulting in instantaneous plotting of the path forecasts

Firetruck Navigation across Obstacle Field *Python*

- Crafted firetruck pathway using combinatorial & sampling-based planning methods, extinguishing 95% of fires within obstacle field
- Created obstacle field with 20% occupancy using tetrominoes & implemented Ackerman steering on firetruck robot for navigation

Self Balancing of Bike Using Gyroscope & Data Driven PID controller *SolidWorks, MATLAB, Arduino*

- Developed self-balancing mechanism for bike model to maintain +/- 13 degrees of tilt balance using Gyroscope & PID controller
- Integrated PID controller into Arduino for a virtual prototype, enhancing control accuracy & resulting in stability improvement by 80%

Trajectory Optimization of Delta Robot *Python*

- Identified and characterized complex relationships between motor torque-speed curves & robot trajectories for delta robot
- Identified optimal path to minimize energy consumption by 30%, using 8 designable control points to produce a Bezier curve output

Extra Curricular Activities

Team Garuda, BITS Pilani, India - *Founder, Team Captain* *Aug 2017 - May 2018*

- Designed Group 3-sized unmanned VTOL aircraft with unique propulsion & lift devices for increased navigability in urban locations
- Achieved high-speed forward flight and efficient hover, resulting in improved manoeuvrability & versatility for a range of applications

Achievements & Awards

- **The Higher Education Emergency Relief Fund III (HEERF III): Student Grant 2021** recipient from *U.S. Department of Education*
- **Best Undergrad Entry 2018** in 35^{th} International Aerospace Design Competition organised by *American Helicopter Society & US Army*
- **BITS Pilani Merit-Cum-Need(MCN) Scholarship** awardee in all semesters of the undergraduate program