Curriculum Vitae

Kunal Nandanwar

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Education

Worcester Polytechnic Institute, Worcester- MA *Aug 2021 - May 2023*
Master of Science in Robotics

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

Patent & Disclosures

- **Nandanwar, K**. Javed, H. Jamali, N. 2023. *SYSTEM & METHOD FOR COMPLETING THREE DIMENSIONAL FACE RECONSTRUCTION* (with USPTO)

Work Experience

FieldAI - *Autonomy Intern* *Jul 2023 - Aug 2023*
- Implemented optimal scan positioning for an automated scanning process with an SPOT robot using BIM models for interior of construction site

Vecros Aerial Robotics - *Autonomy Intern* *Jan 2023 - May 2023*
- Incorporated 2-phased techniques for autonomous image capture of external construction site for improved accuracy of 3D reconstruction

Honda Research Institute, San José - *Machine Learning Intern* *Sept 2022 - Jan 2023*
- Worked on the human-understanding model for Avatar robot designed by Honda Research Institute for human-robot interaction
- Collected & analyzed human behavioural data; estimated human satisfaction level in human-robot interaction using transfer learning

Brain Corporation, San Diego - *Robotics Intern* *May 2022 - Aug 2022*
- Detected & localized the fire extinguishers in the warehouses for fire hazard event management using YOLOv5, SLAM & BPearl Lidar
- Attended delocalization issues of robots in warehouses due to noisy sensor readings & indistinguishable LiDAR features using computer vision
- Worked on point clouds shape completion of boxes due to occlusions & sensor noises; trained segmentation model for counting boxes on pallets
- Addressed lower image quality due to motion blur; ideated different modes for scanning and cleaning, adjusted robot speed & exposure time

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

Design Engineer:
- Worked closely with product development cycle & developing agricultural narrow tractors for American and European markets
- Designed sheet metal parts, routed oil lines, hoses and electrical harnesses using CREO; supervised quality of manufactured parts
- Created a C++ script for CREO software to create 32 rear-wheel configurations, reducing design time by around **20x**

Software Perception Engineer:
- Contributed to perception and sensor fusion(Lidar and Camera) stack for the autonomous operations of tractors in dynamic fields
- Developed ML-based computer vision model for traffic signal detection with 92% precision & for weed detection with 88% precision
- Worked on obstacles & fruits detection, trunk segmentation for tree-counting amid various illumination effects; conducted field tests

Software Engineer:
- Developed a Disease Detection Mobile Application for farmers using CNN and TensorFlow, enhancing agricultural practices
- Implemented advanced image classification and data augmentation techniques, ensuring accurate plant disease detection
- Engineered seamless user experience with React JS & Native, integrated TensorFlow Serving, FastAPI, & optimized model deployment on GCP

Key Projects

3D Object Detection: Camera-Lidar-GPS Sensor Fusion *Camera, Lidar, GPS*
- Implemented a lidar-camera-GPS sensor fusion to perform a 3D object detection on the KITTI dataset using hybrid fusion approach

Multitask Learning: Joint Semantic, Depth, & Normal Estimation | *GitHub Link* *PyTorch, CNN - 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

Implementation of Generative Adversarial Networks (GANs) based research papers | *GitHub Link* *PyTorch*
- Implemented research papers related to GANs: DCGAN, Pix2Pix, Conditional GANs & CycleGAN

3D Reconstruction of a Scene Using Structure From Motion (SfM) | *GitHub Link* *Python, OpenCV*
- Deployed RANSAC to accurately match features, calculated essential matrix from fundamental matrix & estimated camera pose
- Verified chirality condition using Non-Linear Triangulation, implemented PnP & Bundle Adjustment to improve accuracy of 3D model

Visual Odometry for Localization in Autonomous Driving | *GitHub Link* *OpenCV, Python*
- Extracted features from images using vehicle's camera setup to find matches, implemented match filtering by thresholding distance
- Estimated the camera motion between subsequent photographs using PnP & Essential Matrix Decomposition to build trajectory

Zhang Camera Calibration | *GitHub Link* *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

3D Reconstruction of a scene using NeRF | *GitHub Link* *PyTorch*
- Reconstructed a 3D scene from a set of images with different viewpoints using NeRF

Vehicle Detection using classical CV and DL approaches | *Presentation Link* *DeepSort, RNN, CNN, OpenCV*
- Performed HOG feature extraction on labeled training image set, trained Linear SVM classifier & implemented sliding-window tech
- Created heatmap to follow detected vehicles and estimated bounding box on detetcted vehicles; compared results with YOLOv3

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

Deep Reinforcement Learning for Value Function Estimation *DQN*

- Experimented versions of Deep Q Learning (Double DQN, Dueling DQN) for Atari Breakout game from Open Gym AI

Deep Reinforcement learning based Continuous Control of Mobile Robot Navigation *DDPG, SAC*

- Compared deep reinforcement learning methods based on policy gradients (Deep Deterministic Policy Gradient and Soft Actor-Critic) for implementing a learning-based mapless motion planning task of Turtlebot3 robot navigation

Research Experience

DiCE Lab, San Diego State University - *Research Assistant* | *Presentation Link* *Sept 2023 - Present*

- Developing an automated framework for optimizing scan planning using BIM data for efficient data capture using quadruped robot

Eversource Energy & WPI - *NSF Graduate Research Fellow* | *Video Demo Link* *Jan 2023 - Aug 2023*

- Designed autonomous robot that patrols cables to deter birds; deployed deep learning models on Jetson Nano; integrated sensors using ROS

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

- Developed 3D motion planner using A* algorithm for improved object manipulation with precision control along object-surface

BITS Pilani, India - *Research Assistant* | *Presentation Link* *Aug 2018 - Dec 2018*

- Developed bike prototype withstanding **upto +/- 13 degree** disturbance using Gyroscope & PID controller; funded by renowned Indian OEM

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

- Developed mobile manipulator using vision-based navigation approaches to identify obstacles & classify them on type, position & dimensions

Conferences

- **Nandanwar, K.** Akhavian, R. "Optimizing Construction Site Surveys: BIM-Based Scan Planning for Autonomous Indoor Scanning." *International Symposium on Automation and Robotics in Construction(ISARC)* by *The International Association for Automation and Robotics in Construction(IAARC)*. June 2024 (Submitted-in review)
- **Nandanwar, K.** et. al. "Design & Modeling of Spanwise Adaptive Wings for a Reconfigurable VTOL." *11th National Conf. & Exhibition on Aerospace & Defence Related Mechanisms* by *APJ Abdul Kalam Missile Complex, ISRO & INSARM*. Nov 2018

Conference Proceedings

- **Nandanwar, K.** Rout, B.K. "Design and Trajectory Optimization of Delta Robot." *Advances in Industrial Machines and Mechanisms, Springer.* 2021. ISSN: 2195-4356
- 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
- **Nandanwar, K.** Rathore, D. Gupta, R. "A Novel DIY Machine Design to obtain Secondary Raw Materials from Absorbent Hygiene Waste." *Waste management as economic industry towards circular economy, Springer.* 2020. ISBN(P)-978-981-15-1619-1: 115-127

Relevant Skills & Courses

- **Languages**: Python, C/C++, MATLAB, Bash, HTML/CSS
- **Frameworks & Tools**: PyTorch, ROS (Noetic, Humble), Gazebo, Git, Docker, OpenCV
- **Libraries**: PyTorch, Numpy, Pandas, Matplotlib, Scikit-learn
- **Courses**: Artificial Intelligence, Computer Vision, Deep Learning, Motion Planning, Machine Learning Reinforcement Learning, Robot Control, Sensor Fusion

Achievements & Awards

- **Honorable mention** at AMD Robotics Innovation Challenge 2023 for innovation in the autonomous agricultural produce harvest
- **Best Undergrad Entry** in 35^{th} International Aerospace Design Competition organised by *American Helicopter Society & US Army*
- **Second Runner-up** in maiden edition of Schaeffler India 'Open Inspiration' among 110+ entries for designing self-balancing bike