Nirmal Raja Loganathan

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PhD Robotics Researcher | Perception, Manipulation, Motion Planning | Seeking Summer 2026 Internships (CPT eligible)

DOCTORAL RESEARCH:

Multi-Robot Asynchronous Planning & Vision for Cooperative Assembly *July 2025 – Present*

- Developing a dual-arm UR5e workcell for precision assembly of electronic components/PCB subassemblies.
- Integrated Robotiq 2F-85 grippers and a custom force-sensing end-effector for press-fit, alignment, and seating tasks.
- Built a ROS 2 Humble + MoveIt2 stack for collision-aware planning, synchronized dual-arm control, and on-robot execution (tool-frame control).
- Implemented stereo vision + YOLO detection/instance segmentation for small-part localization to drive pick-and-place and insertion actions.
- Calibrated stereo-to-robot extrinsics and maintained tf2 transforms for repeatable vision-to-robot alignment.
- Developed manipulation skills (approach, grasp, align, insert, seat) with recovery for pose and contact disturbances.
- Investigating RLPD from demonstrations and sim-to-real transfer robust to perception noise, calibration drift, and contact dynamics.

PROFESSIONAL EXPERIENCE:

Automation in Manufacturing and Industrial Systems Lab - Michigan Tech (on-site) **Houghton, MI, USA**
Research Engineer I *Apr 2025 – Aug 2025*

- Built a multi-sensor stack (FLIR ADK thermal, RealSense stereo, RGB) for no-light nighttime pedestrian detection under headlight glare, reduced visibility, and higher accident risk.
- Trained and deployed YOLO thermal detectors for pedestrians and nearby roadway objects, remaining reliable when visible-light cameras degrade.
- Fused thermal detections with RealSense stereo depth via 3D frustum association to estimate 3D pedestrian distance and enable online tracking in real time (about 25 FPS) with <5% error up to 40+ m.
- Improved thermal stereo calibration (CLAHE + morphological filtering), boosting successful runs by 80+%.

Advanced Power Systems Research Center - Michigan Tech (on-site) **Houghton, MI, USA**
Software Engineer – Vehicle Perception (ML & Computer Vision) *Oct 2023 – Aug 2025*

1. Project - ARPA-E NextCar ($3M DOE funded)

- Led perception system design for Level 4/5 autonomy, focusing on lateral offset and stop line estimation to enable vehicle following and autonomous braking.
- Trained a lane detection pipeline using YOLOv8 (on 5k+ images), achieving 82% accuracy on unmarked roads.
- Applied CLIP-based VLM for edge-case labeling, doubling annotation throughput, and raising long-tail recall by 11%.
- Designed a 9-point calibration algorithm for cm-level lateral offset estimation (avg. error 0.166 m), validated with GPS RTK on HD maps; *Published* at the **SAE WCX 2025** and adopted by consortium partners.
- Optimized inference to 30 FPS on NVIDIA AGX Orin, reducing latency 32% via CUDA parallelization.
- Developed a stop-line detection model combining traffic signal recognition (8K+ images) and stereo disparity, triggering braking 1.2 m earlier with 92% precision.
- Established GitLab CI/CD and Docker pipelines for automated testing and deployment of perception modules.

Sairam Techno Incubator Foundation (on-site) **Chennai, TN, India**
Lead AI Research Engineer *Mar 2021 - Aug 2023*

1. Project - Ad Astra Autonomous Rover for Mars Exploration ($1M funded)

- Developed autonomy software supporting safe navigation, astronaut detection, and reliable rover operation in unstructured outdoor terrain.
- Implemented a stereo SLAM and state-estimation pipeline, achieving 4 cm RMS pose error in controlled test runs and enabling autonomous traverses of up to 2 km.
- Designed a terrain classification pipeline using DBSCAN on stereo point clouds (14 Hz), achieving 82% F1-score while maintaining a steady traversal speed of 0.25 m/s across varied surfaces.
- Trained a Faster R-CNN (ResNet-101) model (6k images) for astronaut detection, reaching 87 mAP@0.5 (37% improvement over baseline) to support crew–rover interaction.
- Integrated a CUDA-accelerated Hybrid A* planner with MPC-based control, reducing replanning latency from 450 ms to 50 ms, lowering curvature error by 42%, smoothing 85% of turns, and increasing average cruise speed by 18%.
- Led perception, navigation, and safety integration, sustaining >90% mission uptime and resolving 50+ field issues.

2. Project - Jarvis Vision Autonomous Drone System For Flood Rescue Operation

- Built a YOLOv5-based person detector with 2D tracking and RGB-D based 3D localization on 90k+ drone frames.
- Estimated flood-water depth (drone altitude metadata + stereo disparity), evaluated with cm-level RMSE at 20 FPS.
- Developed a multi-scale encoder-decoder network for single-image 3D building detection and coarse shape reconstruction from aerial imagery.

- Integrated ArUco marker pose estimation for precision landing, achieving repeatable centimeter-level touchdown accuracy on a marked landing pad.
- CUDA-accelerated ROS 2 perception (preprocessing + inference) to reduce latency and maintain performance.

Microsoft (remote) **Chennai, TN, India**
Future Ready Talent Intern *Sep 2021 - Apr 2022*
- Built a real-time vehicle detection and clustering pipeline using Azure Computer Vision API and enhanced DBSCAN, enabling lane-specific traffic density estimation under varied conditions.
- Designed scalable workflows with Azure Functions and Cosmos DB for real-time traffic ingestion and visualization.
- Supported dynamic routing and traffic optimization by integrating detection results into live dashboards.

EDUCATION:

Ph.D. in Computational Science & Engineering | Michigan Technological University, MI, USA *Fall 2025 - Fall 2028*
M.S. in Data Science | Michigan Technological University, MI, USA *Fall 2023 - Spring 2025*
B.E. in Electronics & Communication Engineering | Anna University, TN, India *Fall 2019 - Spring 2023*

RESEARCH PUBLICATIONS:

Loganathan, Nirmal Raja Karuppiah, et al. Machine Learning-Based Lane Detection and Lateral Offset Estimation Model for Vehicle Following Applications. No. 2025-01-8020. SAE Technical Paper, 2025.

Priya, E., C. N. Savithri, and **Nirmal Raja KL**. "A machine learning approach to control a Prosthetic arm via signals from residual limb-A boon for amputees." 2023 14th International Conference on Computing Communication and Networking Technologies (ICCCNT). IEEE, 2023.

Gopalram, S., **Nirmal Raja KL** et al. "Smart valve control system for LPG cylinders using IoT." 2023 International Conference on Signal Processing, Computation, Electronics, Power & Telecommunication (IConSCEPT). IEEE, 2023.

Prathibha, S., **Nirmal Raja, K. L.**, Shyamkumar, M., & Kirthiga, M. (2021). COVID-19 Safe Guard: A Smart Mobile Application to Address Corona Pandemic. In Data Engineering for Smart Systems: Proceedings of SSIC 2021 (pp. 569-580). Singapore: Springer Singapore.

Ramesh, Reshmaja K., **KL Nirmal Raja**, M. Kirthiga, K. Varunapriyan, and S. Prabakaran. "Baridefendo-An Autonomous Safety Ensuring System." In 2021 Fourth International Conference on Microelectronics, Signals & Systems (ICMSS), pp. 1-5. IEEE, 2021.

Prathibha, Soma, R. Bhavana, **KL Nirmal Raja**, M. Kirthiga, M. Shyamkumar, and Anitha Jebamani. "Navigating Alert for Visually Impaired Using Computer Vision Aided System." 2021 4th International Conference on Computing and Communications Technologies (ICCCT). IEEE, 2021.

OTHER PROJECTS:

Human Walking Intent Prediction & Collision Avoidance for Boston Dynamics Spot Robot Dog *Fall 2024*
- Built a real-time collision avoidance system using Detectron2 (instance segmentation) and MediaPipe (33-pose keypoints), achieving 88% accuracy; automated a CVAT pipeline to label 5k+ images, improving dataset quality & model performance.
- Designed an 8-point calibration system for cm-level distance estimation, enabling precise navigation; deployed on Spot's CORE I/O at 30 FPS, integrating LiDAR & stereo camera data for enhanced spatial awareness in dynamic environments.

Unmasking Deepfakes with DFD50 - A Cutting-Edge Deep Learning Detection Model *Spring 2024*
- Developed a hybrid (ResNeXt-50 + LSTM) model for deepfake detection, achieving 97% accuracy on real-time DFDC/FF++ Datasets, with a face extraction pipeline, frame selection, and video reconstruction, ensuring precision.
- Optimized training using AdamW with StepLR scheduling and data augmentation, reducing loss from 0.67 to 0.10 and outperforming XceptionNet (F1: 96.24%).

AI-Powered Rubber Duck Code Debugging ChatBot *Fall 2023*
- Built a GPT-4 + CodeBERT debug bot with AST error flagging, cutting Python debug time 40% and boosting throughput 15%.
- Deployed LangChain microservice on AWS EKS, autoscaling for 50+ concurrent users.

TECHNICAL SKILLS:

Languages: Python, C, C++, R, Julia
AI hardware: Jetson AGX (Orin/Xavier/Nano), AStuff Spectra
Cloud: Azure (Virtual Machines, Blob Storage, Azure Functions), AWS (EC2, S3), GCP (Compute Engine, Cloud Storage)
Libraries: PyTorch, TensorFlow, Keras, scikit-learn, Pandas, NumPy, OpenCV, CUDA, MLflow, Hugging Face, Isaac Sim
Core: Data Structures & Algorithms, Data Mining & Visualization, Exploratory Data Analysis, Computer Vision, Robotics & Unmanned Vehicles, ROS/ROS2, Linux, Docker, GitLab CI/CD, Git, Digital Twins (OpenUSD, Unity)
Misc. : Industrial research, project management, publishing peer-reviewed research