

# KULBIR SINGH AHLUWALIA

[Website](#) ◊ [Google Scholar](#) ◊ [GitHub](#)

## SUMMARY

Fourth-year PhD candidate in Computer Science at UIUC, advised by Prof. Julia Hockenmaier and Prof. Girish Chowdhary. Research in physical AI for autonomous robots – natural language-conditioned navigation for mobile manipulators, vision-language model deployment (6 VLMs, 3B–72B parameters), 3D scene understanding, and multi-sensor fusion. Published at ICRA 2025 on active semantic mapping. Experienced in building production ML pipelines, edge inference for autonomous platforms, and fault detection/recovery for safety-critical robotic systems. Co-developed CS498GC: Mobile Robotics course at UIUC. Proficient in PyTorch, JAX, CUDA, Python, C++, ROS/ROS2, MoveIt2, and simulation (Gazebo, RViz2, Blender).

## EDUCATION

**Ph.D. in Computer Science**, University of Illinois at Urbana-Champaign, USA (Jun 2022–Present), GPA: 3.91/4

**M.Eng. in Robotics**, University of Maryland, College Park, USA (Aug 2019–May 2021), GPA: 3.88/4

**B.Tech. in Electrical Engineering**, Punjab Engineering College, India (Aug 2015–May 2019), GPA: 8.12/10

## RESEARCH PAPERS

- Ahluwalia, K.S.\*; Jain, C.\*; Cuaran, J.; Gummadi, S.; McGuire, M.; Sivakumar, A.; Hockenmaier, J.; Chowdhary, G. [Waypoint-Gen++](#). (In Preparation for IEEE RAL)
- Ahluwalia, K.S.\*; Jain, C.\*; Cuaran, J.; Gummadi, S.; McGuire, M.; Sivakumar, A.; Hockenmaier, J.; Chowdhary, G. [Waypoint-Gen: Learning Grounded Waypoint based Navigation for Mobile Manipulators](#). Coordinated Science Laboratory Student Conference (CSL SC) 2026, Machine Learning, Generative AI, and Signal Processing Session.
- Cuaran, J.; Ahluwalia, K.S.; Koe, K.; Uppalapati, N.K.; Chowdhary, G. [Active Semantic Mapping with Mobile Manipulator in Horticultural Environments](#). (Accepted to ICRA 2025) [[Project Website](#)] [[arXiv PDF](#)] [[arXiv](#)]
- Rangwala, M.; Liu, J.; Ahluwalia, K.S.; Ghajar, S.; Dhama, H.S.; Tracy, B.F.; Tokekar, P.; Williams, R.K. [DeepPaSTL: Spatio-Temporal Deep Learning Methods for Predicting Long-Term Pasture Terrains Using Synthetic Datasets](#). *Agronomy* 2021, 11, 2245. [[Link to published paper](#)]
- Liu, J.; Rangwala, M.; Ahluwalia, K.S.; Ghajar, S.; Dhama, H.S.; Tracy, B.F.; Tokekar, P.; Williams, R.K. “[Intermittent Deployment for Large-Scale Multi-Robot Forage Perception: Data Synthesis, Prediction, and Planning](#)”, 2021. (published at IEEE TASE) [[arXiv](#)]

## EXPERIENCE

**Earthsense Inc., Urbana, IL, USA**

*May 2025–Aug 2025*

**Position:** AI Intern

- Built an end-to-end ML pipeline for language-conditioned waypoint generation, integrating 2D and 3D planners into a production-oriented autonomy stack for mobile manipulator navigation.
- Deployed Grounded SAM2 for automated large-scale dataset labeling, increasing training-data throughput for vision-model development.
- Benchmarked and deployed six large-scale VLMs (Molmo-7B-D, Gemma-3-27B, Qwen-2.5-VL-72B, Qwen3-30B-A3B, Llama4-Scout, Spatial-VLM) on GPU infrastructure, comparing inference efficiency, memory behavior, and deployment tradeoffs for production use.

**Teaching Assistant, CS444 & CS498GC, UIUC**

*Spring 2024, 2025, 2026; Fall 2025*

**Courses:** Deep Learning for Computer Vision (CS444, Dr. Svetlana Lazebnik); co-developed [CS498GC: Mobile Robotics](#) (ROS2, MoveIt2, SLAM, mobile manipulators). **Highlight:** [SLAM-ing Mars](#). Nominated for TA award by Prof. Lazebnik (Spring 2025).

**University of Illinois, Distributed Autonomous Systems Lab, Hockenmaier Lab**

*Aug 2022–present*

Graduate Research Assistant

**Mentors:** Dr. Girish Chowdhary & Dr. Julia Hockenmaier

- Built 3D volumetric scene representations and semantic voxel maps for autonomous robot navigation, processing multi-sensor data streams (LiDAR, RGB, IMU) in real time for spatial reasoning and scene understanding.
- Developed natural language-conditioned waypoint generation pipelines for mobile manipulators using VLM-based filtering, BEV representations, and MPPI trajectory selection, enabling vision-language grounded navigation in unstructured outdoor environments.
- Designed fault detection and recovery pipelines for distributed robotic systems, categorizing failure modes and building automated recovery for safety-critical autonomous operation.

## TECHNICAL SKILLS

**Languages**

Python, C++, MATLAB

**Frameworks**

PyTorch, JAX, TensorFlow, Transformers, Diffusers, CUDA, Stable Diffusion

**Robotics**

ROS, ROS2, MoveIt, MoveIt2, RViz, RViz2, Gazebo, Blender, Docker, Linux, Git

**Probabilistic/RL**

EKF, GMM/EM, MDPs, Bayesian State Estimation, Policy Optimization

**Libraries**

NumPy, OpenCV, SciPy, Pandas, scikit-learn

## PROJECTS

- **Enhancing Stereo Depth Maps through RGBD-Conditioned Generative Models**
  - Designed a conditional diffusion model fusing RGB and noisy stereo depth inputs to generate accurate metric depth maps.
  - Fine-tuned Stable Diffusion V2 (Marigold-style training pipeline) on SimSense simulation data for realistic depth synthesis.
  - Outperformed Marigold and Depth-Anything-V2 on IRS, VKITTI, and NYUv2 benchmarks by up to 46% Abs Rel improvement.
- **SLAM from 2D LiDAR Data** - Implemented simultaneous localization and mapping using split-and-merge line extraction from 2D LiDAR point clouds.
- **Visual Odometry for Vehicle Motion Estimation** - Estimated ego-motion of a car from monocular camera using feature matching and essential matrix decomposition.
- **Multi-Sensor Fusion via Extended Kalman Filter** - Bayesian probabilistic state estimation fusing GPS and wheel encoder data for robust localization of a mobile robot platform.
- **Lane Detection and Turn Prediction for Self-Driving Car**
  - Developed lane detection using histogram-based sliding window analysis and polynomial curve fitting for autonomous driving perception.
  - Implemented bird's-eye-view perspective transform for lane visualization.
- **Multi-Agent Coordination (UAV-UGV)** - Implemented persistent monitoring using coordinated multi-robot (aerial + ground) planning algorithms for distributed systems.
- **GestureGAN Optimization for Efficient Inference** - Optimized cross-view image generation using MobileNet backbone, achieving 5.7X parameter reduction for compute-efficient deployment.
- **Color-Based Probabilistic Segmentation via GMM/EM**
  - Implemented Gaussian Mixture Models with Expectation-Maximization for probabilistic color segmentation in video sequences.
- **VAE and GAN Implementation** - Implemented Variational Autoencoder and Generative Adversarial Network architectures for image generation tasks.
- **Reinforcement Learning for Sensor-Based Assessment (SPIE 2020)** - Integrated reinforcement learning with supervised learning for non-destructive quality assessment using near-infrared spectroscopy.