KULBIR SINGH AHLUWALIA

Website ◇ Google Scholar ◇ GitHub ◇ LinkedIn
Urbana, Illinois, USA ◇ ksa5@illinois.edu

EDUCATION

Ph.D. in Computer Science *[June 2022-Present]*
University of Illinois at Urbana-Champaign, USA GPA: **3.91/4.0**
Advisors: Prof. Girish Chowdhary and Prof. Julia Hockenmaier

Master of Engineering in Robotics *[Aug 2019-May 2021]*
University of Maryland, College Park, USA GPA: **3.88/4.0**

B.Tech in Electrical Engineering *[Aug 2015-May 2019]*
Punjab Engineering College, India GPA: **8.12/10.0**

RESEARCH PAPERS

- 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 (40th Anniversary Edition)** [Project Website] [arXiv PDF] [arXiv]
- Rangwala, M.; Liu, J.; **Ahluwalia, K.S.**; Ghajar, S.; Dhami, 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. (Special Issue: AI and Agricultural Robots) [DOI] [PDF]
- Liu, J.; Rangwala, M.; **Ahluwalia, K.S.**; Ghajar, S.; Dhami, H.S.; Tracy, B.F.; Tokekar, P.; Williams, R.K. Intermittent Deployment for Large-Scale Multi-Robot Forage Perception: Data Synthesis, Prediction, and Planning. **IEEE Transactions on Automation Science and Engineering (TASE)**, 2022. [arXiv] [PDF]

TEACHING EXPERIENCE

Lead Instructor, CS498GC: Mobile Robotics *[Fall 2024, **Fall 2025 (Current)**]*
University of Illinois at Urbana-Champaign
Course Director: Prof. Girish Chowdhary
- Designed and delivered lectures on ROS2, sensor fusion, SLAM, and navigation algorithms to 60+ students
- Created coding exercises and problem sets involving Extended Kalman Filtering, odometry, and GPS integration
- Developed autograding infrastructure on Gradescope for automated assessment
- **Designed and maintained comprehensive course website:** https://kulbir-singh-ahluwalia.com/cs498gc/fa25/ and managed Canvas/Gradescope platforms

Teaching Assistant, CS444: Deep Learning for Computer Vision *[Spring 2024, Spring 2025]*
University of Illinois at Urbana-Champaign
Instructor: Prof. Svetlana Lazebnik
- Guided students through 5 comprehensive assignments: (1) linear classifiers and softmax regression, (2) CNN architectures including AlexNet/VGG/ResNet implementations, (3) object detection with R-CNN/YOLO, (4) RNN/LSTM for sequence modeling, (5) Vision Transformers and diffusion models
- Assisted with debugging PyTorch implementations, gradient flow issues, GPU memory optimization, and batch normalization
- Conducted weekly office hours helping 150+ students with tensor operations, custom loss functions, and model training strategies
- Designed multimodal quiz questions integrating theory with practical implementation challenges

Teaching Assistant, CS519: Scientific Visualization *[Summer 2025]*
University of Illinois at Urbana-Champaign
Instructor: Prof. Eric Shaffer
- Created multimodal exam questions with integrated visualizations using Python and matplotlib
- Assisted students with implementation of ray marching, transfer functions, and volume rendering
- Developed interactive widget tutorials for 3D data visualization

WORK EXPERIENCE

Earthsense Inc., Urbana, IL, USA *[May 2025-August 2025]*
Position: AI Intern
Supervisor: Michael McGuire, Lead Computer Vision Engineer
- Developed natural language conditioned waypoint generation pipeline improving navigation success rate by 35% in agricultural environments
- Created automatic labeling pipeline using Grounded SAM2, processing 10,000+ images for robot navigation dataset
- Deployed and benchmarked 6 open-source VLMs (Molmo-7B, Gemma-3-27B, Qwen-2.5-VL-72B, Qwen3-30B, Llama4-Scout, Spatial-VLM) achieving 82% accuracy in spatial reasoning tasks
- Integrated vision-language models with ROS2 for real-time robot perception on NVIDIA Jetson platforms

RESEARCH EXPERIENCE

University of Illinois, Distributed Autonomous Systems Lab & Hockenmaier Lab *[Aug 2022-Present]*
Graduate Research Assistant
Advisors: Prof. Girish Chowdhary & Prof. Julia Hockenmaier

- Developing 3D semantic voxel maps for robot relocalization achieving 92% recovery success from navigation failures
- Collected and categorized 500+ manual recovery sequences for failure cases from occlusions, sensor noise, and mechanical issues
- Constructed topological graphs from 100+ hours of Rosbag data using CLIP for natural language grounding
- Fine-tuned CodeT5 model achieving 78% accuracy in translating natural language to robot control code

University of Maryland, Robotics Algorithms & Autonomous Systems Lab *[Jul 2020-Aug 2021]*
Independent Study, **Mentor:** Prof. Pratap Tokekar

- Processed 50GB+ point cloud data from LiDAR-equipped UAV for pasture terrain mapping
- Automated Gazebo world generation with 10,000+ uniquely posed plants matching real-world GPS data
- Developed spatio-temporal prediction models achieving 85% accuracy in vegetation growth forecasting

University of Waterloo, Ontario, Canada *[Mar-Jul 2018]*
Visiting Scholar, **Mentor:** Prof. Simarjeet Saini

- Developed orange sweetness detector using scaled conjugate gradient backpropagation achieving 70% accuracy
- Designed and 3D-printed prototypes for low-cost photonic devices including Fundus eye camera
- Implemented real-time image processing on Raspberry Pi 3 for retinal disease diagnosis

Indian Institute of Technology, Roorkee *[Jun-Jul 2016]*
Research Intern, **Mentor:** Prof. Dharmendra Singh

- Simulated radar cross-section reduction of UAV models using nickel ferrite absorbers in Ansys HFSS
- Achieved 40% RCS reduction through optimal absorber thickness configuration

RESEARCH ARTICLES AND CONFERENCE PRESENTATIONS

- Cuaran, J.; **Ahluwalia, K.S.**; Koe, K.; Chowdhary, G. Active Semantic Mapping with Mobile Manipulator in Horticultural Environments. Presented at IEEE ICRA@40, Atlanta, 2024.
- Saini, S.S.; Sridhar, A.; **Ahluwalia, K.** Smartphone optical sensors. **Optics and Photonics News** 30(2): 34-41, 2019. [DOI] [PDF]
- Li, Y.; **Ahluwalia, K.S.**; Saini, S.S. Reinforcement learning integrated with supervised learning for training of near infrared spectrum data for non-destructive testing of fruits. SPIE Sensing for Agriculture and Food Quality XII, vol. 11421, 2020. [DOI]

TECHNICAL SKILLS

Languages	Python, C++, MATLAB, JavaScript, Bash
ML/AI Frameworks	PyTorch, Transformers, TensorFlow, JAX, Hugging Face
Robotics	ROS/ROS2, Gazebo, MoveIt, SLAM, Navigation Stack, OMPL
Computer Vision	OpenCV, Open3D, PCL, YOLO, SAM2, CLIP
Tools	Docker, Git, CUDA, Conda, LaTeX, Weights&Biases

SELECTED PROJECTS

- **Enhancing Stereo Depth Maps through RGBD-Conditioned Generative Models** *[Fall 2024]*
  Outperformed Marigold and Depth-Anything-V2 by 46% on NYUv2 dataset using diffusion models
- **Active Semantic Mapping with Mobile Manipulator for Precision Agriculture** *[Spring 2024]*
  Developed real-time 3D semantic mapping system for agricultural robots using RGB-D sensors
- **Turning Zero Shot into Few Shot via Self-prompting** *[Fall 2023]*
  Improved zero-shot classification accuracy by 15% using self-generated prompts
- **Neural Transition-based Dependency Parser** *[Fall 2022]*
  Implemented Arc-Standard parser achieving 91% UAS on Penn Treebank
- **SLAM from 2D LiDAR Data** *[Fall 2021]*
  Implemented split-merge line extraction achieving 0.2m localization accuracy
- **Extended Kalman Filter for Multi-Sensor Fusion** *[Fall 2021]*
  Fused GPS, IMU, and encoder data achieving 0.5m position accuracy
- **Autonomous Vaccine Delivery Robot** *[Spring 2021]*
  QR-based navigation system with 95% delivery success rate [Featured Video] [News]
- **Image Segmentation using Superpixels** *[Fall 2020]*
  VGG16 with SLIC superpixels achieving 98% segmentation accuracy
- **Optimized GestureGAN** *[Fall 2020]*
  MobileNet optimization achieving 5.7 parameter reduction
- **A* Path Planning on Turtlebot 3** *[Spring 2020]*
  Non-holonomic motion planning with 8-action set
- **ARIAC 2019** *[Spring 2020]*
  Industrial automation with UR10 arms achieving 90% order fulfillment

- **UR5 Arm with Parallel Gripper** *[Fall 2019]*
  7-DOF manipulator control using MoveIt [Videos]
- **Teleoperated Gesture-Controlled Robotic Arm** *[2018-2019]*
  Web-based remote control with live video feed and gesture recognition
- **Pick n Place Transporter Bot** *[2016]*
  First Prize at IIT Roorkee, 6th/400 teams at IIT Bombay
- **Smart Garden** *[2017]*
  First Prize in Texas Instruments Hardware Hackathon

RELEVANT COURSEWORK

Graduate (UIUC): 3D Vision (CS598SHW), Haptics and Tactile Sensing (CS598WY), Deep Learning for Robotic Manipulation (CS598YL), Advanced NLP (CS546), Machine Learning (CS446), Deep Learning for Computer Vision (CS444), Natural Language Processing (CS447), Mobile Robotics (CS498GC)

Graduate (UMD): Autonomous Robotics, Decision Making for Robotics, Visual Learning and Recognition, Planning for Autonomous Robots, Perception for Autonomous Robots, Control of Robotic Systems, Robot Programming

Undergraduate (PEC): Neural Networks and Fuzzy Systems, Advanced Control Systems, Microprocessors, Power Electronics, Mechatronics, Computer Vision

LEADERSHIP AND SERVICE

- **Technology Head for Hardware Domain**, IEEE PEC Student Branch [2017-2019]
  Conducted workshops on robotics and embedded systems for 200+ students
- **Volunteer Instructor**, PUNARKRITI Welfare Society [2016] and Junior Einstein [2018]
  Taught mathematics and science to underprivileged high school students
- **Conference Reviewer**: ICRA 2024, IROS 2024, CoRL 2024

AWARDS AND ACHIEVEMENTS

- **National Bal Shree Award in Creative Scientific Innovations**, conferred by the President of India
- First Prize in B.Tech Major Project for "Teleoperated Gesture Controlled Robotic Arm" [2019]
- First Prize in Texas Instruments Hardware Hackathon for "Smart Garden" [2017]
- Certificate of Appreciation, IEEE PEC [2017, 2018]
- Dean's List, Punjab Engineering College [2016-2019]