Senthil Hariharan Arul

Phone: 240-706-5771 | **Email:** sarul1@umd.edu | **LinkedIn:** /in/senthilarul | **GitHub:** /senthilarul | **Website:**senthilarul.github.io

Education

University of Maryland — College Park, USA
Ph.D. in Electrical and Computer Engineering, Robotics (CGPA 3.81/4) — *Aug 2019 – Exp. May 2025*
Advisor: Prof. Dinesh Manocha

National Institute of Technology — Tiruchirappalli, India
B.Tech in Instrumentation and Control Engineering (CGPA 8.99/10) — *Aug 2013 – May 2017*

Research Experience

Research Student Associate (Current Role) — Feb 2025 – May 2025
Honda Research Institute (HRI) — *San Jose, CA, USA*

Project: Behavior Modeling and Interactive Prediction (Mentor: Dr. David Isele)

• Developing predictive behavior models and interactive motion planning for complex real-world autonomous driving scenarios.

Graduate Research Assistant — Jan 2020 – Jan 2025
University of Maryland — *College Park, USA*

Project: Multi-Robot Motion Planning (Advised by Prof. Dinesh Manocha)

• Led research on decentralized multi-agent navigation algorithms using geometric methods, optimization, and reinforcement learning, with expertise in decision-making under uncertainty.

• Improved decentralized multi-robot navigation success by 24% using Multi-Agent RL, visual transformers, and learned selective communication.

• Mentored undergraduate and graduate students, leading to multiple co-authored publications in top robotics conferences.

Applied Scientist Intern — May 2023 – Aug 2023
Amazon Lab126 — *Sunnyvale, CA, USA*

Project: Object-Goal Navigation (Mentor: Dhruva Kumar)

• Developed an object-goal navigation approach leveraging Visual Language Models (VLMs), improving deployment robustness in real-world.

• Developed a novel probability-based mapping and search approach to mitigate occlusions and object displacement.

Applied Scientist Intern — May 2022 – Aug 2022
Amazon Lab126 — *Sunnyvale, CA, USA*

Project: Reducing Robot Freezing Behavior (Mentor: Dr. Jong Jin Park)

• Developed unconstrained MPC cost formulations ensuring safety and stability in probabilistic navigation scenarios, which were later implemented on real-world autonomous robots to significantly reduce freezing.

Research Intern — May 2016 – Aug 2016
McMaster University — *Hamilton, ON, Canada*

Project: Autonomous Collaborative Robotic Arm (Advisor: Prof. Gary Bone)

• Developed vision-based automated grasping and collision avoidance for robotic arms using 3D point clouds, improving safety and efficiency in collaborative environments.

Technical Skills

Programming Languages: C++, Python, MATLAB

Deep Learning & AI: TensorFlow, PyTorch

Tools and Simulators: ROS, Point Cloud Library (PCL), OpenCV, Git, Gazebo, MuJoCo, Isaac Sim

Select Coursework

Robotics (ENEE769M), Robotics Software Dev. (ENPM 808X), Perception (ENPM 673), AI Planning (CMSC 722), Nonlinear Control (ENEE 661), Optimal Control (ENEE 664), Convex Opt. (ENEE 662), Differentiable Prog. (CMSC 838B), Image Understanding (ENEE731)

Invited Talks

Amazon Lab126, Consumer Robotics Symposium Mar 2024
Talk: Navigating the Everyday: Improving robot mobility in household scenarios

FLAIR Talk Series, University of Oxford Apr 2023
Talk: Decentralized Multi-Agent Navigation in Complex Scenarios

Scholarly Engagements and Contributions

Technical Reviewer: T-RO | RA-L | ICRA '21, '22, '23' 24, '25 | IROS '20, '21, '22, '23, '24 | RSS '25

Teaching Assistant: ENEE 460 - Control Systems (Fall 2019), ENEE 641 - Mathematical Foundations for Computer Eng. (Fall 2024)

Open-Source Contribution: D-ORCA: Multi-UAV Collision Avoidance Package (Presented at ROSCon 2019)

Publications

Journal Articles

[1] S. H. **Arul**, A. Sathyamoorthy, S. Patel, M. Otte, H. Xu, M. Lin, and D. Manocha. "LSwarm: Efficient Collision Avoidance for Large Swarms With Coverage Constraints". In: *IEEE Robotics and Automation Letters* **(RA-L)** (2019).

[2] S. H. **Arul** and D. Manocha. "DCAD: Decentralized Collision Avoidance With Dynamics Constraints for Agile Quadrotor Swarms". In: *IEEE Robotics and Automation Letters* **(RA-L)** (2020).

[3] S. H. **Arul** and D. Manocha. "SwarmCCO: Probabilistic Reactive Collision Avoidance for Quadrotor Swarms under Uncertainty". In: *IEEE Robotics and Automation Letters* **(RA-L)** (2021).

[4] V. Zinage, S. H. **Arul**, D. Manocha, and S. Ghosh. "3D-OGSE: A Probabilistically Complete Motion Planner in Obstacle-Cluttered Unknown Environments". In: *IEEE Robotics and Automation Letters* **(RA-L)** (2023).

Conference Proceedings

[5] S. Patel, S. H. **Arul**, P. Dhulipala, M. C. Lin, D. Manocha, H. Xu, and M. Otte. "Multi-Agent Ergodic Coverage in Urban Environments". In: *2021 IEEE International Conference on Robotics and Automation* **(ICRA)**. 2021.

[6] S. H. **Arul** and D. Manocha. "V-RVO: Decentralized Multi-Agent Collision Avoidance using Voronoi Diagrams and Reciprocal Velocity Obstacles". In: *IEEE/RSJ International Conf. on Intelligent Robots and Systems* **(IROS)**. 2021.

[7] S. H. **Arul** and D. Manocha. "CGLR: Dense Multi-Agent Navigation Using Voronoi Cells and Congestion Metric-based Replanning". In: *2022 IEEE/RSJ International Conference on Intelligent Robots and Systems* **(IROS)**. 2022.

[8] A. Agrawal, S. H. **Arul**, A. S. Bedi, and D. Manocha. "DC-MRTA: Decentralized Multi-Robot Task Allocation and Navigation in Complex Environments". In: *IEEE/RSJ International Conf. on Intelligent Robots and Sys.* **(IROS)**. 2022.

[9] S. H. **Arul**, J. J. Park, and D. Manocha. "DS-MPEPC: Safe and Deadlock-Avoiding Robot Navigation in Cluttered Dynamic Scenes". In: *2023 IEEE/RSJ International Conference on Intelligent Robots and Systems* **(IROS)**. 2023.

[10] S. H. **Arul**, J. J. Park, and D. Manocha. "Unconstrained Model Predictive Control for Robot Navigation under Uncertainty". In: *2024 IEEE International Conference on Robotics and Automation* **(ICRA)**. 2024.

[11] S. H. **Arul**, D. Kumar, V. Sugirtharaj, R. Kim, X. Qi, R. Madhivanan, A. Sen, and D. Manocha. "VLPG-Nav: Object Navigation Using Visual Language Pose Graph and Object Localization Probability Maps". In: *IEEE/RSJ International Conference on Intelligent Robots and Systems* **(IROS)**. 2024.

[12] S. H. **Arul**, A. S. Bedi, and D. Manocha. "When, What, and with Whom to Communicate: Enhancing RL-based Multi-Robot Navigation through Selective Communication". In: *IEEE/RSJ* **IROS**. 2024.

[13] K. Weerakoon, M. Elnoor, G. Seneviratne, V. Rajagopal, S. H. **Arul**, J. Liang, M. K. M. Jaffar, and D. Manocha. "BehAV: Behavioral Rule Guided Autonomy Using VLMs for Robot Navigation in Outdoor Scenes". In: *IEEE* **ICRA**. 2025.