Saurav Agarwal

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RESEARCH INTERESTS

My current research focuses on developing theoretical foundations and designing efficient algorithms for coordination and motion planning of robots. My Ph.D. thesis unifies coverage of point, curve, and area features in environments into a novel generalized coverage framework, formalized as optimization problems on graphs. We used the formalization to design approximation algorithms with provable guarantees and heuristic algorithms for fast large-scale applications, validating them extensively in simulations and experiments. Prior to the Ph.D., my research comprised analyzing and designing mechanisms and parallel robots using optimization techniques. My experience includes using symbolic algebra systems, developing open-source libraries, leading research projects, and mentoring students. Building on the current work, my long-term research goal is to develop autonomous systems for gathering reliable information about the environment. I strive to develop theory and scalable algorithms while incorporating artificial intelligence for energy-efficient and risk-aware robot motion planning and swarming.

EDUCATION

1. **University of North Carolina at Charlotte, USA**
   Ph.D. candidate, Computer Science   (August 2016–present)
   Thesis: Generalized Coverage using Multiple Robots: Theory, Algorithms and Experiments

2. **National Institute of Technology, Durgapur, India**
   B. Tech., Mechanical Engineering   (July 2009–May 2013)
   Thesis: Development and analysis of fault tolerant gait patterns in legged robots

PUBLICATIONS

Papers Under Review
1. **S. Agarwal** and S. Akella, "The Single Robot Line Coverage Problem: Theory, Algorithms and Experiments" (under review), The International Journal of Robotics Research (IJRR), December 2021.

Journal Articles
1. **S. Agarwal** and S. Akella, "Area Coverage With Multiple Capacity-Constrained Robots," IEEE Robotics and Automation Letters, vol. 7, no. 2, April 2022. Selected for presentation at the IEEE International Conference on Robotics and Automation (ICRA), May 2022.

2. **S. Agarwal** and S. Bandyopadhyay, "Design of Six-bar Function Generators using Dual-order Structural Error and Analytical Mobility Criteria," Mechanism and Machine Theory, Elsevier, vol. 116, October 2017.

3. **S. Agarwal**, R. A. Srivatsan and S. Bandyopadhyay, "Analytical Determination of the Proximity of Two Right-circular Cylinders in Space," Journal of Mechanisms and Robotics, ASME, vol. 8, no. 4, March 2016.

4. **S. Agarwal**, A. Mahapatra and S. S. Roy, "Dynamics and Optimal Feet Force Distributions of a Realistic Four-legged Robot," IAES International Journal of Robotics and Automation (IJRA), vol. 1, no. 4, December 2012.

Conference Papers

1. **S. Agarwal** and S. Akella, "The Correlated Arc Orienteering Problem" (to appear), Algorithmic Foundations of Robotics XV (WAFR), Springer, June, 2022.

2. **S. Agarwal** and S. Akella, "Approximation Algorithms for the Single Robot Line Coverage Problem," Algorithmic Foundations of Robotics XIV (WAFR), Springer, June, 2020.

3. **S. Agarwal** and S. Akella, "Line Coverage with Multiple Robots," IEEE International Conference on Robotics and Automation (ICRA), May 2020.

4. **S. Agarwal** and S. Akella, "Simultaneous Optimization of Assignments and Goal Formations for Multiple Robots," IEEE International Conference on Robotics and Automation (ICRA), May 2018.

5. A. Nag, V. Reddy, **S. Agarwal** and S. Bandyopadhyay, "Identifying Singularity-free Spheres in the Position Workspace of Semi-regular Stewart Platform Manipulators," Advances in Robot Kinematics, June 2016.

6. **S. Agarwal** and S. Bandyopadhyay, "Optimal Synthesis of Six-Bar Function Generators," 14th International Federation for the Promotion of Mechanism and Machine Science (IFToMM) World Congress, October 2015.

7. J. Kilaru, M. K. Karnam, **S. Agarwal** and S. Bandyopadhyay, "Optimal Design of Parallel Manipulators using a Novel Dynamic Performance Index and Singularity Free Workspace," 14th International Federation for the Promotion of Mechanism and Machine Science (IFToMM) World Congress, October 2015.

8. M. K. Karnam, R. Kalla, A. Nag, **S. Agarwal** and S. Bandyopadhyay, "Improved Tracking Performance Using Dual and Double Dual Feedback Loops," Indian Control Conference, January 2015.

RESEARCH PROJECTS

Research Assistant, **University of North Carolina at Charlotte**, USA   (August 2016–present)
1. NSF PFI-TT: Intelligent Flight Planning of Multiple Drones for Power Line Inspection
   - Design of algorithms for efficient inspection of power lines and associated structures
   - Approximation algorithm for single UAV and heuristic algorithm for multiple UAVs
   - Partnering with the industry to verify algorithms

2. DARPA OFFSET: Autonomous Robot Swarms for Urban Coverage
   - Design of algorithms for road coverage of large networks using multiple robots
   - Fast and efficient heuristic algorithms for online planning

3. UNC IPG: Synchronous Mapping of Coastal Habitat Change Using Multiple Unmanned Aerial Vehicles
   - Design of algorithms for area coverage of large coastal regions using multiple robots
   - Efficient algorithms that respect battery capacity constraints and make use of wind information

4. NSF EAGER: Cybermanufacturing: Smartphone Actuated Optical Lab-on-a-Chip Systems for Biomanufacturing and Analysis
   - Simultaneous optimization of variable goal formation and assignment of robots

Project Associate, **Indian Institute of Technology Madras**, India   (June 2013–June 2016)
1. SDD, Indian army: Design and development of 3-DOF motion seat for a payload of 150kg
   - Design of a parallel manipulator for off-road driving simulation
   - Computing the singularity free workspace and improving dynamic performance to reduce actuator size

2. Systemantics: Development of a 3-RRR parallel robot for industrial applications
   - Computing and optimizing for large singularity free workspace

- Designing robot to have good dynamic performance for sharp turns

3. BEML: Stability analysis of load haul dumper (LHD)
   - Study of dynamics for toppling instability
   - Computation of operation envelope and suggestions in design modification

4. Whirlpool GTEC: Investigation of expanding air bag concept to dry clothes in a vertical axis washing machine
   - Analysing the pressure developed due to centrifugal action on clothes
   - Proposed a feasible design for introducing expanding air bags to dry clothes in present system

Central Mechanical Engineering Research Institute, Durgapur, India
Research Intern under Scientist Abhijit Mahapatra   (May 2012–July 2012)
Kinematic and dynamic modeling of hexapod robot and its simulation for straight and rough path
   - Development and design of a hexapod robot using CATIA (CAD software)
   - Kinematics, dynamics and trajectory planning performed for smooth and rough terrain

SERVICE AND MENTORSHIP

1. **Reviewer:**
   - IEEE Robotics and Automation Letters (RA-L)
   - IEEE International Conference on Robotics and Automation (ICRA)
   - IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)
   - IEEE International Conference on Advanced Robotics (ICAR)
   - International Workshop on the Algorithmic Foundations of Robotics (WAFR)

2. **Student Mentorship:**
   - Satish Balasubramanium and Sheetal Patil, Masters: Development of website for coverage algorithms
   - Sakshi Srivastava, Masters: Development of ROS packages for TurtleBot
   - Prakruthi Reddy, Undergraduate Charlotte Research Scholar: Clustering algorithms for road networks
   - Derrick Zipperer, Undergraduate: Interfacing with the industry for applications of coverage algorithms

3. **Extra-curricular Activities**
   - RSS 2021 Robotics × Arts Workshop: Algorithms for visually appealing formations with robots
   - President, Society of Automotive Engineers (SAE), NIT Durgapur chapter, 2013
   - Training and placement representative, National Institute of Technology, Durgapur, India, 2013
   - Student district operation board, American Society of Mechanical Engineers India, 2011
   - Philately: Awarded silver medal at ARIPEX philately exhibition, Arizona, USA, 2005

REFERENCES

1. **Srinivas Akella** (sakella@uncc.edu), Ph.D. advisor.
   Professor, Computer Science, University of North Carolina at Charlotte, USA.

2. **Min Shin** (mcshin@uncc.edu), dissertation committee member.
   Professor and Chair, Computer Science, University of North Carolina at Charlotte, USA.

3. **Sandipan Bandyopadhyay** (sandipan@iitm.ac.in), advisor at IIT Madras.
   Associate Professor, Engineering Design, Indian Institute of Technology Madras, India.