R. Arun Srivatsan

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SPECIALTIES

Robotics |Probabilistic Estimation |Geometric Vision |Machine Learning |SLAM |3D Reconstruction |Point Cloud Registration| Manipulation |Mechanism Design

EDUCATION

Carnegie Mellon University — *Pittsburgh, USA*
PhD and MS in Robotics — 2013- 2018
Thesis: Probabilistic approaches for pose estimation

Indian Institute of Technology Madras — *Chennai, India*
M. Tech and B. Tech in Robotics — 2007-2012

SKILLS

Software	Python, Matlab, C/C++ APIs, ROS, Tensorflow, Pytorch, Git, Solidworks, Mathematica
Hardware	Arduino, 3D printing, Laser cutting, Machining,

EXPERIENCE

Multimodal Perception — 2018 – present
Project Scientist, Carnegie Mellon University

- Developing systems, tools and algorithms for simultaneous localization and mapping in robotic surgeries (Body-SLAM) using vision and touch sensing. [Video]
- Using deep learning techniques to perform tasks such as classification, segmentation, registration and hole filling for point clouds.

Probabilistic Approaches to Pose Estimation — 2013 – 2018
Graduate research assistant, Carnegie Mellon University

- Developed linear Bayesian filtering algorithms for pose estimation. Applications include 3D reconstruction, hand-eye calibration, SLAM, manipulation, structure from motion and object tracking. [Video]
- Developed a generalized framework for registration of point clouds. The approach generalizes and improves existing methods such as ICP, CPD, G-ICP, EM-ICP, and GoICP. [Video] [Video]
- Developed an augmented reality system for minimally invasive robotic surgeries. The system allows for real time model update and intuitive dynamic annotations by surgeons. [Video]

Kinematic, dynamics, control and singularity analysis of spatial parallel manipulators — 2010- 2012
Graduate research assistant, Indian Institute of Technology Madras

- Designed and developed a parallel manipulator with applications in aviation training/trauma recovery. [Video]
- Developed a concept called safe working zones (SWZ), which helps find the workspace of a manipulator free of singular configurations, link interferences and not restricted by the physical limits of the joints.
- Used population-based nonconvex optimization (NSGA) to design coupler curves for four bar and six bar mechanisms.

Design and fabrication of a new parallel manipulator — Summer 2011
Undergraduate researcher, Centre for artificial intelligence and robotics

- Conceptualized, designed and prototyped a novel 3 DoF parallel manipulator with reconfigurable degrees of freedom.

Development of exoskeleton for shoulder complex — Summer 2010
Undergraduate researcher, Simon Fraser University

- Prototyped an exoskeleton for shoulder complex for rehabilitation of paralytic and stroke affected people.

Concave hull for free-form curves — Spring 2010
Summer intern, Indian Institute of Technology Madras

- Developed a concept called concave hull to find a lower bounding envelope for a set of input free-form curves.

HONORS AND AWARDS

Recipient of the Centre for Machine Learning and Health (CMLH) Fellowship in Digital Health.	2017 - 2018
Best paper finalist at the International Symposium on Medical Robotics (ISMR).	2018
Travel award from the International Symposium on Medical Robotics (ISMR).	2018
Travel award from the Workshop on the Algorithmic Foundations of Robotics (WAFR).	2016
Travel award from the Hamlyn Symposium.	2016
GSA/Provost conference funding from Carnegie Mellon University.	2016
Gold medalist, *Institute Merit Prize* for highest CGPA among students of all departments in IITM.	2012
Institute Merit Prize for highest CGPA among all students of the Department of Engineering Design.	2012
Won third prize in *ASME International Student Mechanism and Robot Design Contest*, Washington DC.	2011

PUBLICATIONS

1. **R. Arun Srivatsan**, Nicolas Zevallos, Prasad Vagdargi and Howie Choset, "Registration with a small number of sparse measurements", in the International Journal of Robotic Research (IJRR), 2019.
2. Hunter Goforth, Yasuhiro Aoki, **R. Arun Srivatsan** and Simon Lucey, "PointNetLK: Robust & Efficient Point Cloud Registration using PointNet", in proceedings of conference on Computer Vision and Pattern Recognition (CVPR), 2019.
3. P. Yin, **R. Arun Srivatsan**, Y. Chen, X. Li, H. Zhang, L. Xu, L. Li, Z. Jia, J. Ji and Y. He, "MRS-VPR: a multi-resolution sampling based global visual place recognition method", In proceedings of the IEEE International Conference on Robotics and Automation, Montreal, Canada, May 2019. [PDF]
4. P. Yin, L. Xu, X. Li, C. Yin, Y. Li, **R. Arun Srivatsan**, L. Li, J. Ji and Y. He, "A Multi-Domain Feature Learning Method for Visual Place Recognition", In proceedings of the IEEE International Conference on Robotics and Automation, Montreal, Canada, May 2019. [PDF]
5. Murali Karnam, Aravind Baskar, **R. Arun Srivatsan**, and Sandipan Bandyopadhyay, "Computation of the safe working zones of parallel manipulators", Robotica, 2019.
6. **R. Arun Srivatsan**, Mengyun Xu, Nicolas Zevallos and Howie Choset, "Probabilistic Pose Estimation Using a Bingham Distribution-Based Linear Filter", in the International Journal of Robotics Research (IJRR), 2018. [PDF]
7. Nicolas Zevallos, **R. Arun Srivatsan**, Hadi Salman, Lu Li, Jianing Qian, Saumya Saxena, Mengyun Xu, Kartik Patath and Howie Choset, "A Real-time Augmented Reality Surgical System for Overlaying Stiffness Information", in proceedings of Robotics: Science and Systems, Pittsburgh, PA, 2018. [PDF]
8. Hadi Salman, Elif Ayvali, **R. Arun Srivatsan**, Yifei Ma, Nicolas Zevallos, Rashid Yasin, Long Wang, Nabil Simaan and Howie Choset, "Trajectory-Optimized Sensing for Active Search of Tissue Abnormalities in Robotic Surgery", in proceedings of international conference on robotics and automation (ICRA), Brisbane, Australia, 2018. [PDF]
9. Nicolas Zevallos, **R. Arun Srivatsan**, Hadi Salman, Lu Li, Jianing Qian, Saumya Saxena, Mengyun Xu, Kartik Patath and Howie Choset, "A surgical system for automatic registration, stiffness mapping and dynamic image overlay", in proceedings of 2018 International Symposium on Medical Robotics (ISMR), Atlanta, GA, 2018, pp. 1-6. **(Best paper finalist)** [PDF]
10. **R. Arun Srivatsan**, Mengyun Xu, Nicolas Zevallos and Howie Choset, "Bingham Distribution-Based Linear Filter for Online Pose Estimation", in proceeding of the Robotics: Science and Systems, 2017. [PDF]
11. Lu Li, Bocheng Yu, Chen Yang, Prasad Vagdargi, **R. Arun Srivatsan** and Howie Choset, "Development of an Inexpensive Bi-axial Force Sensor for Minimally Invasive Surgery", in proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems, Vancouver, Canada, 2017. [PDF]
12. Kartik Patath, **R. Arun Srivatsan**, Nico Zevallos, Howie Choset, "Dynamic Texture Mapping of 3D models for Stiffness Map Visualization", workshop on medical imaging, IEEE/RSJ International Conference on Intelligent Robots and Systems, Vancouver, Canada, 2017. [PDF]
13. **R. Arun Srivatsan**, Prasad Vagdargi and Howie Choset, "Sparse Point Registration", in proceedings of the International Symposium on Robotics Research, 2017. [PDF]

14. Prasad Vagdargi, **R. Arun Srivatsan**, Nicolas Zevallos, Feroze M. Naina and Howie Choset, “Multimodal Approach to Registration Using Stereo Imaging and Contact Sensing”, workshop on Haptics in Robotics: Science and Systems, 2017. [PDF]
15. **R. Arun Srivatsan** and Howie Choset, “Multiple Start Branch and Prune Filtering Algorithm for Nonconvex Optimization”, in the proceedings of Workshop on the Algorithmic Fundamentals of Robotics, San Francisco, 2016. [PDF]
16. **R. Arun Srivatsan**, Gillian T. Rosen, Feroze M. Naina, and Howie Choset, “Estimating SE(3) elements using a dual-quaternion based linear Kalman filter”, in the proceedings of Robotics Science and Systems, Michigan, 2016. [PDF]
17. **R. Arun Srivatsan**, Long Wang, Elif Ayvali, Nabil Simaan, and Howie Choset, “Simultaneous Registration and Stiffness mapping of a Flexible Environment using Stiffness and Geometric Prior”, in the proceedings of the Hamlyn symposium on Medical Robotics, London, UK, June 2016. [PDF]
18. **R Arun Srivatsan**, Elif Ayvali, Long Wang, Rajarshi Roy, Nabil Simaan and Howie Choset, "Complementary Model Update: A Method for Simultaneous Registration and Stiffness Mapping in Flexible Environments", In the proceedings of the International Conference on Robotics and Automation, Sweden, May 2016. [PDF]
19. Elif Ayvali, **R Arun Srivatsan**, Long Wang, Rajarshi Roy, Nabil Simaan, and Howie Choset, "Using Bayesian Optimization to Guide Probing of a Flexible Environment for Simultaneous Registration and Stiffness Mapping", in proceedings of the International Conference on Robotics and Automation, Sweden, May 2016. [PDF]
20. S. Agarwal, **R. Arun Srivatsan**, S. Bandyopadhyay, “Analytical Determination of the Proximity of Two Right-circular Cylinders in Space”, ASME. J. Mechanisms Robotics; 8(4):041010-041010-10, 2013. [PDF]
21. **R. Arun Srivatsan**, Rajarshi Roy, Long Wang, Nabil Simaan, and Howie Choset, "Registering Surgical Tool to a Soft Body using Mechanical Palpation" Tech. report CMU-RI-TR-13, Robotics Institute, Carnegie Mellon University, June, 2015. [PDF]
22. **R. Arun Srivatsan**, Matthew Travers and Howie Choset, "Using Lie algebra for shape estimation of medical snake robots", proceedings of the 27th IEEE/RSJ International Conference on Intelligent Robots and Systems, Chicago, 2014. [PDF]
23. **R. Arun Srivatsan** and Sandipan Bandyopadhyay, "Analysis of constraint equations and their singularities", in proceedings of 14th International Symposium on Advances in Robot Kinematics, Slovenia, June 2014. [PDF]
24. **R. Arun Srivatsan**, Sandipan Bandyopadhyay, Ashitava Ghosal, “Analysis of the degrees-of-freedom of spatial parallel manipulators in regular and singular configurations”, Mechanism and Machine Theory, Vol 69, Pages 127-141, 2013. [PDF]
25. **R. Arun Srivatsan** and Sandipan Bandyopadhyay, “On the position kinematic analysis of MaPaMan: a reconfigurable three-degrees-of-freedom spatial parallel manipulator”, Mechanism and Machine Theory, Vol 62, Pg.150-165, 2013. [PDF]
26. A. V. Vishwanath, **R. Arun Srivatsan** and M. Ramanathan, "Minimum area enclosure and alpha hull of a set of freeform planar closed curves", Computer-Aided Design, Volume 45, Issue 3, Pages 751–763, 2013. [PDF]
27. Jaideep Badduri, **R. Arun Srivatsan**, G. Saravana Kumar and Sandipan Bandyopadhyay, "Coupler-curve synthesis via multi-objective optimisation using NSGA-II", In proceedings of iNaCoMM, December 2013. [PDF]
28. **R. Arun Srivatsan**, Sandipan Bandyopadhyay, “Determination of the safe working zone of a parallel manipulator”, Proceedings of the 6th International Workshop of Computational Kinematics, Vol 15, 2013. [PDF]
29. **R. Arun Srivatsan**, Sandipan Bandyopadhyay, “An analytical formulation for finding the proximity of two arbitrary cylinders in space”, proceedings of the International Conference on Advances in Robotics, 2013. [PDF]
30. Jaideep Badduri, **R. Arun Srivatsan**, G. Saravana Kumar and Sandipan Bandyopadhyay, “Coupler-curve synthesis of a planar four-bar mechanism using a genetic algorithm-based optimization method”, 9th International Conference on Simulated Evolution And Learning, Volume 7673, pp 460-469, 2012. [PDF]

PATENTS

1. Sandipan Bandyopadhyay, **R. Arun Srivatsan** and Tarun Mehta, "A reconfigurable parallel manipulator", Indian provisional patent 5187/CHE/2012, December 2012.
2. Sandipan Bandyopadhyay, **R. Arun Srivatsan** and Tarun Mehta, "An encoder mounting assembly", Indian provisional patent 3277/CHE/2012, August 2012.
3. **R. Arun Srivatsan**, Bhavin Gawali, Hem Rampal, Kartik Mehta, Sandipan Bandyopadhyay and G. Saravana Kumar, "A hands free device for enabling the differently-abled to turn the pages of a book while reading: A device to automatically flip pages of book without use of hands", Indian provisional patent 2597/CHE/2010, September 2010.

AUTHORED GRANTS

NSF CMMI- 1734360, "In-Situ Collaborative Robotics in Confined Spaces", 2017. PI: Howie Choset and Nabil Simaan.

ACADEMIC SERVICE

Invited Speaker at Workshop on Continuum Robots in Medicine – Design, Integration, and Applications, IROS 2017.
Reviewer for journals: IEEE T-RO, ROBOTICA, TBME, RAM, RAL, Mechatronics.
Reviewer for conferences: RSS, ICRA, IROS, WAFR, ICAR, IDETC/CIE, Bio-Rob, Hamlyn symposium.
Teaching Assistant for, "Robot Kinematics and Dynamics", CMU, 2014.
Teaching Assistant for, "Geometric Modeling" and "Computer Aided Design" at IIT Madras, 2012.

MENTORING

PhD qualifier committee		
Venkataraman Rajagopalan	Carnegie Mellon University	2015-2018
Tejas Sudharshan Mathai	Carnegie Mellon University	2016-2018
Arkadeep Chaudhary	Carnegie Mellon University	2018-present
Masters qualifier committee		
Feroze Naina	Carnegie Mellon University	2016-2017
Bradley Saund	Carnegie Mellon University	2017
Shohin Mukherjee	Carnegie Mellon University	2017
Hadi Salman	Carnegie Mellon University	2017-2018
Xueqian Li	Carnegie Mellon University	2018-present
Mengjie Li	Carnegie Mellon University	2018-present
Stamatis Athiniotis	Carnegie Mellon University	2018-present
Tejas Zodage	Birla Institute of Technology and Sciences	2017-present
Undergraduate students		
Gillian Rosen	Carnegie Mellon University	2014-2016
Nate Appelson	Carnegie Mellon University	2014-2016
Prasad Vagdargi	Visvesvaraya National Institute of Technology	2017
Karthik Patath	Visvesvaraya National Institute of Technology	Summer 2017
Olivia Xu	Carnegie Mellon University	2017-2018
Long Tran	Carnegie Mellon University	2018-present
Vinit Sarode	Visvesvaraya National Institute of Technology	2018-present

ACTIVITIES:

President of the Carnegie Mellon University cricket team. 2017-2018
Developed a product - Tangle, ran an Indiegogo Campaign and sold the product to 18 countries. 2013-2014