Shantanu Thakar

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RESEARCH INTERESTS

- Physics aware motion planning of mobile robots and high degree of freedom robotic systems
- AI for robot task and motion planning
- Machine learning and optimization for robotic applications

EDUCATION

PhD in Mechanical Engineering, University of Southern California, USA *Aug 2016 - Present*
Selected Courses: *AI, Deep Learning, Optimization, Manufacturing Automation, Analytical Dynamics*

Bachelor & Master of Technology in Mechanical Engineering, IIT Bombay, India *Jul 2010 - May 2015*
Selected Courses: *Mobile Robotics, Non-linear & Embedded Control, System Identification, FEM, MEMS*

INTERNSHIPS

Applied Scientist Intern *May 2020 - Aug 2020*
Turn Automation, Amazon Prime Air, Seattle, WA, USA *Advisor*: Dr. Pragyam Mishra

- Defined Force-Affordance Map, a map that encodes the magnitude and direction of force allowed at any point of an object so as to operate it. Designed a Gaussian Process Regression-based algorithm for learning and computing the Force-Affordance Map of any object
- Based on this map, implemented an iterative algorithm for solving sequential peg-in-hole problems with force/torque feedback for precise robotic grasping of Amazon Prime Air vehicles with an industrial manipulator mounted with a specialized end of arm tool (Multiple Patent filings in process)

Robotics Research Intern *Aug 2019 - Dec 2019*
Siemens Corporate Technology, Berkeley, CA, USA *Advisor*: Dr. Chengtao Wen

- Designed and implemented compliance control on Yaskawa Motoman GP50 robot arm in Gazebo using *ros_control* for robotic surface finishing applications
- Developed suction grasping heuristics for robotic pick-up of mobile phones to generate data in simulation. Trained deep neural network to learn the robot grasping pose from a bin of randomly placed phones.

Research Associate *Aug 2015 - Apr 2016*
Autonomous Vehicles Lab, IISc Bangalore, India *Advisor*: Dr. Ashwini Ratnoo

- Designed a virtual target-based guidance logic for path following of UAVs, such that with respect to the line-of-sight, the UAV maintains an equal and opposite lead angle with the virtual target. Resulted in a significantly faster ($> 100\%$) convergence to the desired path as compared to state-of-the-art

RESEARCH PROJECTS

Motion Planning for High-DOF Robotic Systems *Advisor:* Dr. S.K. Gupta, USC

- Developed motion planning algorithms for point-to-point motions in cluttered environments and efficient pick-up and transport operations for redundant manipulators and non-holonomic mobile manipulators.
- Devised sequential optimization based algorithms for constrained motion planning of high-DOF systems

Learning for High-Speed Grasping *Advisor:* Dr. S.K. Gupta, USC

- Developed an SVM based active machine learning approach to construct a meta-model for estimating the probability of successfully grasping objects under pose uncertainty with a fast moving gripper

Design and Development of ADAMMS *Advisors:* Dr. S.K. Gupta, USC & Dr. Jeremy Marvel, NIST

- Led the design and development of the Agile Dexterous Autonomous Mobile Manipulation System (ADAMMS) at the Center for Advanced Manufacturing at USC for autonomous pick-up & transportation and semi-autonomous machine tending operations for warehouse automation in collaboration with National Institute of Standards and Technology (NIST), Gaithersburg, MD

Planning for Bi-manual Mobile Manipulation *Advisor:* Dr. S.K. Gupta, USC

- Designed search based spatial constraint checking and caching algorithms for task assignment and motion planning for bi-manual mobile manipulators resulting in 86% decrease in computation time as compared to traditional techniques.

Design and Navigation of a Spherical Robot *Advisors*: Dr. L. Vachhani & Dr. A. Gupta, IIT-B

- Designed and built a gearless two-pendulum spherical robot (Patent Pending)
- Formulated and implemented an online non-holonomic motion planning algorithm citing the discrete and erroneous position measurements from the indoor navigation system by estimating the yaw angle

LEADERSHIP EXPERIENCE

Development of ADAMMS-UV *Feb 2020 - Apr 2020*

Center for Advanced Manufacturing, USC *Advisor*: Dr. S K. Gupta, USC

- Led and managed a team of 10 graduate students under strict social distancing constraints for the development and demonstration of ADAMMS-UV, our modified mobile manipulation platform that manipulates objects and performs deep disinfection of occluded areas using UV light in a semi-autonomous manner.
- ADAMMS-UV was featured in Forbes Magazine, New York Times, IEEE The Institute, Spectrum, IEEE RAS, NBC BayArea News, Mashable.com, Forrester Market Research & several USC Media Forums.

COMPUTER AND INDUSTRIAL ROBOT SKILLS

- **Programming & Frameworks:** Python, C++, MATLAB, JAVA, TensorFlow, PyTorch, ROS, PyBullet, Mujoco, Gazebo, OMPL, MoveIt!, VREP, Solidworks, Simulink, Eigen, IPOPT, OpenCV, PCL
- **Robots:** Kuka LWR iiwa 7 and iiwa 14, EPSON C3, S5, Rethink Robotics Baxter, Clearpath Robotics Husky, Universal Robots UR5, InspectorBots Super Mega Bot, ABB IRB

AWARDS AND ACHIEVEMENTS

- Awarded the Provost PhD Fellowship from The Viterbi School of Engineering, USC, 2016
- Awarded the J. N TATA fellowship for Higher Education, 2016
- Part of USC team amongst the 5 Finalist for the Kuka Innovation Award 2017, Hannover Messe, Germany

SELECTED PUBLICATIONS

- **S. Thakar**, P. Rajendran, V. Annem, A. M. Kabir, S. K. Gupta; "Accounting for Part Pose Estimation Uncertainties during Trajectory Generation for Part Pick-Up Using Mobile Manipulators "; IEEE ICRA 2019, Montreal, Canada
- **S. Thakar**, P. Rajendran, H. Kim, A. M. Kabir, S. K. Gupta; "Accelerating Bi-Directional Sampling-Based Search for Motion Planning of Non-Holonomic Mobile Manipulators"; IEEE IROS 2020, Las Vegas, Nevada, USA
- **S. Thakar**, P. Rajendran, A. M. Kabir, S. K. Gupta; "Manipulator Motion Planning for Part Pick-up and Transport Operations from a Moving Base"; IEEE Transactions on Automation Science and Engineering
- **S. Thakar**, L. Fang, B. C. Shah, S. K. Gupta; "Towards Time-Optimal Trajectory Planning for Pick-and-Transport Operation with a Mobile Manipulator"; IEEE CASE 2018, Munich, Germany,
- **S. Thakar**, A. M. Kabir, R. K. Malhan, P. Rajendran, B. C. Shah, S. K. Gupta; "Task assignment and motion planning for bi-manual mobile manipulation"; IEEE CASE 2019, Vancouver, Canada
- **S. Thakar** and A. Ratnoo; "A Tangential Guidance Logic for Virtual Target Based Path Following"; AIAA-GNC 2017, Grapevine, Texas, USA
- **S. Thakar**, S. Al-Hussaini, J. A. Marvel, S. K. Gupta; "Human-Supervised Semi-Autonomous Mobile Manipulators for Safely and Efficiently Executing Machine Tending Tasks"; AAAI, AI-HRI 2020
- A. M. Kabir, **S. Thakar**, R. K. Malhan, A. Shembekar, B. C. Shah, S. K. Gupta; "Generation of Synchronized Configuration Space Trajectories with Workspace Path Constraints for Multi-Robot Systems"; (Accepted) International Journal of Robotics Research (IJRR)
- A. M. Kabir, **S. Thakar**, P. M. Bhatt, R. K. Malhan, P. Rajendran, B. C. Shah, S. K. Gupta; "Incorporating Motion Planning Feasibility Considerations during Task-Agent Assignment to Perform Complex Tasks Using Mobile Manipulators"; IEEE ICRA 2020, Paris, France
- P. Rajendran, **S. Thakar**, A. M. Kabir, B. C. Shah, S. K. Gupta;"Context-Dependent Search for Generating Paths for Redundant Manipulators in Cluttered Environments"; IEEE IROS 2019, Macau, China
- P. Rajendran, **S. Thakar**, S. K. Gupta; "User-guided path planning for redundant manipulators in highly constrained work environments"; 15th IEEE CASE, 2019, Vancouver, Canada
- P. R. Colombo, F. Gennari, V Annem, P. Rajendran, **S. Thakar**, L. Bascetta, S. K. Gupta; "Parameterized Model Predictive Control of a Nonholonomic Mobile Manipulator: A Terminal Constraint-Free Approach"; 15th IEEE CASE, 2019, Vancouver, Canada
- V. Reddy, **S. Thakar**, L. Vachhani, A. Gupta, A Yadav, S Modi; "Motion Planning for Point-to-Point Navigation of Spherical Robot Using Position Feedback"; IEEE Transactions on Mechatronics, 2019