Shantanu Thakar

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RESEARCH INTERESTS

- Physics aware motion planning of high degree of freedom systems
- Artificial intelligence for robot task and motion planning
- Machine learning and non-linear optimization for robotic applications

EDUCATION

PhD in Mechanical Engineering, University of Southern California, USA *Aug 2016 - Present*
GPA: **3.63** Courses: *AI, Deep Learning, Optimization, Manufacturing Automation, Analytical Dynamics*
Bachelor & Master of Technology in Mechanical Engineering, IIT Bombay, India *Jul 2010 - May 2015*
GPA: **8.31** Courses: *Mobile Robotics, Non-linear & Embedded Control, System Identification, FEM, MEMS*

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

- Designed and build 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

INTERNSHIPS

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 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 of the virtual target. Resulted in a significantly faster ($> 100\%$) convergence to the desired path as compared to state-of-the-art
- Developed an analytical survey for rendezvous guidance laws for aerial recovery of UAVs using a mothership-cable-drogue system

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
- Awarded the J. N TATA fellowship for Higher Education
- Part of USC team amongst the 5 Finalist for the Kuka Innovation Award 2017, Hannover Messe, Germany

PUBLICATIONS

- **S. Thakar**, P. Rajendran, V. Annem, A. 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**, L. Fang, B. Shah, S K Gupta; "Towards Time-Optimal Trajectory Planning for Pick-and-Transport Operation with a Mobile Manipulator"; 14th IEEE CASE 2018, Munich, Germany,
- **S. Thakar**, A M Kabir, P M Bhatt, R K Malhan, P. Rajendran, B C Shah, S K Gupta; "Task assignment and motion planning for bi-manual mobile manipulation"; In 15th IEEE CASE 2019, Vancouver, Canada
- **S. Thakar**, P. Rajendran, A M Kabir, S K Gupta; "Manipulator Motion Planning for Part Pick-up and Transport Operations from a Moving Base"; (Under Revision) IEEE Transactions on Automation Science and Engineering (TASE)
- **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"; (Submitted) IEEE IROS 2020, Las Vegas, Nevada, USA
- A M Kabir, **S. Thakar**, A. Kanyuck, R. Malhan, A. Shembekar, B C Shah, S K Gupta; "Generation of Synchronized Configuration Space Trajectories of Multi-Robot Systems"; IEEE ICRA 2019, Montreal, Canada
- 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
- A M Kabir, **S. Thakar**, R. Malhan, A. Shembekar, B C Shah, S K Gupta; "Generation of Synchronized Configuration Space Trajectories with Workspace Path Constraints for Multi-Robot Systems"; (Submitted) International Journal of Robotics Research (IJRR)
- P. Rajendran, **S. Thakar**, P M Bhatt, A M Kabir, S K Gupta; "Speeding Up Manipulator Path Planning by Exploiting Search-Tree States"; (Submitted) IEEE Robotics and Automation Letters (RAL)
- V. Annem, P. Rajendran, **S. Thakar**, S K Gupta; "Towards remote teleoperation of a semi-autonomous mobile manipulator system in machine tending tasks"; 12th ASME MSEC 2019, Erie, Pennsylvania, USA
- 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
- N. Kumbla, **S. Thakar**, K. Kaipa, J. Marvel, S K Gupta; "Simulation Based On-Line Evaluation Of Singulation Plans to Handle Perception Uncertainty In Robotic Bin Picking"; 12th ASME MSEC 2017, Los Angeles, California, USA
- N. Kumbla, **S. Thakar**, K. Kaipa, J. Marvel, S K Gupta; "Handling Perception Uncertainty in Simulation based Singulation Planning for Robotic Bin Picking"; Journal of Computing and Information Science in Engineering (JCISE) 2017
- **S. Thakar** and A. Ratnoo; "A Tangential Guidance Logic for Virtual Target Based Path Following"; AIAA-GNC 2017, Grapevine, Texas, USA
- **S. Thakar** and A. Ratnoo; " Rendezvous Guidance Laws for Aerial Recovery using Mothership-Cable-Drogue System"; 4th IFAC ACODS 2016: Tiruchirappalli, India
- 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
- V. Reddy, **S. Thakar**, A. Kumar and L. Vachhani; "Discrete time position feedback based steering control for autonomous homing of a mobile robot"; IEEE ICCA 2016, Kathmandu, Nepal