

SHANTANU THAKAR

CURRICULUM VITAE

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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
- Non-linear optimization

EDUCATION

PhD in Mechanical Engineering

University of Southern California, Los Angeles, CA

Aug 2016 - Present

CGPA: 3.68/4.00

Bachelor and Master of Technology in Mechanical Engineering

Indian Institute of Technology Bombay, India

Jul 2010 - May 2015

CGPA: 8.31/10.00

PUBLICATIONS

- **S. Thakar**, V. Annem, A. Kabir, P. Rajendran, S. K Gupta; “Accounting for Part Pose Estimation Uncertainties during Trajectory Generation for Part Pick-Up Using Mobile Manipulators ”; (Submitted) IEEE International Conference on Robotics and Automation 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”; (Accepted & Presented) IEEE International Conference on Automation Science and Engineering 2018, Munich, Germany
- **S. Thakar**, A. Ratnoo. “A Tangential Guidance Logic for Virtual Target Based Path Following”, AIAA Guidance, Navigation and Control Conference GNC 2017, Grapevine, Texas, AIAA 2017-1042
- **S. Thakar**, A. Ratnoo. “ Rendezvous Guidance Laws for Aerial Recovery using Mothership-Cable-Drogue System”, 4th IFAC Conference on Advances in Control and Optimization of Dynamical Systems ACODS 2016: Tiruchirappalli, India
- A. Kabir, **S. Thakar**, A. Kanyuck, R. Malhan, A. Shembekar, B. Shah, S. K. Gupta; “Generation of Synchronized Configuration Space Trajectories of Multi-Robot Systems ”; (Submitted) IEEE International Conference on Robotics and Automation 2019, Montreal, 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”, ASME 12th International Manufacturing Science and Engineering Conference 2017, Los Angeles, California
- 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-17-1115; doi: 10.1115/1.4038954
- V. Reddy D., **S Thakar**, A. Kumar G.K. and L. Vachhani, “Discrete time position feedback based steering control for autonomous homing of a mobile robot”, IEEE International Conference on Control & Automation, Kathmandu, Nepal, 2016 doi 10.1109/ICCA.2016.7505372

PATENT

- **S. Thakar**, L. Vachhani, A. Gupta, V. Reddy, D. Gandhi; Design and development of a gearless two-pendulum spherical robot; Patent Application no. 4717/MUM/2015; 16 December 2015; In Process

COMPUTER AND INDUSTRIAL ROBOT SKILLS

- **Software**
Robot Operating System (ROS), Gazebo, VREP, Solidworks
- **Programming**
High Proficiency: Python, MATLAB
Medium Proficiency: C++, JAVA, LUA, Julia
- **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
- Finalist for the Kuka Innovation Award 2017, Hannover Messe, Germany

RESEARCH EXPERIENCE

Time-Optimal Trajectory Planning with a Mobile Manipulator

Aug 2016 - Present

Realization of Robotic Systems Lab, AME, USC

Advisor: Dr. S. K Gupta

- Designed a graph based search algorithm for trajectory planning of mobile manipulators for time optimal pick-up and transport of objects
- Developed an SVM based active machine learning approach to construct a meta-model for estimating the probability of successful part pick-up for uncertainty in the part pose estimate
- Machine learned model resulted in more than 100% reduction in number of samples as compared to Monte-Carlo
- An optimization based framework was developed to generate time-optimal trajectories for picking-up parts that satisfy the given level of success probability threshold

Constrained Trajectory Generation for High DOF Robots

Feb 2018 - Present

Realization of Robotic Systems Lab, AME, USC

Advisor: Dr. S. K Gupta

- Implemented Jacobian based control for following end-effector trajectories for high-DOF robotic arms and non-holonomic mobile manipulator
- Successive refinement based optimization algorithm for parametric curve based joint angles for time-optimal execution of trajectories with multiple high DOF robots

Guidance Logic for UAV Path Following

Aug 2015 - Apr 2016

Autonomous Vehicles Lab, IISc Bangalore, India

Advisor: Dr. Ashwini Ratnoo

- Designed a guidance logic for path following of a UAV using a virtual target, such that with respect to the line-of-sight, the UAV maintains an equal and opposite lead angle as that of the virtual target.
- A linear analysis of the resulting error dynamics presents a faster (greater than 100%) convergence to straight line path as compared to existing methods. With no overshoot in the response, the method presents a smooth trajectory following

Non-holonomic Navigation of a Spherical Robot

May 2014 - Jul 2015

Master's Thesis, IIT-Bombay

Advisors: Dr. Leena Vachhani & Dr. Abhishek Gupta

- Designed and built a double pendulum and yoke actuated autonomous robot spherical robot with digital servo actuators
- Developed an online non-holonomic motion planning algorithm citing the discrete and erroneous position measurements from the indoor navigation system for the spherical robot by estimating the yaw.
- Formulated theoretical continuous curvature trajectories for navigation of this spherical robot based on Dubin's path approach using the steady state steering dynamic equations of the system.

PROFESSIONAL EXPERIENCE

Design and control of a robotic arm

May 2013 - Jul 2013

AIRBUS Innovation Cell, Bangalore, India

Advisor: Mr. Ajit Krishnamohan

- The goal was to design and fabricate a prototype of a 5 Dof dexterous robotic arm to project aircraft manuals for pilot reference in the cockpit. Used proximity sensing to enable manual maneuvering. Implemented search based algorithm motion planning to ensure contact avoidance with the complex cockpit environment
- Resulted in Patent application: Aircraft part with robot arm; International Patent Application no. PCT/IN2013/000803; 26 December 2013; Applicants: Airbus Engineering Center India, Airbus (France)

Diesel Engine Data Processing

May 2012 - Jul 2012

Johannes Kepler University, Austria

Advisor: Prof. Luigi Del Re

- Used MATLAB for writing scripts and functions to facilitate the processing and organisation of the numerical data from an experiment on particle measurement on engine test benches
- Received a scholarship from **OeAD** (Austrian Exchange service) for research assistantship