

# SHANTANU THAKAR

# CURRICULUM VITAE

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## RESEARCH INTERESTS

- Physics Aware Motion Planning of High Degree of Freedom Systems
- AI for planning robot tasks and motion
- Machine Learning and robot control
- Non-linear optimization for trajectory generation

## 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) 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, AIAA SciTech Forum, (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 2017 12th International Manufacturing Science and Engineering Conference, 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-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

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- 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

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### **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 active learning-based approach to construct a meta-model for estimating the probability of successful part pick-up for uncertainty in the part pose estimate
- 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

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### **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