

Ajinkya Jain

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RESEARCH INTERESTS

Robot Learning, Robot Manipulation, Motion Planning Under Uncertainty, Model Learning for Planning and Control, Reinforcement Learning, Optimal Control, Human-Robot Interaction

EDUCATION

The University of Texas at Austin

Ph.D., Mechanical Engineering (*Robotics, Dynamic Systems and Controls*)

2015–Current

Advisor: Prof. Scott Niekum (Expected Graduation: Spring 2021)

Indian Institute of Technology Kanpur

B.Tech. - M.Tech. (Dual Degree), Mechanical Engineering (*Robotics and Automation*)

2010–2015

Advisor: Prof. Bishakh Bhattacharya

INTERNSHIPS

AI (Robotics) Researcher, Samsung AI Research Center-Robotics (New York City, NY) May'19-Aug'19

GrAB-Net: Grasping with optimal Approach Behavior [Deep Learning, Grasp Planning]

- Developed a fully autonomous training pipeline to train networks for generating category-level optimal grasping behaviors given a single RGB-D image of the scene via imitation learning
- Achieved high success rate ($\sim 70\%$) in grasping 40 different objects belonging to two object categories

Roboticist, Vicarious (Union City, CA)

May'18-Aug'18

Task Agnostic High Precision Assembly using Visual Servoing [Perception, Motion Planning]

- Implemented state-of-the-art visual servoing algorithms to do high precision ($\leq 2mm$) assembly tasks. Ensured fast convergence ($\leq 20s$) to target features with high repeatability ($\geq 90\%$ success)
- Developed python-based interfaces ensuring a task and platform-agnostic implementation

RESEARCH EXPERIENCE

Graduate Research Assistant, Dept. of Computer Science, UT Austin

2015–Current

Robot Motion Planning Under Uncertainty and Hybrid Dynamics [Manipulation Planning]

- Developed a POMDP motion planner that leverages object interactions to generate efficient plans (via trajectory optimization; 5x faster) to perform long-horizon manipulation tasks with high accuracy ($\geq 90\%$) under uncertainty

Learning Object Kinematics Models from Observations [Model Learning, Manipulation Planning]

- Developed a novel method for learning planning-compatible hybrid kinematics models for articulated objects from human demonstrations (improved up to 3x in accuracy over the state-of-the-art method)

Object Articulation Model Estimation From Raw Depth Images [Deep Learning, Robot Perception]

- Developed a novel deep learning based method (using CNNs) to estimate articulation models for objects directly from raw depth images without knowing their articulation type a priori using screw theory (2x data efficient)

Graduate Research Assistant, Dept. of Mechanical Engineering, IIT Kanpur

2014–2015

Thesis: Two Design Challenges in Exoskeleton Systems: Optimal Gripper Design and Optimal Bipedal Gait Controller [Optimal Control, System Modeling]

- Developed a simple, computationally-cheap, yet effective model for piezoelectric stack actuators as a replacement of black-box models used in engineering design optimization problems
- Optimized design of a piezoelectric actuator driven gripper using the proposed model with NSGA-II algorithm
- Designed a time-varying optimal controller (LTV-LQR controller) for exoskeleton bipedal locomotion

Robot Motion Planning using Feedback Information Based RoadMaps [\[Motion Planning\]](#)

- Modeled dynamics of 5 different holonomic and non-holonomic mobile robot platforms and implemented motion planning library FIRM to perform navigation tasks under uncertainty
- Interfaced robotic simulator, V-Rep, with the library with added features including customizable work environments and synchronized communication for real-time control

PUBLICATIONS

A. Jain, R. Lioutikov, C. Chuck, and S. Niekum, *ScrewNet: Category-Independent Articulation Model Estimation From Depth Images Using Screw Theory*, IEEE International Conference on Robotics and Automation (ICRA), 2021

A. Jain and S. Niekum, *Learning Hybrid Object Kinematics for Efficient Hierarchical Planning Under Uncertainty*, IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2020

A. Jain and S. Niekum, *Efficient Hierarchical Robot Motion Planning Under Uncertainty and Hybrid Dynamics*, 2nd Conference on Robot Learning (CoRL), 2018

A. Jain and S. Niekum, *Belief Space Planning under Approximate Hybrid Dynamics*, Workshop on POMDPs in Robotics, Robotics: Science and Systems (R:SS), 2017

R. Datta, **A. Jain**, and B. Bhattacharya, *A Piezoelectric Model based Multi-Objective Optimization of Robot Gripper Design*, Structural and Multidisciplinary Optimization, Springer 2015

A. Jain, R. Datta, and B. Bhattacharya, *Unified Minimalistic Modelling of Piezoelectric Stack Actuators for Engineering Applications*, Advances in Intelligent Systems and Computing, Springer 2014

TECHNICAL SKILLS

- Languages/Frameworks:** Python, C++, MATLAB/R, PyTorch
- Robotics Software:** ROS, MuJoCo, Gazebo, V-Rep, PyBullet, OMPL, MoveIt!, GraspIt!, ViSP (Visual Servoing Platform), SNOPT, IPOPT, Solidworks, PCL, OpenCV
- Robot Platforms:** Universal Robotics UR5, Toyota Human Support Robot, Kinova Jaco2 6-DOF, 7-DOF, Gen-3 arms, Rethink Robotics Sawyer, Robotiq grippers

SELECTED PROJECTS

- RobotCup@Home SSPL league, Robocup, Nagoya, Japan** [\[Manipulation Planning, Perception\]](#) 2017
Developed manipulation pipeline for fast pick-up and placement of household objects for Toyota Human Support Robot
- Optimal Control Schemes for Car Active Suspension Assembly** [\[Controls\]](#) 2017
Designed and implemented a reduced-order observer with an optimal finite time tracker
- Nonlinear controller for 6-DOF robot arm** [\[Controls\]](#) 2017
Designed and Implemented a Passivity-based feedback linearization controller for 6-DOF arm
- Learning Optimal Policy under Spatially-Varying Dynamics** [\[Reinforcement Learning\]](#) 2016
Developed an on-policy algorithm for learning optimal policies on domains with spatially-varying dynamics
- Stochastic Motion Planning for State-Dependent Dynamics** [\[Motion Planning\]](#) 2016
Modeled state-dependent dynamics as hybrid dynamics and extended belief-space LQR to hybrid systems for planning robot motion under uncertainty
- Classification of Human Actions in Video** [\[Computer Vision, Machine Learning\]](#) 2014
Implemented multiclass SVM and SCHM for classifying Human Actions in Videos
- Gameplay Strategies for 2D soccer playing robots** [\[Motion Planning\]](#) 2013
Implemented A* algorithm for devising game play strategies for 2D multiplayer soccer playing robots
- Boeing IIT-K Autonomous Navigation System (Abhyast) Phase-III** [\[Motion Planning\]](#) 2012-13
Built a graph-search based navigation planner for a jumping robot capable of navigating in cluttered environment using 3D Laser scanner data

AWARDS

- Second Runner-up Worldwide (Team Austin Villa), RobotCup@Home SSPL league, Nagoya, Japan 2017
- UT AI-lab travel grant 2017, 2018
- Certificate of Merit for Academic Excellence at IIT Kanpur 2011-12, 2012-13
- Robotics Scholarship, Boeing Corporation 2012-13
- TAMU-IITK Student Exchange Program at Texas A&M University, College Station, TX 2013
- CBSE Merit Scholarship-AIEEE for undergraduate studies in Engineering 2010-14
- KVPY (Kishore Vaigyanik- Protsahan Yojana) Scholarship, by DST, Govt. of India 2009

TEACHING

- **Guest Lecturer** at UT Austin Spring 2016
Mechatronics (ME 340), Topic: Introduction to Python
- **Teaching Assistant** at UT Austin 2015-16
Dynamics Systems and Controls Lab (ME 144L)
- **Teaching Assistant** at IIT Kanpur 2014-15
 - Optimization Methods in Engineering Design (ME 752)
 - Mechanical Engineering Lab-II (ME 471N)

RELEVANT COURSES

- **Robotics:** Introduction to Robotics, Robot Motion Planning, Robot Manipulators: Dynamics and Control, Robot Mechanism Design, Optimization Methods
- **Machine Learning:** Reinforcement Learning, Robot Learning from Demonstration and Interaction, Computer Vision and Image Processing
- **Controls:** Optimal Control, Nonlinear Dynamics & Control, Modern Control, Automation & Control

PROFESSIONAL SERVICE

Reviewer

Conferences: IROS'20, ICRA'20, ICRA'19, ARSO'17, Humanoids'16