Vikash Kumar
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Education

University of Berkeley, Berkeley Artificial Intelligence Research Lab (BAIR), Post Doc.	Sept 2017 - present
University of Washington, Ph.D. in Computer Science and Engineering	Sept 2017 - Dec 2016
University of Washington, M.S. in Computer Science and Engineering	Sept 2010 - Feb 2013
Indian Institute of Technology (IIT) Kharagpur, M.S. in Mathematics and Computing	July 2009 - Apr 2010
Indian Institute of Technology (IIT) Kharagpur, B.S. in Mathematics and Computing	July 2005 - Apr 2009

Interests

Embodied Artificial Intelligence, Robotics Optimal Control, Machine Learning

Manuscripts

Conference:-

- Optimal Control with Learned Local Models: Application to Dexterous Manipulation. *Kumar V, Todorov E, Levine S.* **BEST MANIPULATION PAPER AWARD**, *IEEE International Conference on Robotics and Automation (ICRA) 2016*
- MuJoCo Haptix: A virtual reality system for hand manipulation. *Kumar V, Todorov E. IEEE-RAS International Conference on Humanoid Robots (Humanoids) 2015*
- Real-time behavior synthesis for dynamic hand-manipulation. *Kumar V, Tassa Y, Erez T, Todorov E. IEEE International Conference on Robotics and Automation (ICRA) 2014*
- STAC: Simultaneous Tracking And Calibration. *Wu T, Tassa Y, Kumar V, Movellan J, Todorov E. Humanoids 2013*
- An integrated system for real time Model Predictive Control for humanoid robots. *Erez T, Lowrey K, Kumar V, Kolev S, Todorov E. Humanoids 2013*
- A low cost and modular, 20 dof anthropomorphic robotic hand: Design, Actuation and Modelling. *Zhe X, Kumar V, Todorov E. IEEE-RAS International Conference on Humanoid Robots (Humanoids) 2013*
- Synthesis of Complex Behaviors with Optimal Control. *Todorov E, Tassa Y, Erez T, Mordatch I, Kulchenko P, Kumar V Computational and Systems Neuroscience (COSYNE) 2013*
- Fast, strong and compliant pneumatic actuation for dexterous tendon-driven hands. *Kumar V, Todorov E. IEEE International Conference on Robotics and Automation (ICRA) 2013*
- Design of an anthropomorphic robotic finger system with biomimetic artificial joints. *Zhe X, Kumar V, Matsuoka Y, Todorov E. IEEE International Conference on Biomedical Robotics and Bio mechatronics (BioRob) 2012*
- Self and Mutual learning in Robotic Arm, based on Cognitive systems. *Kumar V, Patil C, Sachan S. (best paper award finalist) International Multi-Conference of Engineers and Computer Scientists 2010*

Workshop :-

- Divide-and-Conquer Reinforcement Learning. *Ghosh D, Singh A, Rajeswaran A, Kumar V, Levine S. Neural Information Processing Systems (NIPS) 2017*
- Variance Reduction for Policy Gradient with Action-Dependent Factorized Baselines. *Wu C., Rajeswaran A., Duan Y., Kumar V, Bayen A, Kakade S, Mordatch I, Abbeel P. Neural Information Processing Systems (NIPS) 2017*
- Learning Complex Dexterous Manipulation with Deep Reinforcement Learning and Demonstrations. *Rajeswaran A, Kumar V, Gupta A, Schulman J, Todorov E and Levine S. Neural Information Processing Systems (NIPS) 2017*
- Hand Manipulation Suite: A benchmark for dexterous manipulation. Kumar V, Rajeswaran R, Gupta A, Todorov E, Levine S, Robotics Science and Systems (RSS) 2017
- Optimal control with learned local models: Scaling dexterous manipulation. Kumar V, Todorov E, Levine S. Exploiting Contact Dynamics in Manipulation. IEEE International Conference on Robotics and Automation (ICRA) 2016
- Physically-Consistent Hand Manipulation Dataset. Kumar V, Todorov E. Workshop on Grasping and Manipulation Datasets. IEEE International Conference on Robotics and Automation (ICRA) 2016

Under Review :-

- Divide-and-Conquer Reinforcement Learning. *Ghosh D, Singh A, Rajeswaran A, Kumar V, Levine S.*
- Variance Reduction for Policy Gradient with Action-Dependent Factorized Baselines. *Wu C., Rajeswaran A., Duan Y., Kumar V, Bayen A, Kakade S, Mordatch I, Abbeel P*
- Learning Complex Dexterous Manipulation with Deep Reinforcement Learning and Demonstrations. *Rajeswaran A, Kumar V, Gupta A, Schulman J, Todorov E and Levine S.*
- Learning Dexterous Manipulation Policies from Experience and Imitation. *Kumar V, Gupta A, Todorov E, Levine S.* International Journal of Robotics Research (Special issue – Limits and Potentials of Deep Learning in Robotics)
- High-Performance Pneumatics using Model Predictive Control. *Kumar V, Todorov E.*
- Pneumatic Modelling for Adroit Manipulation Platform. *Kumar V.C.V, Kumar V.*
- Optimizing fuzzy multi-objective problems using fuzzy genetic algorithms and FZDT test functions. *Kumar V, Chakroborty D*

Selected Press Coverage

- New Atlas: Bridging the gap between science and fiction. Dec 28, 2016
- Communications of the ACM: Hand Jive: A Robot Hand Learns to Spin. Aug 23, 2016
- Reuters: Robot hand gets a human touch. May 13th 2016
- Wired: This dexterous robot can teach itself to spin a tube of coffee beans. May 10, 2016
- Business Insider: Researchers created a robotic hand that is eerily human-like and can learn on its own. May 29, 2016
- MIT Tech Review: ADROIT featured in TR35. 2016
- UW360: A robotic hand that can move like a human hand, Aug 31 2016
- ScienceDaily: This 5-fingered robot hand learns to get a grip on its own. May 9th 2016
- Engadget: Robot hand learns to twirl objects on its own. May 11th 2016
- GeekWire: UW team creates robotic hand that learns to become more dexterous than yours. May 9th 2016
- Gizmodo: This Robot's Teaching Itself to Twirl a Stick. May 11th 2016
- UWToday: This five-fingered robot hand learns to get a grip on its own. May 9th 2016
- UW CSE News: UW CSE robot hand teaches itself to manipulate objects. May 9th 2016
- CNN: The superhuman robot hand that learns from its mistakes. May 19th 2016
- Tech Insider: Researchers created a robotic hand that is eerily human-like and can learn on its own. May 25th 2016
- Indian Express: Five-fingered robot hand learns to get a grip on its own. May 10th 2016
- UK's Daily Mirror: Incredible five-fingered robotic hand has ability to learn from its own experiences. May 11th 2016
- Economic Times: Five-fingered robot hand learns to get a grip on its own. May 10th 2016
- ZDNet: Five-fingered robot hand has a mind of its own. May 11th 2016
- Kurzweil: This five-fingered robot hand is close to human in functionality. May 10th 2016
- Most significant bit: Adroit: The robot hand for which practice makes perfect. UW-CSE, Summer'16
- Futurism: This five-fingered robot hand is nimbler than your own. May 13th 2016
- Hackaday: Robot cheerleader just needs a hand to learn basic tricks. May 13th 2016
- Futurism: This five-fingered robot hand is nimbler than your own. May 13th 2016
- Interesting engineering: Robotic Hands that Teach Themselves to Move. May 12th 2016
- Foxnews: Cool robot hand learns as it goes. May 10th 2016
- IEEE Spectrum: Next-Gen Prosthetic Limbs in Simulation and Reality. Feb 12th 2015
- UW CSE News: People's choice award. Oct 24th 2013
- The New York Times: A robot with a delicate touch. Sep 18th 2012
- The Daily: UW programmers create software for disaster response robot. Nov 12th 2012

Research Experiences/ Internships

Extreme Sample Efficiency in Mode-Free Deep-RL Oct'17-present

Advisor: Dr. Sergey Levine, UC Berkeley

Scale model-free deep reinforcement leanring to high-demensional conteneous spaces on physical hardware. Our approach leverages few demonstrations and takes few robot hours to solve complex, contact rich, in-hand manipulation tasks from scratch.

MuJoCo: Advanced Physics Simulation Jan'12-present

Advisor: Dr. Emanuel Todorov, Roboti, llc.

Significantly contributed towards the development of MuJoCo physics simulation engine and MuJoCo Haptix framework.

OpenAI: Embodied Artifical Intelligence Apr'17-Sept'17

Advisor: **Elon Musk**, OpenAI

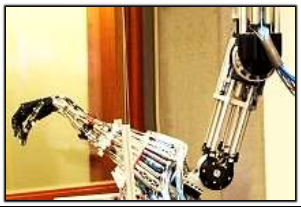
Directly reported to Mr. Elon Musk. Conceptualized and developed the vision for the robotics team at OpenAI. Designed and developed reinforcement learning amenable infrastructure for the robotics lab. Led efforts for accelerating deep reinforcement learning for high dimensional contineous control problems.

Virtual Embodiment for bootstrapping learning based techniques Aug'16-Nov'16

Advisor: Wojciech Zaremba, co-founder, OpenAI

Developed first person virtual embodiment for FETCH robot. The low latency system is capable of hosting dexterous manipulation, both in simulation and on the physical robot. Further involvements include advisory and strategic mentorship for robotics infrastructure, robust physics simulation and motion planning.

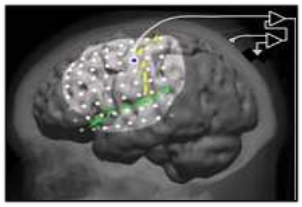
Design, Control, & Behavior Synthesis for ADROIT- A reconfigurable manipulation platform Mar'12-Dec'16



Advisor: Dr. Emanuel Todorov, Applied math & CSE, Univ. of Washington, USA

Design, control, and dexterous manipulation behavior synthesis for a pneumatically-actuated, compliant, anthropomorphic, 28 degree-of-freedom robotic hand capable of performing dexterous object manipulation tasks. Adroit features: joint, touch, tendon length and muscle force sensing capabilities.

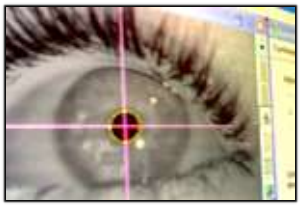
Closed-loop optimal control of prosthetic hands Jan'14-June'15



Advisors: Dr. Raj Rao, Director - CSNE & CSE, Univ. of Washington, USA
Dr. Emanuel Todorov, Applied math & CSE, Univ. of Washington, USA

Closing the loop between the 28-dof-ADROIT-hand and the brain, using ECoG signals, for feedback during hand manipulation. ECoG signals provide high-level feedback in terms of goal selection & corrective maneuvers while an automated controller tries to control the hand.

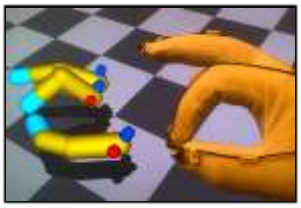
Gesture based control strategies Feb'11-May'14



Advisor: Dr. Emanuel Todorov, Applied math & CSE, Univ. of Washington, USA

Exploiting natural gestures such as eye movements, speech etc. for specifying high-level goals for robots (running low-level controller that realizes the specified high-level goals) thus seamlessly bridging the communication gap between a human and a machine.

Modeling & statistical analysis of virtual environment for understanding human finger interactions April-July'09



Visiting Researcher, CSE, Univ. of Washington, USA
Advisor: Dr. Emanuel Todorov, Applied math & CSE, Univ. of Washington, USA

Studied human finger performing dexterous manipulation experiments analyzing contacts, object interactions and grasping behaviors, addressing issues like contact forces, tactile feedback, 3D depth feedback, obstacle avoidance, optimal trajectories etc.

Optically perfect machining of acrylic surface- Discovery & Automation April-July'08

Summer intern– Intelligent Automation Inc. (IAI), USA
Advisor: Founder & President Emeritus Leonard S. Haynes, IAI, Washington DC, USA

Identification/discovery of a process to polish glued edges of acrylic boxes to optical clarity and realization of an industrial assembly to automate the identified process.

Dissertation

Ph.D. : Manipulators and Manipulation in High Dimensional Spaces
Advisor: Dr. Emanuel Todorov, Applied math & CSE, Univ. of Washington, USA
Dr. Sergey Levine, EECS, Univ. of California, Berkeley, USA

M.S. : Fuzzy genetic Algorithms(FGA)
Advisor: Prof. Debjani Chakraborty, Dept. of Mathematics, IIT Kharagpur

B.S. : New Genetic Algorithm based multi-objective optimization algorithm(NMGA)
Advisor: Prof. Nirupam Chakraborty, Head of Dept. of Metallurgical & Materials Engineering, IIT-Kharagpur

Achievements

Honors
- **Best All Rounder**, Indian Institute of Technology IIT-Kharagpur '10 (Ankik Dhar Memorial)
- 'Spirit Of Nehru Award', Nehru Hall, IIT Kharagpur '10
- Best All Rounder'09 & Budding Spirit'07, Nehru Hall, IIT Kharagpur

Awards
- Best Manipulation Paper Award, ICRA'16

	• 'Viewer's choice award', Affiliates'13, UW, CSE • Gold, Open hardware, KSHITIJ'09- Asia's largest techno-management Fest • 'Most Industrially feasible', Techkriti'09, IIT Kanpur • Silver, Open hardware, KSHITIJ'08, IIT Kharagpur • Gold, Geobotics, Great Step'08, IIT Kharagpur • Gold in Inter-hall Hardware modeling'07, IIT Kharagpur • Silver in Inter-hall Hardware modeling'08, IIT Kharagpur • Bronze, Robotic Water-polo, KSHITIJ'06, IIT Kharagpur • Gold, Inter-hall Product design'06, IIT Kharagpur • Bronze, Inter-hall ad-design'09, IIT Kharagpur
Position of Responsibilities	• **Vice President, Dept. of Mathematics'08-09, IIT** Kharagpur • Chief Editor, AWAAZ – campus monthly newsletter'06-09 • Member of Kharagpur Robotics & Artificial Intelligence Group (KRAIG)
Others	• Several state/district level awards in Hockey, Volleyball, Fine Arts

Scholarships and Grants

- NSF Student travel grant, 2014
- Center for Neuroscience Travel Award, Univ. of Washington, 2012, 2014, 2015
- MERIT-CUM-MEANS Scholarship, IIT Kharagpur, 2005, 2006, 2007, 2008, 2009, 2010
- Inter-IIT Sports Scholarship, IIT Kharagpur, 2006-07

Students Advised

- Visak CV, Master's in Mechanical Engineering, University of Washington (Mar'15-Aug'16) (Pursuing Ph.D. in Georgia Tech under Dr. C. Karen Liu)
- Dylan Holmes, Bachelors in Computer Science, University of Washington (Jul'14-Mar'16)
- Anselm Nicklas, Visiting student from Department of Electrical and Computer Engineering, Technische Universitat Munich, Germany (Apr'15-Sept'15)
- Kaiyu Zheng, , Bachelors in Computer Science, University of Washington (Mar'14-Apr'14)