Avik De

Ph.D. candidate (University of Pennsylvania), Co-founder Ghost Robotics
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Education

Postdoctoral fellow. University of Pennsylvania, Philadelphia, PA. Advisor: Dr. Daniel E. Koditschek	2017—now
Ph.D. University of Pennsylvania, Philadelphia, PA. Advisor: Dr. Daniel E. Koditschek	2010—17
M.S. (Mech Engg), B.S. (Engg Mech), B.S. (Appl Math). Johns Hopkins Univ, Baltimore, MD. Advisors: Dr. Noah J. Cowan (research), Dr. Alison Okamura (academic); GPA: 3.96/4.00	2006—10

Research areas & projects

Steady-state legged behaviors. Reactive gaits (tailed and monopedal hopping, quadrupedal bounding, pronking, trotting, pacing, and walking, bipedal walking) created from template compositions	2013—now
Transitional legged behaviors. Leaping using a leg and a tail; tailed inertial reorientation	2014—now
Applied dynamical systems. Interpret high-DOF coupled mechanical systems as coupled oscillators, developed a hybrid systems extension to dynamical averaging, use it to formally analyze stability of composed dynamical systems	
Design. Principles for direct-drive legged robot design; hardware design of a family of direct-drive robots, including complete design of Jerboa, Delta hopper, and partial design of Minitaur; motor and gearbox selection for steady and transient loads; electronics, firmware, base software and system architecture for high-bandwidth, high-transparency platforms spun off into Ghost Robotics	2012—now
Sensorimotor loops (servoing). "Active antenna"-based wall following; active visual servoing	2012—2013
Bayesian estimation. Proof of convergence of approximate Bayesian estimation using a finite parameterization of posterior belief state; SLAM on graphs	2007—2013
Paddle juggling. Analysis of the role of feedback in human paddle juggling	2009—2010

Work & teaching experience

Ghost Robotics LLC co-founder. Co-founded a company commercializing legged robots; current customers include universities (CMU, FSU, UTSA, …) and companies (Google, DeepMind). YouTube channel	2015—now
UPenn/Coursera instructor. Robotics specialization instructor for Mobility, Capstone courses; developed curriculum including topics like how animals and robots are designed and how they move, linearized control and balancing a mobile inverted pendulum	2016
UPenn TA. TA for ESE 201 (undergraduate dynamical systems), ESE 512 (graduate dynamical systems)	2011—12
LIMBS lab (Noah Cowan), JHU. Undergrad research assistant: neuromechanical control of juggling; SLAM on graphs	2007—10
Advanced Academic Programs, JHU. Web/database developer (Coldfusion/SQL)	2006—10
Academic Advising, JHU. Tutor (Physics I/II, Calculus I/II/III)	2007—08
Residential Life, JHU. Resident advisor	2008—10

Publications

Preprints / under review

A. De and D. E. Koditschek, "Vertical hopper compositions for preflexive and feedback-stabilized quadrupedal bounding, pacing, pronking, and trotting," recommended for publication, pending revisions.	2017
A. De, S. A. Burden and D. E. Koditschek, "A hybrid dynamical extension of averaging and its application to the analysis of legged gait stability," under review.	2017

Journal

G. Kenneally, **A. De**, and D. E. Koditschek, "Design Principles for a Family of Direct-Drive Legged Robots," IEEE Robotics and Automation Letters, vol. 1, no. 2, pp. 900–907, Jul. 2016.	2016
M. M. Ankarali, H. T. Sen, **A. De**, A. M. Okamura, and N. Cowan, "Haptic Feedback Enhances Rhythmic Motor Control By Reducing Variability, Not Convergence Rate," Journal of Neurophysiology, p. jn.00140.2013.	2013

Conference

G. Wenger, **A. De**, and D. E. Koditschek, "Frontal plane stabilization and hopping with a 2DOF tail," in Intelligent Robots and Systems (IROS), 2016 IEEE/RSJ International Conference on, 2016, pp. 567–573.	2016
T. T. Topping, V. Vasilopoulos, **A. De**, and D. E. Koditschek, "Towards bipedal behavior on a quadrupedal platform using optimal control," in SPIE 9837, Unmanned Systems Technology XVIII, 2016, p. 98370H.	2016
A. L. Brill, **A. De**, A. M. Johnson and D. E. Koditschek, "Tail-Assisted Rigid and Compliant Legged Leaping," in 2015 IEEE/RSJ International Conference on Intelligent Robots and Systems, Sep, 2015.	2015
A. De and D. E. Koditschek, "Averaged Anchoring of Decoupled Templates in a Tail-Energized Monoped, 2015 International Symposium on Robotics Research, Sep, 2015.	2015

A. De and D. E. Koditschek, "Parallel composition of templates for tail-energized planar hopping," in Robotics and Automation (ICRA), 2015 IEEE International Conference on, 2015, pp. 4562–4569	2015
A. De and D. E. Koditschek, "The Penn Jerboa: A Platform for Exploring Parallel Composition of Templates," arXiv:1502.05347 [cs.RO]	2015
A. De, K. S. Bayer, and D. E. Koditschek, "Active sensing for dynamic, non-holonomic, robust visual servoing," in Robotics and Automation (ICRA), 2014 IEEE International Conference on, 2014, pp. 6192–6198	2014
A. De, A. Ribeiro, W. Moran, and D. E. Koditschek, "Convergence of Bayesian Histogram Filters for Location Estimation," in Proceedings of the 2013 IEEE Intl. Conference on Decision and Control, 2013.	2013
A. De and D. E. Koditschek, "Toward dynamical sensor management for reactive wall-following," in Robotics and Automation (ICRA), 2013 IEEE International Conference on, 2013, pp. 2400–2406.	2013
A. De, G. Lynch, A. Johnson, and D. Koditschek, "Motor sizing for legged robots using dynamic task specification," in 2011 IEEE Conference on Technologies for Practical Robot Applications (TePRA), pp. 64–69	2011
A. De, J. Lee, N. Keller, and N. J. Cowan, "Toward SLAM on Graphs," in Algorithmic Foundation of Robotics VIII, vol. 57, G. S. Chirikjian, H. Choset, M. Morales, and T. Murphey, Eds. Berlin, Heidelberg: Springer Berlin Heidelberg, pp. 631–645	2009

Abstracts, posters, workshops, `and technical reports

A. De and D. E. Koditschek, "Within-stance symmetry helps mitigate coupling interactions between DOFs," Dynamic Walking.	2017
A. De and D. E. Koditschek, "Reactive coordination: stabilizing common quadrupedal gaits without CPGs," Sixth Annual Winter Workshop on Neuromechanics and Dynamics of Locomotion, Tulane University - New Orleans, Louisiana, January 19 – 20, 2017.	2017
G. Kenneally, **A. De** and D. E. Koditschek, "Design Principles for a Family of Direct-Drive Legged Robots," RSS Workshop.	2015
G. J. Wenger, **A. De** and D. E. Koditschek, "Roll Stabilization on a Tailed Biped," RSS workshop on robotic uses for tails.	2015
A. De and D. E. Koditschek, "The Penn Jerboa: A Platform for Exploring Parallel Composition of Templates," arXiv:1502.05347 [cs.RO]	2015
A. De, A. M. Johnson and D. E. Koditschek, "Planar Hopping with a Leg and a Tail," Dynamic Walking.	2014

Invited talks (excluding conference talks)

Stable hopping and running from compositions of dynamical primitives. UMichigan, JHU (June)	2017
Anchored Behaviors from Template Compositions. CMU bipedal seminar (Feb); UW seminar (Feb)	2017
Mechanically Simple, Behaviorally Versatile Quadrupeds. (with G. Kenneally) TRI (Palo Alto, CA), Google (Mountain View)	2017
Sequential, Parallel and Symbolic Compositions. UPenn ESE PhD Colloquium (Fall 2015)	2015
Anchor synthesis via template composition. AMAM 2015 in Boston, MA.	2015

Hardware

Electrical. Eagle PCB (2/4-layer boards); high-power electronics including brushless motor controllers capable of 1.5KW (continuous), >10KW (peak); versatile microcontroller mainboards with motor comms, logging, IMU, power distribution, operator control

Firmware. Created an Arduino-like set of libraries for STM32F3/4 microcontrollers (open-source "Koduino" repository); extensive experience with STM32 microcontrollers (timers, communication interfaces, DMA, …); communication protocols (EtherCAT, Ethernet, RS485 9-bit addressing multiprocessor communication, USART, SPI, I2C)

Mechanical. CAD (SolidWorks); designed a lightweight 2DOF spherical joint for Jerboa tail using parallel motors at the base and a linkage; designed a 3DOF parallel leg for Delta hopper; designed chassis, suspension, and steering for a single-seat 200 kg Baja SAE offroad vehicle

Honors and awards

Robert George Gerstmeyer Award. For academic achievement (JHU Mech. Engg. Department)	2008—09
Provost's Undergraduate Research Award. For summer research (JHU)	2008—09
Pi Tau Sigma Mech. Engg. honor society. Inductee (JHU)	2008
International Scholarship. Merit-based full-tuition scholarship (JHU)	2006—10

Activities and service

Reviewer. Bioinspiration & Biomimetics, Automatica, T/RO, RA/L, European Journal of Physics, Control Engineering Practice, ICAR, ICHR, ICRA, IFACWC, IROS, SYROCO, WAFR	2016
Mentoring. Mentored two undergraduate students to write papers accepted to ICRA/IROS	2013—14
Outreach. Two-time volunteer / judge at Penn First Lego League (FLL)	2014—16
Animal welfare. Volunteer at Philadelphia Animal Welfare Society (PAWS); cat fostering	2014—now
Hopkins Baja, JHU. Team captain of an engineering design team creating a single-seat offroad vehicle for an SAE-organized collegiate competition; suspension and steering design lead	2006—10
JH Math Club, JHU. Part of JHU Putnam team; contributed problems to JH math tournament for HS students	2006—09
ASME chapter, JHU. Secretary/treasurer	2006—10