Nicholas (Nick) Rotella, Ph.D.

CONTACT
INFORMATION

Nicholas Rotella
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BACKGROUND

I am a robotics engineer interested in state estimation, sensor fusion, motion planning and model-based control. I specialize in developing robust and efficient methods using a combination of physical models and sensors. My expertise spans both software implementation and hardware testing for a variety of autonomous systems including legged robots, self-driving vehicles, unmanned aerial and marine systems and industrial applications. My academic background in mechanical engineering, neuroscience and computer science allows me to approach robotics problems from a multidisciplinary perspective. I remain engaged with the academic community and perform literature reviews to solve problems using current research methods.

EDUCATION

Doctor of Philosophy (Computer Science)
June 2014 - May 2018

The University of Southern California, Los Angeles, CA

- Thesis: "Estimation-Based Control for Humanoid Robots"
- Advisor: Dr. Stefan Schaal (**Computational Learning and Motor Control Lab**)
- Co-Advisor: Dr. Ludovic Righetti (in collaboration with the **Max-Planck Institute for Intelligent Systems**, Tuebingen, Germany)
- Viterbi Dean's Fellowship, 2012 - 2016

Master of Science (Computer Science)
August 2012 - June 2014

The University of Southern California, Los Angeles, CA

- Specialization: Intelligent Robotics
- GPA: 3.82

Bachelor of Engineering (Mechanical Engineering)
August 2008 - June 2012

The Cooper Union for the Advancement of Science and Art, New York, NY

- Academic Societies: American Society of Mechanical Engineers, Tau Beta Pi Engineering Honors Society, Pi Tau Sigma Mechanical Engineering Honors Society

- Senior Project: "Gestural Language for Operations in Virtual Environments" (G.L.O.V.E.), an Arduino-based wearable device equipped with finger flex sensors and IMUs for gesture recognition and sign language translation (advised by Dr. Stan Wei)
- GPA: 3.71

INDUSTRY
EXPERIENCE

Ainstein (Lawrence, KS)
September 2018 - Present

Robotics Software Engineer and Research Scientist

- Sensor fusion and sensor-based controls for autonomous systems including self-driving vehicles, drones and industrial automation using RADAR, LIDAR, cameras, GPS, IMU
- Development, release, support and documentation of ROS packages for sensor integration and 3d perception (PCL)
- Implementation (C/C++, Python) of SLAM, object tracking/detection and model-based control in simulation (Gazebo) and on real systems (drones, mobile robots)
- Utilization of high-performance embedded computing platforms (NVIDIA Drive PX2, Jetson TX2) for deep learning applications (TensorFlow) and GPU programming
- NSF IUCRC representative, co-PI on SBIR grant proposal (to be submitted)
- Software engineering and system integration work for various client projects

Garmin International (Olathe, KS)
January 2018 - September 2018

Software Engineer, Controls

- Design and implementation (C/C++, Python) of optimal controllers (LQR) and estimators (EKF/UKF, MMAE) based on simplified models for underactuated marine systems
- Development and use of custom dynamics simulations (Qt, OpenGL) for prototyping control algorithms
- Hardware testing and controller verification for electromechanical systems
- Use of code reviews, software quality testing and documentation (Jira, Confluence)

RESEARCH
EXPERIENCE

Research Assistant, Computational Learning and Motor Control (CLMC) Lab
University of Southern California, Los Angeles, CA
August 2012 - January 2018

- Formulate, prototype (MATLAB, Python), implement (C/C++) and publish novel estimation and control algorithms for humanoid robots
- Use model-based optimization (QPs, LQR, DDP) for trajectory planning and whole-body control of high-dimensional systems
- Apply optimal filtering (EKF, UKF, PF) and statistical learning to fuse models with a variety of types of sensor data
- Develop realtime-safe software (Xenomai) and embedded motor control algorithms for the operation of a hydraulic humanoid robot
- Peer review conference and journal paper submissions for major robotics conferences

Research Assistant, The Joe Francis Lab
SUNY Downstate Medical School, Brooklyn, NY
June 2011 - December 2011

- Simulated a population of motor cortex neurons for a target-based reaching task
- Implemented a simulated brain-machine interface (BMI) using an artificial neural network trained by reinforcement learning

Research Assistant, Laboratory for Energy Reclamation and Innovation
The Cooper Union, Hveragerdi, Iceland
June 2010 - August 2010

- Designed and constructed a geothermally-heated garden at the HNLFI health clinic
- Performed data collection and analysis for ongoing plant growth comparison experiments

TEACHING
EXPERIENCE

Guest Lecturer, Introduction to Robotics (CSCI545)
The University of Southern California, Los Angeles, CA
August 2012 - December 2017

- Developed and gave occasional lectures on graduate-level robotics topics such as state estimation and humanoid control

Teaching Assistant, Introduction to neurophysiology and the biophysics of computation (PH330)
The Cooper Union, New York, NY
August 2011 - December 2011

- Facilitated experiments involving invertebrate dissection, neural recording and data processing throughout the semester-long course
- Maintained the lab space and constructed tools for electrophyisological experiments

Teaching Assistant, Summer Engineering Research Program
The Cooper Union, New York, NY
June 2011 - August 2011

- Assisted high school students with neuroscience course material and experiments
- Aided students in developing, performing and analyzing novel research projects

VOLUNTEERING

Mentor, FIRST robotics team 1939
Kansas City, MO
2019 - Present

Robotics Mentor, PREP-KC
Kansas City, MO
2019 - Present

Judge, PLTW KC Engineering Design Contest
Kansas City, MO
2019

Judge, Greater KC Science and Engineering Fair
Kansas City, MO
2018, 2019

Teaching Assistant, TEALS K-12 Program
Kansas City, MO
2018 - 2019

Research Lab Tour Guide, USC Robotics Open House
Los Angeles, CA
2012 - 2017

HARDWARE AND
SOFTWARE SKILLS

Programming and Scripting Languages:
- Proficient in: C/C++, Python, ROS, MATLAB, LaTeX, Markdown
- Familiar with: Java, JavaScript, HTML/CSS

Programming Libraries:
- Simulation environments (Gazebo), linear algebra (Eigen), GUI development (Qt, TkInter), graphics programming (OpenGL, OGRE), GPU programming (CUDA), deep learning (TensorFlow), point cloud processing (PCL), machine vision (OpenCV)

Operating Systems and Tools:
- Proficient in: Git, Linux and realtime Xenomai patch, Windows, C/C++ IDEs (Eclipse, CLion)
- Familiar with: Atlassian tools (Confluence, JIRA), embedded systems (NVIDIA PX2/TX2, ARM microprocessors)

Robotics:

- Extensive theoretical and practical knowledge of model-based robot control (inverse kinematics/dynamics), optimal control (LQR and nonlinear variants, e.g. iLQR, DDP), optimal estimation (Kalman Filtering and nonlinear variants, e.g. EKF, UKF), trajectory optimization, data analysis and machine learning techniques (supervised, unsupervised and reinforcement learning)
- Experience setting up linux systems for robot control, writing realtime-safe software, interfacing with sensors and performing experiments on a torque-controlled hydraulic humanoid robot

PROFESSIONAL
MEMBERSHIPS
- Institute of Electrical and Electronics Engineers (2012–present)
- Tau Beta Pi Engineering Honors Society (2011–present)
- Pi Tau Sigma Mechanical Engineering Honors Society (2011–present)

PUBLICATIONS

[1] N. Rotella, , S. Schaal, and L. Righetti, "Unsupervised contact learning for humanoid estimation and control," in *2018 IEEE International Conference on Robotics and Automation (ICRA)*, 2018. [Online]. Available: https://arxiv.org/abs/1709.07472

[2] S. Mason, N. Rotella, , S. Schaal, and L. Righetti, "Mpc walking framework with external contact forces," in *2018 IEEE International Conference on Robotics and Automation (ICRA)*, 2018.

[3] S. Mason, N. Rotella, S. Schaal, and L. Righetti, "Balancing and walking using full dynamics lqr control with contact constraints," in *2016 IEEE-RAS 16th International Conference on Humanoid Robots (Humanoids)*, Nov 2016, pp. 63–68.

[4] N. Rotella, S. Mason, S. Schaal, and L. Righetti, "Inertial sensor-based humanoid joint state estimation," in *2016 IEEE International Conference on Robotics and Automation (ICRA)*, May 2016, pp. 1825–1831.

[5] N. Rotella, A. Herzog, S. Schaal, and L. Righetti, "Humanoid momentum estimation using sensed contact wrenches," in *Humanoid Robots (Humanoids), 2015 IEEE-RAS 15th International Conference on*, Nov 2015, pp. 556–563.

[6] A. Herzog, N. Rotella, S. Schaal, and L. Righetti, "Trajectory generation for multi-contact momentum control," in *Humanoid Robots (Humanoids), 2015 IEEE-RAS 15th International Conference on*, Nov 2015, pp. 874–880.

[7] A. Herzog, N. Rotella, S. Mason, F. Grimminger, S. Schaal, and L. Righetti, "Momentum control with hierarchical inverse dynamics on a torque-controlled humanoid," *Autonomous Robots*, vol. 40, no. 3, pp. 473–491, 2015. [Online]. Available: http://dx.doi.org/10.1007/s10514-015-9476-6

[8] N. Rotella, M. Bloesch, L. Righetti, and S. Schaal, "State estimation for a humanoid robot," in *2014 IEEE/RSJ International Conference on Intelligent Robots and Systems*, Sept 2014, pp. 952–958.

[9] A. Tarigoppula, N. Rotella, and J. T. Francis, "Properties of a temporal difference reinforcement learning brain machine interface driven by a simulated motor cortex," in *2012 Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, Aug 2012, pp. 3284–3287.

CONFERENCE
TALKS

[1] N. Rotella, "Humanoid Momentum Estimation Using Sensed Contact Wrenches," in the IEEE-RAS Conference on Humanoid Robots (Humanoids), Seoul, Korea, November 3–5, 2015.

[2] N. Rotella, "Estimation, Planning and Control for Force-Centric Bipedal Locomotion," in the Conference on Dynamic Walking, Columbus, OH, 2015.

CONFERENCE
POSTERS

[3] N. Rotella, "Unsupervised contact learning for humanoid estimation and control," in IEEE International Conference on Robotics and Automation (ICRA), Brisbane, Australia, May 21–25, 2018

[4] N. Rotella, "IMU-based joint state estimation for humanoid control," in the Conference on Dynamic Walking, Ann Arbor, MI, June 4–7, 2016.

[5] N. Rotella, "Inertial Sensor-Based Humanoid Joint State Estimation," in IEEE International Conference on Robotics and Automation (ICRA), Stockholm, Sweden, May 16–21, 2016.

[6] N. Rotella, "Momentum Estimation, Planning and Control for Force-Centric Bipedal Locomotion," in the Conference on Dynamic Walking, Columbus, OH, July 21–24, 2015.

[7] N. Rotella, "State estimation for a humanoid robot,"in the IEEE/RSJ International Conference on Intelligent Robots and Systems, Chicago, IL, September 14–18, 2014.

[8] N. Rotella, "State Estimation for Walking Humanoids on Unknown Terrain," in the Conference on Dynamic Walking, Zurich, Switzerland, June 10–13, 2014.

PAPER REVIEWS

NB: Although IEEE provides an official compliation of reviewer activities, it is not provided here on the basis of preserving author-reviewer confidentiality. Instead, here is a summary:

- IEEE-RAS International Conference on Humanoid Robots (Humanoids): 2013, 2014, 2016, 2017, 2018

- IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS): 2013, 2014, 2015, 2016, 2017, 2018, 2019

- IEEE International Conference on Robotics and Automation (ICRA): 2017, 2018, 2019

- IEEE International Conference on Multisensor Fusion and Integration for Intelligent Systems (MFI): 2016, 2017

- IEEE International Conference on Advanced Intelligent Mechatronics (AIM): 2017, 2018, 2019

- IEEE RAS/EMBS International Conference on Biomedical Robotics and Biomechatronics (BioRob): 2018

- Conference on Robot Learning (CoRL): 2018

- IEEE Transactions on Robotics (TR-O): x4

- IEEE Robotics and Automation Letters (RA-L): x6

- Journal of Intelligent and Robotic Systems (JINT): x1

- Autonomous Robots (AURO): x1

- Sensors Journal: x1

- Robotics and Autonomous Systems: x1