

CURRICULUM VITAE

Gabriel M. Nelson

Principal Robot Scientist
Boston Dynamics

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Work address

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SUMMARY

Experienced roboticist, specializing in the modeling and control of highly-dynamic machines, especially legged robots.

GOALS

Develop and demonstrate in hardware, world-class game-changing results in robotics, especially in the areas of manipulation, legged robotics, and perception.

SKILLS

Dynamics, robotics, mechanics, modeling, algorithms, simulation, control systems, mechanical engineering, mathematics, Matlab, Mathematica, C++; Some experience with perception-based sensing and terrain modeling, including stereo vision and LIDAR.

EDUCATION

Ph.D. Mechanical Engineering, Case Western Reserve University, 2002
Emphases: robotics, dynamics, control of legged locomotion
M.S. Mechanical Engineering, Case Western Reserve University, 1995
B.S. Mechanical Engineering, Case Western Reserve University, 1992

WORK EXPERIENCE

2012 - 2018 Principal Robot Scientist, Boston Dynamics: Developed and implemented core control algorithms for dynamic bipedal and quadrupedal robots, such as the regulation of balance, gait and movement coordination, balance-state estimation, force and posture control, control of parkour movements. Perception work with stereo vision and LIDAR, occlusion detection and terrain inference, and simple SLAM algorithms. Some projects include (see [YouTube.com/BostonDynamics/](https://www.youtube.com/BostonDynamics/)):

- BigDog: Boston Dynamics' first autonomous, rough-terrain, dynamic quadruped
- LS3: 'Legged Squad Support System,' a much larger version of BigDog

- PETMAN: Anthropometric bipedal robot for testing chemical protective clothing
 - Atlas: Humanoid robots for dynamic locomotion over real-world terrain
 - Spot: The latest line of smaller, faster, more agile quadrupeds at Boston Dynamics
- 2014 - 2017 Staff Robotacist, Google, Boston Dynamics subsidiary
- 2005 - 2012 Lead Robotics Engineer, Boston Dynamics
- 2003 - 2005 Simulation Engineer, Boston Dynamics: Responsible for developing, testing, and implementing advanced movement and locomotion control for simulated humans and real and simulated robots.
- 2002 - 2003 Research Associate and Instructor, CWRU, Mechanical and Aerospace Engineering: Assisted in proposal writing and funding solicitation, advising graduate students, undergraduate and graduate teaching responsibilities; research in the control of legged locomotion.
- 1989 - 1992 Co-op Engineer, LTV Steel Technology Center, Independence, OH: R&D in support of continuous casting, continuous and batch annealing.

TEACHING EXPERIENCE

- 2002 Instructor for Robotics I (EMAE/EECS 489): Graduate level course in Departments of Mechanical and Electrical Engineering/ Computer Science at CWRU.
- 2002 Instructor for Engineering Dynamics (EMAE 181).
- 1999 - 2001 Instructor for Robotics I (EMAE/EECS 489): Taught kinematics and dynamics portions of class for three consecutive years.

SELECT HONORS AND AWARDS

- The Robert and Leona Garwin Award for Theoretical Scientific Ability and Experimental Competence, 1992.
- Graduate Student Researchers Program Fellowship, NASA/Marshall Space Flight Center, Huntsville, Alabama, August 1993 - August 1997.
- As part of the BigDog Team:
 - Popular Mechanics Breakthrough Award for BigDog, 2006.
 - Winner, Association for the Advancement of Artificial Intelligence (AAAI), Best Short Video: “BigDog,” M. Raibert, K. Blankespoor, G. Nelson, R. Playter and the Entire BigDog Team, 2008.
 - BigDog: 2012 Inductee into the Robot Hall of Fame, in the “Research” category.

PUBLICATIONS

Invited Publications

1. Raibert, M., K. Blankespoor, G. Nelson, R. Playter, and the BigDog Team, “BigDog, the Rough-Terrain Quadruped Robot,” *Proceedings of the 17th International Federation of Automatic Control World Congress*, Seoul, Korea, July, 2008.

2. Nelson, G., A. Saunders, N. Neville, B. Swilling, J. Bondaryk, D. Billings, C. Lee, R. Playter, M. Raibert, "PETMAN: A Humanoid Robot for Testing Chemical Protective Clothing," *Journal of the Robotics Society of Japan*, Vol. 30, No. 4, pp. 372-377, May 2012.
3. Nelson, G., A. Saunders, R. Playter, "The PETMAN and Atlas Robots at Boston Dynamics," in *Humanoid Robotics: A Reference* (Springer), eds. A. Goswami, P. Vadakkepat, Oct 2017.

Invited Talks

1. Nelson, G., K. Blankespoor, M. Raibert, "Walking BigDog: Insights and Challenges from Legged Robotics," World Congress of Biomechanics, Munich, Germany, 2006.
2. Raibert, M., and G. Nelson, "Dynamic Legged Robots at Boston Dynamics," Dynamic Walking Conference, MIT, Cambridge, Massachusetts, 2010.

Refereed Publications

1. Nelson, G.M., and Quinn, R.D., "A Lagrangian Quasicoordinate Formulation for Dynamic Simulations of Multibody Systems," *1995 ASME International Mechanical Engineering Congress, Dynamic Systems and Control Division*, San Francisco, Ca., Nov., 1995.
2. Nelson, G.M., Quinn, R.D., Bachmann, R.J., Flannigan, W.C., Ritzmann, R.E., Watson, J.T., "Design and Simulation of a Cockroach-like Hexapod Robot," *1997 IEEE International Conference on Robotics and Automation (ICRA)*, Albuquerque, NM, April, 1997.
3. Nelson, G.M., Quinn, R.D., "Posture Control of a Cockroach-like Robot," *1998 IEEE International Conference on Robotics and Automation (ICRA)*, Leuven, Belgium, May, 1998.
4. Nelson, G. M. and Quinn, R. D., "Posture Control of a Cockroach-like Robot," *IEEE Control Systems*, Vol. 19, No. 2, April 1999.
5. Flannigan, W.C., Nelson, G.M., Quinn, R.D., "Locomotion Controller for a Crab-like Robot," *1998 IEEE International Conference on Robotics and Automation (ICRA)*, Leuven, Belgium, May, 1998.
6. Nelson, G. M. and Quinn, R. D., "A Lagrangian Quasicoordinate Formulation for Dynamic Simulations of Multibody Systems," *Journal of the Chinese Society of Mechanical Engineers*, Vol. 21, No. 1, pp. 25-33, February, 2000.
7. Wei, T., Nelson, G.M., Quinn, R.D., Verma, H., Garverick, S. "A 5cm autonomous hopping robot," *2000 IEEE International Conference on Robotics and Automation (ICRA)*, San Francisco, CA., April, 2000.
8. Laksanacharoen, S., Pollack, A., Nelson, G.M., Ritzmann, R.E., Quinn, R.D., "Biomechanics and simulation of cricket for microrobot design," *2000 IEEE Conference on Robotics and Automation (ICRA)*, San Francisco, CA., April, 2000.
9. Quinn, R.D., Nelson, G.M., Bachmann, R.J., and Ritzmann, R.E., "Toward Mission Capable Legged Robots through Biological Inspiration," *Autonomous Robots*, 11 (3), 215-220, 2001.
10. Colbrunn, R.W., Nelson, G.M., and Quinn, R.D. "Design and Control of a Robotic Leg with Braided Pneumatic Actuators," *2001 Int. Conf. on Intelligent Robots and Systems (IROS)*, Maui, HI, 2001.
11. Colbrunn, R.W., Nelson, G.M., and Quinn, R.D., "Modeling of Braided Pneumatic Actuators for Robotic Control," *2001 Int. Conf. on Intelligent Robots and Systems (IROS)*, Maui, HI, 2001.

12. Quinn, R., Nelson, G., Bachmann, R., Kingsley, D., Offi, J., Allen, T., Ritzmann, R., "Parallel Complementary Strategies for Implementing Biological Principles into Mobile Robots," *International Journal of Robotics Research*, Vol. 22, No. 3-4, pp. 169-186, March, 2003.

Video Conference Proceedings (Refereed)

Nelson, G.M., Bachmann, R.J., Quinn, R.D., Watson, J.T., Ritzmann, R.E., "Posture Control of a Cockroach-like Robot," *Video Proceedings of the 1998 IEEE International Conference on Robotics and Automation*, Leuven, Belgium, May, 1998.

Book Chapters

1. Quinn, R.D., Nelson, G.M. and Ritzmann, R.E. "Toward the Development of Agile and Mission Capable Legged Robots" in *Neurotechnology for Biomimetic Robots*, edited by J. Ayers, J. Davis, and A. Rudolph, MIT Press, MA.
2. Quinn, R.D., Colbrunn, R.W., Nelson, G.M., Kingsley, D.A., Bachmann R.J., Ritzmann, R.E., "McKibben Artificial Muscles for Insect Inspired Robots," in *Biomechanical Modeling*, edited by M.D. Grabiner, Human Kinetics.

Other Publications

1. Nelson, G.M., "Learning about Control of Legged Locomotion using a Hexapod Robot with Compliant Pneumatic Actuators," Ph.D. Dissertation, Case Western Reserve University, Mechanical and Aerospace Engineering, May, 2002.
2. Nelson, G.M., "Modeling and Simulation of an Insect-like Hexapod," Masters Thesis, Case Western Reserve University, Mechanical and Aerospace Engineering, August, 1995.
3. Nelson, G.M., and Quinn, R.D., "A Quasicoordinate Formulation for Dynamic Simulations of Complex Multibody Systems with Constraints," 3rd International Conference on Dynamics and Control of Structures in Space, London, UK, May 27-31, 1996, appearing in *Dynamics and Control of Structures in Space III*, ed. C.L. Kirk, D.J. Inman, pp.523-538, Computational Mechanics Publications, Southampton, UK, 1996.
4. Flannigan, W. C., Nelson, G. M., Quinn, R. D., "Control of a Crab-like Robot with Complex Kinematic Constraints," *The 11th VPI&SU Symposium on Structural Dynamics and Control*, May 12-14, 1997.
5. Bachmann, R. J., Nelson, G. M., Quinn, R. D., Watson, J., Ritzmann, R. E. "Design of a Cockroach-like Robot," *The 11th VPI&SU Symposium on Structural Dynamics and Control*, May 12-14, 1997.
6. Bachmann, R. J., Nelson, G. M., Quinn, R. D., Watson, J., Tryba, A. K , Ritzmann, R. E. "Construction of a Cockroach-like Hexapod Robot," *Sixth IASTED International Conference on Robotics and Automation*, Banff, Canada, pp. 22-27, July 26-29, 1998.
7. Ramasubramanian, S., Flannigan, W. C., Nelson, G. M., Quinn, R. D., Zill, S. N., "Modeling of load sensing during the stance phase of cockroach walking," *Conference on Climbing and Walking Robots (CLAWAR '99)*, Portsmouth, September 13-15, 1999.

8. Sari, K., Nelson, G. M., and Quinn, R. D., "Dynamics of a Humanoid Biped," *Nonlinear Vibration Conference*, Virginia Tech, Blacksburg, VA, July 23-27, 2000.
9. Sari, K., Nelson, G. M., and Quinn, R. D., "Dynamics and Control of a Simulated 3-D Humanoid Biped," *Int. Symposium on Adaptive Motion of Animals and Machines (AMAM)*, Montreal, Quebec, Canada, August 8-12, 2000.
10. Quinn, R. D. Nelson, G.M., Bachmann, R.J., Kingsley, D.A., Offi, J. and Ritzmann, R.E., "Insect Designs for Improved Robot Mobility," *Conference on Climbing and Walking Robots (CLAWAR'2001)*, Karlsruhe, Germany, 2001.
11. Nelson, G.M. and Quinn, R.D., "A numerical solution to inverse kinematics for swing control of a cockroach-like robot," *Conference on Climbing and Walking Robots (CLAWAR'2001)*, Karlsruhe, Germany, 2001.
12. Choi, J., Watson, J.T., Nelson, G.M., Ritzmann, R.E., and Quinn, R.D., "Virtual versus Real Locomotion over Obstacles," 5th International Conference on Dynamics and Control of Structures in Space, Cambridge, UK, July 14-18, 2002, appearing in *Dynamics and Control of Structures in Space 2002*, ed. T.S. Bowling, R.L. Oswald, pp.317-324, Cranfield University Press, Bedfordshire, UK, 2002.

RESEARCH GRANTS

NASA/MSFC GSRP Fellowship Grant NGT-52832, "Biologically-Inspired Control of an Insect-like Robot," initial award for three years through August 1996, additional award through August 1997, \$88,000.

PATENTS

At this time, several patents pending with Google/Boston Dynamics, in the areas of the control of legged locomotion.