

# **JEAN-JACQUES SLOTINE**

*PROFESSOR OF MECHANICAL ENGINEERING AND INFORMATION SCIENCES  
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Professor Jean-Jacques Slotine is Professor of Mechanical Engineering and Information Sciences, Professor of Brain and Cognitive Sciences, and Director of the Nonlinear Systems Laboratory. He received his Ph.D. from the Massachusetts Institute of Technology in 1983, at age 23. After working at Bell Labs in the computer research department, he joined the faculty at MIT in 1984. Professor Slotine teaches and conducts research in the areas of dynamic systems, robotics, control theory, computational neuroscience, and systems biology.

Research in Professor Slotine's laboratory focuses on developing rigorous but practical tools for nonlinear systems analysis and control. These have included key advances and experimental demonstrations in the contexts of sliding control, adaptive nonlinear control, adaptive robotics, machine learning, and contraction analysis of nonlinear dynamical systems.

Professor Slotine is the co-author of two popular graduate textbooks, "Robot Analysis and Control" (Asada and Slotine, Wiley, 1986), and "Applied Nonlinear Control" (Slotine and Li, Prentice-Hall, 1991) and is one of the most cited researcher in both systems science and robotics. He was a member of the French National Science Council from 1997 to 2002, and a member of Singapore's A\*STAR SigN Advisory Board from 2007 to 2010. He is currently a member of the Scientific Advisory Board of the Italian Institute of Technology. He has held Invited Professor positions at College de France, Ecole Polytechnique, Ecole Normale Supérieure, Università di Roma La Sapienza, and ETH Zurich.

Professor Slotine is the recipient of the 2016 Rufus Oldenburger Medal.

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## EDUCATION

**1981-1983**      **MASSACHUSETTS INSTITUTE OF TECHNOLOGY**      **CAMBRIDGE, MA**

Received the Ph.D. Degree in Estimation and Control (May 1983) from the Department of Aeronautics and Astronautics. Thesis in Nonlinear Control with applications to Robotics.

Minor Field in Business Administration at the Harvard Business School.

**1978-1981**      **ECOLE NATIONALE SUPERIEURE DE L'AERONAUTIQUE ET DE L'ESPACE**      **TOULOUSE, FRANCE**

Received the Aerospace Engineer Degree (July 1981). Board Member, European Association of Aerospace Students.

## PROFESSIONAL EXPERIENCE

**1984-current**      **MASSACHUSETTS INSTITUTE OF TECHNOLOGY**      **CAMBRIDGE, MA**

Joined the faculty in October 1984. Currently, Professor of Mechanical Engineering and Information Sciences, Professor of Brain and Cognitive Sciences, and Director of the Nonlinear Systems Laboratory. Research focuses on nonlinear dynamics, computational neuroscience, systems biology, and robotics.

Visiting positions: Ecole polytechnique, Directeur de Recherche, 1992, Professeur de Mathematiques Appliquees, 1999; Ecole Normale Superieure, Professeur Invite, 2003, 2004, 2005 and 2009; College de France, Professeur Invite, 1996, 2000, and 2007.

Member of the French National Science Council, 1997-2002.

Member of the Director's Advisory Board, McGovern Institute of Brain Research, 1999-2004.

Member of the Scientific Advisory Board, Singapore Immunology Network, 2007-2009.

President of the Scientific Advisory Board for Recruitment, CIRB, College de France, 2010.

Member of the Scientific Advisory Board, Italian Institute of Technology, 2010-present.

Winner of the 2016 Rufus Oldenburger Medal.

**Oct. 1983-  
Oct. 1984**      **ROBOTICS SYSTEMS RESEARCH DEPARTMENT, AT&T BELL LABORATORIES HOLMDEL, NJ**

Designed and developed the control algorithms for a high performance Direct-Drive Arm used for research on robot control and fast sensor-based motion.

**June-Sept.1983**      **MAN-MACHINE SYSTEMS LABORATORY, M.I.T.**      **CAMBRIDGE, MA**

Developed the control algorithms for a large marine manipulator.

**Apr.-Jul. 1981**      **LABORATORY FOR INFORMATION AND DECISION SYSTEMS, M.I.T.**      **CAMBRIDGE, MA**

Designed an autopilot to compensate for severe wind-shears in landing.

**June-Sept. 1980**      **STANFORD UNIVERSITY MEDICAL SCHOOL**      **STANFORD, CA**

Developed algorithms for acquisition and analysis of cytofluorographic data.

## Publications of Jean-Jacques Slotine

### 1. Books

1. Asada, H., and Slotine, J.J.E., *Robot Analysis and Control*, John Wiley & Sons, New York, 1986.
2. Slotine, J.J.E., and Li, W., *Applied Nonlinear Control*, Prentice-Hall, 1991.

### 2. Papers in Refereed Journals

1. Slotine, J.J.E., and Sastry, S. S., "Tracking Control of Nonlinear Systems using Sliding Surfaces with Application to Robot Manipulators," *Int. J. Control*, 38(2), 1983.
2. Slotine, J.J.E., "Sliding Controller Design for Nonlinear Systems," *Int. J. Control*, 40(2), 1984.
3. Slotine, J.J.E., "The Robust Control of Robot Manipulators," *Int. J. Robotics Res.*, 4(2), 1985.
4. Yoerger, D. R., and Slotine, J.J.E., "Robust Trajectory Control of Underwater Vehicles," *I.E.E.E. J. Oceanic Eng.*, 10(4), 1985.
5. Slotine, J.J.E., and Spong, M. S., "Robust Feedback Control of Robot Manipulators with Bounded Input Torques," *Int. J. Robotics Systems*, 2(3), 1985.
6. Slotine, J.J.E., and Coetsee, J. A., "Adaptive Sliding Controller Synthesis for Nonlinear Systems," *Int. J. Control*, 43(4), 1986.
7. Yoerger, D. R., Newman, and J. B., Slotine, J.J.E., "Supervisory Control System for the Jason ROV," *I.E.E.E. J. Oceanic Eng.*, 11(6), 1986.
8. Slotine, J.J.E., and Yoerger, D. R., "A General Inverse Kinematics Algorithm for Redundant Manipulators," *Int. J. Robotics and Automation*, 2(2), 1987.
9. Slotine, J.J.E., and Li, W., "On The Adaptive Control of Robot Manipulators," *Int. J. Robotics Research*, 6(3), 1987.
10. Slotine, J.J.E., Hedrick, J. K., and Misawa, E., "On Sliding Observers for Nonlinear Systems," *A.S.M.E. J. Dynamic Systems, Measurement, and Control*, 109(3), 1987.
11. Yoerger, D. R., and Slotine, J.J.E., "Task-Resolved Motion Control of Vehicle-Manipulator Systems," *Int. J. Robotics and Automation*, 2(3), 1987.
12. Slotine, J.J.E., and Khatib, O., "Robust Control in Operational Space for Goal-Positioned Manipulator Tasks," *Int. J. Robotics and Automation*, 3(1), 1988.
13. Slotine, J.J.E., "Putting Physics in Control," *I.E.E.E. Control Systems Magazine*, 8(6), 1988.
14. Slotine, J.J.E., and Li, W., "Adaptive Manipulator Control: A Case Study," *I.E.E.E. Trans. Automatic Control*, 11(3), 1988.
15. Li, W., and J.J.E. Slotine, "An Indirect Adaptive Robot Controller," *Systems and Control Letters*, 12(3), 1989.
16. Slotine, J.J.E., and Yang, H. S., "Improving the Efficiency of Time-Optimal Path-Following Algorithms," (Communication), *I.E.E.E. J. Robotics and Automation*, 5(1), 1989.
17. Slotine, J.J.E., and Li, W., "Composite Adaptive Control of Robot Manipulators," *Automatica*, 25(4), 1989.
18. Slotine, J.J.E., and di Benedetto, M. D., "Hamiltonian Adaptive Control of Spacecraft," (Communication), *I.E.E.E. Trans. Automatic Control*, 35(7), 1990.
19. Yoerger, D. R., Cooke, J. G., and Slotine, J.J.E., "The Influence of Nonlinear Thruster Dynamics on Underwater Vehicle Behavior," *I.E.E.E. J. of Oceanic Engineering*, 15(3), 1990.

## Publications of Jean-Jacques Slotine

20. Niemeyer, G., and Slotine, J.J.E., "Performance in Adaptive Manipulator Control," *Int. J. Robotics Research*, 10(2), 1991.
21. Canudas, C., and Slotine, J.J.E., "Nonlinear Observers for Robot Manipulators," (communication), *Automatica*, 27(5), 1991.
22. Niemeyer, G., and Slotine, J.J.E., "Stable Adaptive Teleoperation," *I.E.E.E. J. of Oceanic Engineering*, 16(1), 1991.
23. Sanner, R., and Slotine, J.J.E., "Gaussian Networks for Direct Adaptive Control," *I.E.E.E. Tran. Neural Networks*, 3(6), 1992. (Best Paper Award)
24. Slotine, J.J.E., and Hedrick, J. K., "Robust Input-Output Feedback Linearization," *Int. J. Control*, 57(5), 1993.
25. Yang, H. S., and Slotine, J.J.E., "Fast Algorithms for Near-Minimum-Time Robot Motion," (Communication), *Int. J. Robotics Research*, 13(6), 1994.
26. Sanner, R., and Slotine, J.J.E., "Stable Robotic Learning using 'Neural' Networks," *Neural Computation*, 7(4), 1995.
27. Cannon, M., and Slotine, J.J.E., "Space-Frequency Localized Basis Function Networks for Nonlinear Estimation and Control," *Neurocomputing*, 9(3), 1995. (Best Paper Award).
28. Lloyd, S., and Slotine, J.J.E., "Information Theoretic Tools for Stable Adaptation and Learning," *Int. J. Adaptive Systems*, 10, 1996.
29. Massaquoi, S., and Slotine, J.J.E., "The Intermediate Cerebellum May Function as a Wave Variable Processor," *Neuroscience Letters*, 214, 1996.
30. Hanneton, S., Berthoz, A., Droulez, D., and Slotine, J.J.E., "Does the Brain Use Sliding Variables for the Control of Movements," *Biological Cybernetics*, 77(6), 1997.
31. Lohmiller, W., and Slotine, J.J.E., "Contraction Analysis for Nonlinear Systems," *Automatica*, 34(6), 1998.
32. Lloyd, S., and Slotine, J.J. E., "Analog Quantum Error Correction," *Physical Review Letters*, 80(18), 1998.
33. Lohmiller, W., and Slotine, J.J.E., "Nonlinear Process Control Using Contraction Theory," *AICHE Journal*, 46(3), March 2000. 1999.
34. Lohmiller, W., and Slotine, J.J.E., "Control System Design for Mechanical Systems Using Contraction Theory," *I.E.E.E. Trans. Aut. Control*, 45(5), 2000.
35. Lloyd, S., and Slotine, J.J.E., "Feedback Control of Quantum Systems Using Ensemble Measurements," *Physical Review A*, July 2000.
36. Slotine, J.J.E., and Lohmiller, W., "Modularity, Evolution, and the Binding Problem: A View from Stability Theory," *Neural Networks*, 14(2), February, 2001.
37. Slotine, J.J.E., "La Robotique à l'heure des Neurosciences," *La Recherche*, 350, Fevrier 2002.
38. Hahnloser, R., Seung, H.S., and Slotine, J.J.E., "Permitted and Forbidden Sets in Symmetric Threshold-Linear Networks," *Neural Computation*, 15, 2003.
39. Slotine, J.J.E., "Modular Stability Tools for Distributed Computation and Control," *Int. J. Adaptive Control and Signal Proc.*, 17(6), 2003.
40. Zuo, L., and Slotine, J.J.E., "Robust Vibration Isolation via Frequency-Shaped Sliding Control and Modal Decomposition," *Journal of Sound and Vibration*, 2004.
41. Lloyd, S., Landahl, A., and Slotine, J.J.E., "Universal Quantum Interfaces," *Physical Review A*, 69, 2003.

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42. Niemeyer, G., and Slotine J.J.E., "Telemanipulation with Time Delays," *International Journal of Robotics Research*, 23(9), 2004.
43. Wang, W., and Slotine, J.J.E., "On Partial Contraction Analysis for Coupled Nonlinear Oscillators," *Biological Cybernetics*, 92(1), 2005.
44. Zuo, L., Slotine, J.-J.E., and Nayfeh, S., "Model Reaching Adaptive Control for Vibration Isolation," *I.E.E.E. Transactions on Control Systems Technology*, 13(4), 2005.
45. Richardson, A., Slotine, J.J.E., Bizzi, E. and Tresch, M., "Intrinsic Musculoskeletal Properties Stabilize Wiping Movements in the Spinalized Frog," *Journal of Neuroscience*, 25(12), 2005.
46. Lohmiller, W., and Slotine, J.J.E., "Contraction Analysis of Nonlinear Distributed Systems," *International Journal of Control*, 78(9), 2005.
47. Wang, W., and Slotine, J.J.E., "Fast Computation with Neural Oscillators," *Neurocomputing*, 63, 2005.
48. Zhao, Y., and Slotine, J.J.E., "Discrete Nonlinear Observers for Inertial Navigation," *Systems and Control Letters*, 54(6), 2005.
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55. Pham, Q.C., and Slotine, J.J.E., "Stable Concurrent Synchronization in Dynamic System Networks," *Neural Networks*, 20(1), 2007.
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57. McIntyre, A. and J.J.E. Slotine, Does the brain use wave variables to improve stability?, *Brain Res. Bulletin*, 71, 2007
58. Liu, C., Cheah, C.C., and Slotine, J.J.E., "Adaptive Task-Space Regulation of Flexible-Joint Robots with Uncertain Kinematics," *Automatica*, 43, 2007.
59. Girard, B., Tabareau, N., Pham, Q.C., Berthoz, A., and Slotine, J.J.E., "A Contracting Basal Ganglia Model for Action Selection," *Neural Networks*, 21(5), 2008.
60. Aylward, E., Parrilo, P., and Slotine, J.J.E., "Robustness Analysis of Nonlinear Systems via Contraction Metrics and SOS Programming," *Automatica*, 44, 2008.
61. Faugeras, O., Grimbert, F., and Slotine, J.J.E., "Absolute Stability and Complete Synchronization in a Class of Neural Fields Models," *S.I.A.M. Journal on Applied Mathematics*, 69(1), 2008.
62. Chung, S.J., Slotine, J.J.E., and Miller, D.W., "Propellant-Free Tethered Formation Flight: Nonlinear Underactuated Control", *A.I.A.A. Journal of Guidance, Control, and Dynamics*, 31(5), 2008.

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63. Yu, G., and Slotine, J.J.E., "Visual Grouping by Oscillator Networks," *I.E.E.E. Transactions on Neural Networks*, 20(12), 2009.
64. Pham, Q.C., Tabareau, N., and Slotine, J.J.E., "A Contraction Theory Approach to Stochastic Incremental Stability," *I.E.E.E. Transactions on Automatic Control*, 54(4), 2009.
65. Cheah, C.C., Hou, S.P., and Slotine, J.J.E., "Region-based Shape Control of Robot Swarms," *Automatica*, 45(9), 2009.
66. Chung, S.J., and Slotine, J.J.E., "Cooperative Robot Control and Concurrent Synchronization of Lagrangian Systems," *I.E.E.E. Transactions on Robotics*, 25(3), 2009.
67. Schwager, M., Rus, D., and Slotine, J.J.E., "Adaptation and Consensus Learning for Decentralized Coverage Control of Networked Robots," *International Journal of Robotics Research*, 28(2), 2009.
68. Chung, S.J., Ahsun, U., and Slotine, J.J.E., "Synchronization of Formation Flying Spacecraft," *A.I.A.A. Journal of Guidance, Control and Dynamics*, 32(2), 2009.
69. Seo, K., Chung, S.J., and Slotine, J.J.E., "CPG-Based Control of a Turtle-like Underwater Vehicle," *Autonomous Robots*, 28(3), 2010.
70. Tabareau, N., Slotine, J.J.E., and Pham, Q.C., "How Synchronization Protects from Noise," *PLoS Computational Biology* 6(1), 2010.
71. Russo, G., di Bernardo, M., and Slotine, J.J.E., "A Graphical Approach to Prove Contraction of Nonlinear Circuits and Systems," *I.E.E.E. Transactions on Circuits and Systems II*, 57(11), 2010.
72. Schwager, M., Rus, D., and Slotine, J.J.E., "Unifying Geometric, Probabilistic, and Potential Field Approaches to Multi-Robot Deployment," *International Journal of Robotics Research*, 29(11), 2010.
73. Rutishauser, U., Douglas, R.J., and Slotine, J.J.E., "Collective Stability of Networks of Winner-take-all Circuits," *Neural Computation*, 22(12), 2010.
74. Cheah, C.C., Hou, S.P., Zhao, Y., and Slotine, J.J.E., "Adaptive Vision and Force Tracking Control for Robots with Constraint Uncertainty," *I.E.E.E. Transactions on Mechatronics*, 15(3), 2010.
75. Russo, G., and Slotine J.J.E., "Global Convergence of Quorum Sensing Networks," *Physical Review E* 82(4), 2010.
76. Laflamme, S., Slotine, J.J.E., and Connor, J.J., "Wavelet Network for Semi-Active Control," *A.S.C.E. Journal of Mechanics*, 137(7), 2011.
77. Russo, G., and Slotine, J.J.E., "Symmetries, Stability, and Control in Nonlinear Systems and Networks," *Physical Review E* 84(4), 2011.
78. Bouvrie, J., and Slotine, J.J.E., "Synchronization and Redundancy: Implications for Robustness of Neural Learning and Decision Making," *Neural Computation*, 23(10), 2011.
79. Liu, Y.Y., Slotine, J.J.E., and Barabasi, A.L., "Controllability of Complex Networks," *Nature*, 473(7346), 2011 (cover article).
80. Slotine, J.J.E., and Liu, Y.Y., "Complex networks: The Missing Link," *Nature Physics*, 8(7), 2012.
81. Rutishauser, U., Slotine, J.J.E., and Douglas, R.J., "Competition through Selective Inhibitory Synchrony," *Neural Computation*, 24(8), 2012.
82. Laflamme, S., Slotine, J.J.E., and Connor, J.J., "Self-Organizing Input Space for Control of Structures," *Smart Materials and Structures*, 11, 2012.
83. Landsman, A.S., and Slotine, J.J.E., "Control of Traveling-Wave Oscillations and Bifurcation Behavior in Central Pattern Generators," *Physical Review E* 86(4), 2012.
84. Liu, Y.Y., Slotine, J.J.E., and Barabasi, A.L., "Control Centrality and Hierarchical Structure in Complex Networks," *PLoS One* 7(10), 2012.
85. Del Vecchio, D., and Slotine, J.J.E., "A Contraction Theory Approach to Singularly Perturbed Systems," *I.E.E.E. Transactions on Automatic Control*, 58(3), 2013.

## Publications of Jean-Jacques Slotine

86. Perie, L., Aru, J., Kourilsky, P., and Slotine, J.J.E., "Does a Quorum Sensing Mechanism Direct the Behavior of Immune Cells," *C.R. Biologies*, 2013.
87. Jia, T., Liu, Y.Y., Csoka, E., Posfai, M., Slotine, J.J.E., and Barabasi, A.L., "Emergence of Bimodality in Controlling Complex Networks," *Nature Communications* 4:2002, 1-6, 2013.
88. Mukovskiy, A., Slotine, J.J.E., and Giese, M.A., "Dynamically Stable Control of Articulated Crowds," *Journal of Computational Science*, 4(4), 2013.
89. Liu, Y.Y., Slotine, J.J.E., and Barabasi, A.L., "Observability of Complex Systems," *P.N.A.S.*, 110(7), 2013 (cover article).
90. Dydek, Z.T., Annaswamy, A., Slotine, J.J.E., Lavretsky, E., "Composite Adaptive Posicast Control," *Automatica*, 49(6), 2014.
91. Manchester, I.R., and Slotine, J.J.E., "Transverse Contraction Criteria for Existence, Stability, and Robustness of a Limit Cycle," *Systems & Control Letters*, 63, 2014.
92. Zhao, C., Wang, W.X., Liu, Y.Y., and Slotine, J.J.E., "Intrinsic Dynamics Induce Global Symmetry in Network Controllability," *Scientific Reports*, 5, 2015.
93. Bonnabel, S., and Slotine, J.J.E., "A Contraction Theory-Based Analysis of the Stability of the Deterministic Extended Kalman Filter," *I.E.E.E. Transactions on Automatic Control*, 60(2), 2015.
94. Yan, G., Tsekenis, G., Barzel, B., Slotine, J.J.E., Liu, Y.Y., and Barabasi, A.L., "Spectrum of Controlling and Observing Complex Networks," *Nature Physics*, 11(9), 2015.
95. Rutishauser, U., Slotine, J.J.E., and Douglas, R., "Computation in Dynamically Bounded Asymmetric Systems," *PLoS Computational Biology*, 11(1), 2015.
96. Angulo, M.T., Liu, Y.Y., and Slotine, J.J.E., "Network Motifs Emerge from Interconnections that Favor Stability," *Nature Physics*, 11(10), 2015.
97. Dewolf, T., Stewart, T., Slotine, J.J.E., and Eliasmith, C., "A Spiking Neural Model of Adaptive Arm Control," *Proceedings of the Royal Society B*, 283, 2016.
98. Angulo, M.T., and Slotine, J.J.E., "Qualitative Stability of Nonlinear Networked Systems," *I.E.E.E. Transactions on Automatic Control*, 61(12), 2016.
99. Shnitzer, T., Talmon, R., and Slotine, J.J.E., "Manifold Learning with Contracting Observers for Data-Driven Time Series," *I.E.E.E. Transactions on Signal Processing*, 23, 2016.