References

[1] M. Iwasaki, J. Akizono, H. Takahashi, T. Umetani, T. Nemoto, O. Asakura, and K. Asayama, "Development on Aquatic Walking Robot for Underwater Inspection," *Report of the Port and Harbour Research Institute*, vol. 26, pp. 393–422, December 1987.

[2] *Proc. of the 20th Annual Technical Symposium and Exhibition of the Association for Unmanned Vehicle Systems.* Washington, D.C.: Association for Unmanned Vehicle Systems, June 1993.

[3] M. J. Zyda, R. B. McGhee, S. Kwak, D. B. Nordman, R. C. Rogers, and D. Marco, "Three-Dimensional Visualization of Mission Planning and Control for the NPS Autonomous Underwater Vehicle," *IEEE Journal of Oceanic Engineering*, vol. 15, no. 3, pp. 217–221, 1990.

[4] S.-Y. Oh and D. E. Orin, "Dynamic Computer Simulation of Multiple Closed-Chain Robotic Mechanisms," in *IEEE Int. Conf. on Robotics and Automation*, (San Francisco, CA), pp. 15–20, April 1986.

[5] L. Shih, A. A. Frank, and B. Ravani, "Dynamic Simulation of Legged Machines Using a Compliant Joint Model," *Int. Journal of Robotics Research,* The MIT Press, vol. 6, pp. 33–46, Winter 1987.

[6] K. W. Lilly and D. E. Orin, "Efficient Dynamic Simulation for Multiple Chain Robotic Mechanisms," in *Proc. 3rd Annual Conf. on Aerospace Computational Control* (D. E. Bernard and G. K. Man, ed.), vol. 1, (Pasadena, CA), pp. 73–87, December 1989.

[7] P. S. Freeman and D. E. Orin, "Efficient Dynamic Simulation of a Quadruped Using a Decoupled Tree-Structured Approach," *Int. Journal of Robotics Research,* The MIT Press, vol. 10, pp. 619–627, December 1991.

[8] D. P. Brutzman, Y. Kanayama, and M. J. Zyda, "Integrated Simulation for Rapid Development of Autonomous Underwater Vehicles," in *Proc. of IEEE Symposium on Autonomous Underwater Vehicle Technology*, (Washington, D.C.), pp. 3–10, June 1992.

[9] L. Conway, R. Volz, and M. Walker, "Tele-Autonomous Systems: Methods and Architectures for Intermingling Autonomous and Telerobotic Technology," in *Proc. of 1987 IEEE Int. Conf. on Robotics and Automation*, (Raleigh, NC), pp. 1121–1130, 1987.

[10] J. Funda and R. P. Paul, "Teleprogramming: Overcoming Communication Delays in Remote Manipulation," in *Proc. of 1st IARP Workshop on Mobile Robots for Subsea Environments*, (Monterey, CA), pp. 155–162, October 1990.

[11] D. E. Orin, "Dynamical Modelling of Coordinated Multiple Robot Systems," in *Report of Workshop on Coordinated Multiple Robot Manipulators* (A. J. Koivo and G. A. Bekey, eds.), (San Diego, CA), Jan. 1987.

[12] R. B. McGhee, D. E. Orin, D. R. Pugh, and M. R. Patterson, "A Hierarchically-Structured System for Computer Control of a Hexapod Walking Machine," in *Proc. of Symposium on Theory and Practice of Robots and Manipulators* (A. Morecki *et al.*, ed.), (London), pp. 375–381, Hermes Publishing Co., 1985.

[13] D. E. Orin and S. Y. Oh, "Control of Force Distribution in Robotic Mechanisms Containing Closed Kinematic Loops," *Transactions of the ASME*, vol. 102, pp. 134–141, 1981.

[14] M. W. Walker and D. E. Orin, "Efficient Dynamic Computer Simulation of Robotic Mechanisms," *Journal of Dynamic Systems, Measurement, and Control*, vol. 104, pp. 205–211, September 1982.

[15] R. Featherstone, "The Calculation of Robot Dynamics Using Articulated-Body Inertias," *The Int. Journal of Robotics Research,* The MIT Press, vol. 2, pp. 13–30, Spring 1983.

[16] C. A. Balafoutis and R. V. Patel, "Efficient Computation of Manipulator Inertia Matrices and the Direct Dynamics Problem," *IEEE Transactions on Systems, Man, and Cybernetics*, vol. 19, pp. 1313–1321, Sept./Oct. 1989.

[17] H. Brandl, R. Johanni, and M. Otter, "A Very Efficient Algorithm for the Simulation of Robots and Similar Multibody Systems Without Inversion of the Mass Matrix," in *Proc. of IFAC/IFIP/IMACS Int. Symp. on Theory of Robots*, (Vienna, Austria), December 1986.

[18] M. Amin-Javaheri and D. E. Orin, "Systolic Architectures for the Manipulator Inertia Matrix," *IEEE Trans. on Systems, Man, and Cybernetics*, vol. 18, pp. 939–951, November/December 1988.

[19] C. S. G. Lee and P. R. Chang, "Efficient Parallel Algorithms For Robot Forward Dynamics Computation," *IEEE Transactions on Systems, Man, and Cybernetics*, vol. 18, pp. 238–251, March/April 1988.

[20] P. Sadayappan, Y. L. C. Ling, K. W. Olson, and D. E. Orin, "A Restructurable VLSI Robotics Vector Processor Architecture for Real-Time Control," *IEEE Trans. on Robotics and Automation*, vol. 5, pp. 583–599, October 1989.

[21] A. Fijany and A. K. Bejczy, "Techniques for Parallel Computation of Mechanical Manipulator Dynamics. Part II: Forward Dynamics," *Control and Dynamic Systems*, vol. 40, pp. 357–410, 1991.

[22] C. L. Chen, C. S. G. Lee, and E. S. H. Hou, "Efficient Scheduling Algorithms for Robot Inverse Dynamics Computation on a Multiprocessor System," in *IEEE Int. Conf. on Robotics and Automation*, (Philadelphia, PA), pp. 1146–1151, 1988.

[23] J. Y. S. Luh and C. S. Lin, "Scheduling of Parallel Computation for a Computer-Controlled Mechanical Manipulator," *IEEE Transactions on Systems, Man, and Cybernetics*, vol. SMC–12, pp. 214–234, March/April 1982.

[24] K. W. Lilly and D. E. Orin, "Efficient Dynamic Simulation of Multiple Chain Robotic Mechanisms," To appear in *ASME Journal of Dynamic Systems, Measurement, and Control*, June 1994.

[25] K. W. Lilly and D. E. Orin, "Alternate Formulations for the Manipulator Inertia Matrix," *International Journal of Robotics Research,* The MIT Press, vol. 10, pp. 64–74, February 1991.

[26] J. J. Craig, *Introduction to Robotics: Mechanics and Control.* Reading, MA: Addison-Wesley, 1986.

[27] R. Featherstone, *Robot Dynamics Algorithms.* Boston: Kluwer Academic Publishers, 1987.

[28] J. Y. S. Luh, M. W. Walker, and R. P. Paul, "On-Line Computational Scheme for Mechanical Manipulators," *IEEE Transactions on Automatic Control*, vol. AC-35, no. 3, pp. 468–474, 1980.

[29] C. A. Balafoutis, R. V. Patel, and P. Misra, "Efficient Modeling and Computation of Manipulator Dynamics Using Orthogonal Cartesian Tensors," *IEEE Trans. of Robotics and Automation*, vol. 4, pp. 665–676, December 1988.

[30] G. Rodriguez, A. Jain, and K. Kreutz-Delgado, "A Spatial Operator Algebra for Manipulator Modeling and Control," *The Int. Journal of Robotics Research,* The MIT Press, vol. 10, pp. 371–381, August 1991.

[31] G. Rodriguez, "Recursive Forward Dynamics for Multiple Robot Arms Moving a Common Task Object," *IEEE Transactions on Robotics and Automation*, vol. 5, pp. 510–521, August 1989.

[32] S. H. Murphy, J. T. Wen, and G. N. Saridis, "Simulation of Cooperating Robot Manipulators on a Mobile Platform," *IEEE Trans. on Robotics and Automation*, vol. 7, pp. 468–478, August 1991.

[33] K. W. Lilly and D. E. Orin, "Efficient Dynamic Simulation of a Single Closed-Chain Manipulator," in *IEEE Int. Conf. on Robotics and Automation*, (Sacramento, California), pp. 210–215, April 1991.

[34] O. Khatib, "A Unified Approach for Motion and Force Control of Robot Manipulators: The Operational Space Formulation," *IEEE Trans. of Robotics and Automation*, vol. RA–3, pp. 43–53, February 1987.

[35] K. W. Lilly, *Efficient Dynamic Simulation of Robotic Mechanisms.* Norwell, MA: Kluwer Academic Publishers, 1993.

[36] S. McMillan, D. E. Orin, and P. Sadayappan, "Towards Super-Real-Time Simulation of Robotic Mechanisms Using a Parallel Integration Method," *IEEE Transactions on Systems, Man, and Cybernetics*, vol. 22, pp. 384–391, March/April 1992.

[37] K. W. Lilly and D. E. Orin, "Efficient $O(N)$ Recursive Computation of the Operational Space Inertia Matrix," *IEEE Transactions on Systems, Man, and Cybernetics*, vol. 23, pp. 1384 – 1391, September/October 1993.

[38] M. Amin-Javaheri and D. E. Orin, "Parallel Algorithms for Computation of the Manipulator Inertia Matrix," *The International Journal of Robotics Research,* The MIT Press, vol. 10, pp. 162–170, April 1991.

[39] C. S. G. Lee and P. R. Chang, "Efficient Parallel Algorithms For Robot Inverse Dynamics Computation," *IEEE Transactions on Systems, Man, and Cybernetics*, vol. SMC–16, pp. 532–542, July/August 1986.

[40] T. Kailath, *Linear Systems.* Englewood Cliffs, NJ: Prentice-Hall, Inc., 1980.

[41] L. G. Birta and O. Abou-Rabia, "Parallel Block Predictor-Corrector Methods for ODE's," *IEEE Trans. on Computers*, vol. C-36, pp. 299–311, March 1987.

[42] Y. F. Zheng, "Dynamic and Kinetic Behavior of Two Coordinating Robots in Assembly," *Mathl. Comput. Modelling*, vol. 12, no. 1, pp. 77–88, 1989.

[43] J. P. Keener, *Principles of Applied Mathematics.* Redwood City, CA: Addison Wesley, 1988.

[44] W. Khalil and J. F. Kleinfinger, "A New Geometric Notation for Open and Closed-Loop Robots," in *IEEE Int. Conf. on Robotics and Automation*, (San Francisco, CA), pp. 1174–1179, 1986.

[45] A. Fijany and A. Bejczy, "A Class of Parallel Algorithms for Computation of the Manipulator Inertia Matrix," *IEEE Trans. on Robotics and Automation*, vol. 5, pp. 600–615, October 1989.

[46] J. B. Newman and B. H. Robison, "Development of a Dedicated ROV for Ocean Science," *Marine Technology Society Journal*, vol. 26, pp. 46–53, Winter 1992.

[47] Anon., "Titan II High Resolution Bilateral Force Feedback Remote Manipulator System," Technical Report, Schilling Development, Inc., Davis, CA, April 1991.

[48] D. R. Yoerger and J.-J. E. Slotine, "Robust Trajectory Control of Underwater Vehicles," *IEEE Transactions of Oceanic Engineering*, vol. OE-10, pp. 462–470, October 1985.

[49] J. Yuh, "Modeling and Control of Underwater Robotic Vehicles," *IEEE Transactions on Systems, Man, and Cybernetics*, vol. 20, pp. 1475–1483, November/December 1990.

[50] K. Ioi and K. Itoh, "Modelling and Simulation of an Underwater Manipulator," *Advanced Robotics*, vol. 4, no. 4, pp. 303–317, 1990.

[51] A. K. Ramadorai and T. J. Tarn, "On Modeling and Adaptive Control of Underwater Robots," in *Proc. IARP 4th Workshop on Underwater Robots*, (Capri, Italy), pp. 47–58, June 1992.

[52] I. H. Shames, *Mechanics of Fluids*. New York, NY: McGraw-Hill, 1962.

[53] J. N. Newman, *Marine Hydrodynamics*. Cambridge, MA: The MIT Press, 1977.

[54] "Controllability," in *Principles of Naval Architecture* (E. Lewis, ed.), vol. 3, (New York, NY), Society of Naval Architects and Marine Engineers, 1987.

[55] J. L. Synge and B. A. Griffith, *Principles of Mechanics*. New York, NY: McGraw Hill, 1949.

[56] T. Sarpkaya and M. Isaacson, *Mechanics of Wave Forces on Offshore Structures*. New York, NY: Van Nostrand Reinhold Co., 1981.

[57] W. H. Press, B. P. Flannery, S. A. Teukolsky, and W. T. Vetterling, *Numerical Recipes in C: The Art of Scientific Computing*. New York, NY: Cambridge University Press, 1988.

[58] S. K. Chakrabarti, W. A. Tam, and A. L. Wolbert, "Wave Forces on a Randomly Oriented Tube," in *Proc. of the O.T.C.*, no. 2190, (Houston, TX), 1975.

[59] O. M. Griffin and S. E. Ramberg, "Some Recent Studies of Vortex Shedding with Application to Marine Tubulars and Risers," *Transactions of the ASME*, vol. 104, pp. 2–13, March 1982.

[60] J. M. Cooke, M. J. Zyda, D. R. Pratt, and R. B. McGhee, "NPSNET: Flight Simulation Dynamic Modeling Using Quaternions," *Presence*, vol. 1, pp. 404–420, Fall 1992.

[61] G. Booch, *Object Oriented Design with Applications*. Redwood City, CA: Benjamin/Cummings Publishing Co., Inc., 1986.

[62] A. Register and M. Hopper, "Programming with Objects," *IEEE Potentials*, vol. 13, pp. 34–36, April 1994.

[63] J. R. Goetz, "Graphical Simulation of Articulated Rigid Body System Kinematics with Collision Detection," Master's thesis, Naval Postgraduate School, Monterey, CA 93943, March 1994.

[64] J. Wernecke, *IRIS Inventor Programming Guide*. Silicon Graphics, Inc., Mountain View, CA, 1992.

[65] P. McLendon, *IRIS Performer Programming Guide*. Silicon Graphics, Inc., Mountain View, CA, 1992.

[66] K. P. Wilson, M. J. Zyda, and D. R. Pratt, "NPSGDL: An Object Oriented Graphics Description Language for Virtual World Application Support," in *Proc. 3rd Eurographics Workshop on Object Oriented Graphics*, (Champrey, Switzerland), October 28–30 1992.

[67] K. J. R. W. Kristiansen, "A Computer Simulation of Vehicle and Actuator Dynamics for a Hexapod Walking Robot," Master's thesis, Naval Postgraduate School, Monterey, CA 93943, March 1994.

[68] S. McMillan, "Real-Time Simulation of a Robotic Manipulator Using a Parallel Integration Method," Master's thesis, The Ohio State University, Columbus, OH 43210, Spring 1990.

[69] R. B. McGhee and A. L. Pai, "An Approach to Computer Control for Legged Vehicles," *Journal of Terramechanics*, vol. 11, no. 1, pp. 9–27, 1974.

[70] J. Denavit and R. S. Hartenberg, "A Kinematic Notation for Lower-Pair Mechanisms Based on Matrices," *ASME Journal of Applied Mathematics*, pp. 215–221, June 1955.

[71] X. He and A. A. Goldenberg, "An Algorithm for Efficient Computation of Dynamics of Robotic Manipulators," in *Proc. Fourth Int. Conf. on Advanced Robotics*, (Columbus, OH), pp. 175–188, 1989.