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Optimal Task Placement of a Serial Robot Manipulator for Manipulability and Mechanical Power Optimization

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ABSTRACT

Power consumption and accuracy are main aspects to be taken into account in the movement executed by high performance robots. The first aspect is important from the economical point of view, while the second is requested to satisfy technical specifications. Aiming at increasing the robot performance, a strategy that maximizes the manipulator accuracy and minimizes the mechanical power consumption is considered in this work. The end-effector is constrained to follow a predefined path during the optimal task positioning. The proposed strategy defines a relation between mechanical power and manipulability as a key element of the manipulator analysis, establishing a performance index for a rigid body transformation. This transformation is used to compute the optimal task positioning through the optimization of a multicriteria objective function. Numerical simulations regarding a serial robot manipulator demonstrate the viability of the proposed methodology.

KEYWORDS

Optimal Task Placement, Optimal Robot Path Planning, Multicriteria Optimization

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References

[1] S. F. P. Saramago and V. Steffen Jr., "Optimization of the Trajectory Planning of Robot Manipulators Taking Into-Account the Dynamics of the System," Mechanism and Machine Theory, Vol. 33, 1998, pp. 883-894.

[2] R. R. D. Santos, V. Steffen Jr. and S. F. P. Saramago, "Robot Path Planning: Avoiding Obstacles," In: 18th International Congress of Mechanical Engineering, Ouro Preto-MG, Brazil, 2005.

[3] S. S. Chiddarwar and N. R. Babu, "Offline Decoupled Path Planning Approach for Effective Coordination of Multiple Robots," Robotica, Vol. 28, No. 4, 2010, pp. 477- 491.

[4] R. R. D. Santos, V. Steffen Jr. and S. F. P. Saramago, "Optimal Path Planning and Task Adjustment for Cooperative Flexible Manipulators," ABCM Symposium Series in Mechatronics, Associa??o Brasileira de Engenharia e Ciências Mecanicas, ABCM, Vol. 3, 2008, pp. 236-245.

[5] O. Von Stryk and M. Schlemmer, "Optimal Control of the Industrial Robot Manutec r3," Computational Optimal Control, International Series of Numerical Mathematics, Vol. 115, 1994, pp. 367-382.

[6] R. R. D. Santos, V. Steffen Jr. and S. F. P. Saramago, "Robot Path Planning in a Constrained Workspace by Using Optimal Control Techniques," In: III European Conference on Computational Mechanics, Lisbon, Portugal, 2006, pp. 159-177.

[7] J. E. Bobrow, S. Dubowsky and J. S. Gibson, "Time-Optimal Control of Robotic Manipulators along Specified Paths," The Intemational Journal of Robotics Research, Vol. 4, 1995, pp. 3-17.

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[8] J. E. Slotine and H. S. Yang, "Improving the Efficiency of Time-Optimal Path-Following," IEEE Transaction on Robotics and Automation, Vol. 5, No. 1, 1989, pp. 118- 124.

[9] D. Constantinescu and E. A. Croft, "Smooth and Time- Optimal Trajectory Planning for Industrial Manipulators along Specified Paths," Journal of Robotic Systems, Vol. 17, 2000, pp. 233-249.

[10] H. Seraji, "Reachability Analysis for Base Placement in Mobile Manipulator," Journal of Robotic Systems, Vol. 12, 1995, pp. 29-43.

[11] S. Zeghloul and J. A. Pamanes, "Multi-Criteria Optimal Placement of Robots in Constrained Environments," Robotica, Vol. 11, No. 2, 1993, pp. 105-110.

[12] J. T. Feddema, "Kinematically Optimal Robot Placement for Minimum Time Coordinated Motion," Proceedings of the IEEE International Conference of Robotics and Automation, Minneapolis, 1996, pp. 3395-3400.

[13] F. C. Park, "Distance Metrics on the Rigid-Body Motions with Applications to Mechanicsm Design," ASME Journal of Mechanical Design, Vol. 117, 1995, pp. 48-54.

[14] G. S. Chirikjian and S. Zhou, "Metrics on Motion and Deformation of Solid Models," ASME Journal of Mechanical Design, Vol. 120, 1998, pp. 252-261.

[15] J. M. R. Martinez and J. Duffy, "On the Metrics of Rigid Body Displacement for Infinite and Finite Bodies," ASME Journal of Mechanical Design, Vol. 117, No. 1, 1995, pp. 41-47.

[16] B. Tabarah, B. Benhabib, R. Fenton and R. Cohen, "Cycle-Time Optimization for Single-Arm and Two-Arm Robots Performing Continuous Path Operation," 21st Biennial Mechanisms Conference, Chicago IL, 1990, pp. 401-406.

[17] Y. Zhang, and K. Li, "Bi-Criteria Velocity Minimization of Robot Manipulators Using LVI-Based Primal-Dual Neural Network and Illustrated Via PUMA560 Robot Arm," Robotica, Vol. 28, No. 4, 2010, pp. 525-537.

[18] K. Abdel-Malek and W. Yu, "On the Placement of Serial Manipulator," Proceedings of DETC00 2000 ASME Design Engineering Technical Conferences, Baltimore, MD, 2000, pp. 1-8.

[19] Y. Chen and A. A. Desrochers, "Structure of Minimum-Time Control Law for Robotic Manipulators with Constrained Paths," IEEE International Conference on Robot and Automat, Scottsdale, Az, USA, 1989, pp. 971- 976.

[20] Z. Shiller and H. H. Lu, "Computation of Path Constrained Time Optimal Motions with Dynamic Singularities," ASME Journal of Dynamic Systems, Measurement, and Control, Vol. 114, 1992, pp. 34-40.

[21] E. K. Xidias, P. T. Zacharia and N. A. Aspragathos, "Time-Optimal Task Scheduling for Articulated Manipulators in Environments Cluttered with Obstacles," Robotica, Vol. 28, No. 3, 2010, pp. 427-440.

[22] K. S. Fu, R. C. Gonzales and C. S. G. Lee, "Robo-Tics: Control, Sensing, Vision and Intelligence," McGraw-Hill, New York, 1987.

[23] T. Yoshikawa, "Manipulability of Robot Mechanisms," The International Jouranl Robotics Research, Vol. 4, 1985, pp. 3-9.

[24] M. J. Richard and C. M. Gosselin, "A Survey of Simulation Programs for the Analysis of Mechanical Systems," Mathematics and Computers in Simulation, Vol. 35, No. 2, 1993, pp. 103-121.

[25] V. Mata, F. Benimeli, N. Farhat and A. Valera, "Dynamic Parameter Identification in Industrial Robots Considering Physical Feasibility," Journal of Advanced Robotics, Vol. 19, No. 1, pp. 101-120.

[26] V. Mata, S. Provenzano, F. Valero and J. I. Cuadrado, "Serial Robot Dynamics Algorithms for Moderately Large Numbers of Joints," Mechanism and Machine Theory, Vol. 37, No. 8, pp. 739-755.

[27] J. J. Craig, "Introduction to Robotics: Mechanics & Control," 2nd Edition, Reading, MA: Addison-Wesley, 1989.

[28] R. R. D. Santos, V. Steffen Jr. and S. F. P. Saramago, "Solving the Inverse Kinematics Problem through Performance Index Optimization," In: XXVI Iberian Latin-American Congress on Computational Methods in Engineering, Guarapari-ES, 1985.

[29] H. Eschenauer, J. Koski and A. Osyczka, “Multicriteria Design Optimization,” Springer-Verlag, Berlin,