

Trajectory Programming of Parallel Manipulators for Minimum Energy Consumption

許書豪、陳俊達

E-mail: 9707913@mail.dyu.edu.tw

ABSTRACT

Has the singular point in the history all Stewart platform manipulator working space, in order to enable in the work to achieve most reduces effort the pattern, must have to enable the path to shunt these singular points, otherwise when contacts these singular points, the entire work radio station also can have the collapse possibility, in order to obtain avoids the singular point the best path, the present paper uses grain of subgroup optimization calculating method (PSOA) to obtain group of control points first, then in takes into this control point gradient calculating method (Gradient) to be possible to obtain group of more accurate control points, matching originally some and, may obtain the best path movement equation. These two calculating methods obtain the best path movement equation, may cause us to work the singular point, achieved most reduces effort the pattern, in the article the Boltzmann-Hamel-d' Alenbert method, calculates the enclosed type dynamics equation.

Keywords : Stewart platform manipulator, particle swarm optimization algorithm, Gradient, Boltzmann-Hamel-d' Alenbert.

Table of Contents

封面內頁 簽名頁 授權書 iii 中文摘要 iv 英文摘要 v 誌謝 vi 目錄 vii 圖目錄 ix 第一章 緒論 1 1.1 研究動機和目的 1 1.2 並聯式運動平台 2 1.3 文獻回顧 5 1.4 研究方法 7 第二章 SPM之運動學分析 8 2.1 SPM並聯式平台之介紹 8 2.2 定義座標系統 8 2.3 運動平台之座標轉換 10 2.4 馬達輸出扭力與沿腿方向作用力關係 13 2.5 混合空間中之運動方程式 14 2.6 工作空間中的運動方程式 17 第三章 最小能量消耗之無奇異點軌跡規劃 19 3.1 價值函數 19 3.2 拘束條件 19 3.3 參數軌跡規劃 20 3.4 拘束粒子群最佳化演算法的整體搜尋 21 3.5 梯度演算法(gradient) 25 第四章 結果和討論 28 4.1 參數條件 28 4.2 數值結果 29 4.3 數?範例和比較 31 4.4 結果分析 54 第五章 結論 55 5.1 結論 55 5.2 未來研究方向 55 參考文獻 57 附錄 59 圖目錄 圖1.1 空間中任兩點之運動軌跡 1 圖1.2 典型的stewart platform 2 圖1.3 串聯式機構 4 圖1.4 並聯式機構 5 圖1.5 手術用機械手臂 6 圖2.1 並聯式電致驅動滑台機構之座標示意圖 9 圖2.2 Z軸轉角 11 圖2.3 軸轉角 11 圖2.4 軸轉角 12 圖3.1 迭代模式 23 圖3.2 PSO演算法流程圖 24 圖3.3 gradient演算法流程圖 27 圖4.1 路徑參數和行列式值的關係 30 圖4.2 路徑參數和條件數的關係 31 圖4.3 =0.0無奇異點軌跡規劃 34 圖4.4 =0.3無奇異點軌跡規劃 34 圖4.5 =0.6無奇異點軌跡規劃 35 圖4.6 =0.8無奇異點軌跡規劃 35 圖4.7 =1.0無奇異點軌跡規劃 36 圖4.8 無奇異點軌跡由下而上 =1.0, 0.8, 0.6, 0.3, 0.0 36 圖4.9 =0.0條件數沿著符合的軌跡規劃 37 圖4.10 =0.3條件數沿著符合的軌跡規劃 37 圖4.11 =0.6條件數沿著符合的軌跡規劃 38 圖4.12 =0.8條件數沿著符合的軌跡規劃 38 圖4.13 =1.0條件數沿著符合的軌跡規劃 39 圖4.14 =0.0行列式?沿著符合的軌跡規劃 40 圖4.15 =0.3行列式?沿著符合的軌跡規劃 40 圖4.16 =0.6行列式?沿著符合的軌跡規劃 41 圖4.17 =0.8行列式?沿著符合的軌跡規劃 41 圖4.18 =1.0行列式?沿著符合的軌跡規劃 42 圖4.19 =0.0SPM的扭力沿著符合的軌跡規劃 43 圖4.20 =0.3SPM的扭力沿著符合的軌跡規劃 43 圖4.21 =0.6SPM的扭力沿著符合的軌跡規劃 44 圖4.22 =0.8SPM的扭力沿著符合的軌跡規劃 44 圖4.23 =1.0SPM的扭力沿著符合的軌跡規劃 45 圖4.24 =0.0SPM的腿長改變符合軌跡規劃 46 圖4.25 =0.3SPM的腿長改變符合軌跡規劃 46 圖4.26 =0.6SPM的腿長改變符合軌跡規劃 47 圖4.27 =0.8SPM的腿長改變符合軌跡規劃 47 圖4.28 =1.0SPM的腿長改變符合軌跡規劃 48 圖4.29 =0.0SPM的速度與時間關係 49 圖4.30 =0.3SPM的速度與時間關係 49 圖4.31 =0.6SPM的速度與時間關係 50 圖4.32 =0.8SPM的速度與時間關係 50 圖4.33 =1.0SPM的速度與時間關係 51 圖4.34 =0.0SPM的加速度與時間關係 52 圖4.35 =0.3SPM的加速度與時間關係 52 圖4.36 =0.6SPM的加速度與時間關係 53 圖4.37 =0.8SPM的加速度與時間關係 53 圖4.38 =1.0SPM的加速度與時間關係 54

REFERENCES

- [1] D.Stewart,"A Platform with Six Degrees of Freedom"Proceedings of the Institution of Mechanical Engineering .vol.180,part1,pp.371 -386 ,1965.
- [2] S.Bhattacharya, H.Hatwal and A. Ghosh, omparison of an exact and an approximate method of singularity avoidance in platform type parallel manipulator,Mech.Mach.Theory 33,965-974(1998).
- [3] B.Dasgupta and T.S.Mruthyunjaya.,ingularity-free planning for the Stewart platform manipulator,Mech. Mach.Theory 33,771- 725(1998).
- [4]-S.Sen,B.Dasgupta and S.Bhattacharya, ariational approach for the singularity-freepath-planning of parallel manipulators,Mech.Mach. Theory 38,1165 -1183(2003).

- [5] A.K.Dash,I. Chen,S.Yeo and G. Yang, workspace generation and planning singularity-free path for parallel manipulators, Mech. Mach. Theory 40,776 -805(2005).
- [6] L.W. Tsai, Solving the Inverse Dynamics of a Stewart-Gough Manipulator by the Principle of Virtual Work, Trans. ASME J. Mech. Design 122, 3-9 (2000).
- [7] M.J. Liu, C.X. Li and C.N. Li, Dynamics Analysis of the Gough-Stewart Platform Manipulator, IEEE Trans. Robot. Automat. 16, 94-98 (2000).
- [8] S.C. Wang, H. Hikita, H. Kubo, Y.S. Zhao, Z. Huang and T. Ifukube, Kinematics and Dynamics of a 6 Degree-of-Freedom Fully Parallel Manipulator with Elastic Joints, Mech. Mach. Theory 38, 439-461 (2003).
- [9] Y. Nakamura and K. Yamane, Dynamics Computation of Structure-Varying Kinematic Chains and Its Application to Human Figures, IEEE Trans. Robotics and Automation 16,124-134 (2000).
- [10] J.Kennedy and R.Eberhart.Particle swarm optimization proc.of IEEE Int.Conf. on Neural Network,Australia, 1942-1948(1995).
- [11] Z.L. Gaing, A Particle Swarm Optimization Approach for Optimum Design of PID Controller in AVR System, IEEE Trans. Power system 19, 384-391 (2004).
- [12] B. Zhao, An Improved Particle Swarm Optimization for Power System Unit Commitment, Power System Technology 28, 6-10 (2004).
- [13] W. Zhang and Y.T. Liu, Reactive power optimization based on PSO in a Practical Power System, in IEEE Power Engineering Society General Meeting, Denver, pp. 239-243(2004).
- [14] 鄧琪曄, 2003, “HEXAPOD並聯式平台之動態分析與控制”, 大葉大學自動化工程研究所碩士論文。
- [15] 洪榮村, 2005, “6-6 Linkage 製造系統的運動分析與驗證”, 大葉大學機械工程研究所碩士論文。
- [16] 林顯育, 2007, “並聯式機械手臂有最小致動力之無奇異點軌跡規劃”, 大葉大學機械工程研究所碩士論文。
- [17] George Lindfield John Penny黃俊銘, 數值方式使用MATLAB程式語言, 台灣培生教育出版股份有限公司, 全華科技圖書股份有限公司, 2001