

DEVELOPMENT AND RESEARCH OF A ROBOT WHEELCHAIR FOR ALL TERRAIN

鄭嘉森、陳俊達

E-mail: 9018472@mail.dyu.edu.tw

ABSTRACT

THERE ARE SEVERAL DESIGNS FOR MOBILE ROBOTS. AMONG THEM, THE WHEEL DESIGN IS UNFAVORABLE FOR NAVIGATION OF STAIRS OR OVER OBSTACLES, THE LEG DESIGN DEMANDS VERY INTRICATE CONTROL SYSTEM AND IS NOT EFFICIENT ON FLAT SURFACES, THE CATERPILLAR DESIGN IS UNSTABLE IN STAIR NAVIGATION. IN THIS THESIS, A NEW TYPE OF QUADRUPED-LIKE DESIGN FOR A MOBILE ROBOT IS DEVELOPED. THE MOBILE ROBOT ENABLES TO ASCEND OR DESCEND STAIRS BY LEG-CREEPING, AND NAVIGATE ON FLAT SURFACES BY WHEELS. MOREOVER IT CAN ALSO BE APPLIED TO A WHEELCHAIR. FROM LOCOMOTION EXPERIMENTS, THE ROBOT WHEELCHAIR VALIDATE THAT IT CAN ADAPT TO ALL TERRAIN WITH BODY HELD HORIZONTAL AND LOWER CENTER OF WEIGHT.

Keywords : ROBOT WHEELCHAIR, STAIR, QUADRUPED.

Table of Contents

第一章 緒論--P1 1.1 研究背景--P1 1.2 輪椅之介紹--P2 1.2.1輪椅之分類--P2 1.2.2特性--P3 1.2.3具克服特殊地形功能之輪椅--P4 1.3 移動型機器人之設計參考--P7 1.4研究動機與目的--P14 第二章 移動機器人輪椅之設計--P15 2.1概念設計--P15 2.1.1功能需求--P15 2.1.2 初步設計--P16 2.1.3各部位之相對關係--P19 2.2大部設計--P21 2.2.1相對運動設計--P21 2.2.2動力傳遞--P22 2.3細部設計--P22 2.4元件選用--P26 2.4.1車輪估算--P27 2.4.2皮帶輪之估算--P28 2.4.3馬達之選用--P30 2.4.4軸承之選用--P30 2.5 製造組立--P31 2.6 電控整合--P33 2.6.1 D/A輸出--P33 2.6.2解碼控制--P34 2.6.3馬達速度控制--P34 2.6.4 馬達正反轉控制--P36 第三章 功能模式與運動模式--P37 3.1 輪子與履帶輪之交換--P37 3.2 身體高度之改變--P38 3.3 站立姿態--P38 3.4 平地移動--P39 3.5 不平整地形之靜穩定步態--P39 3.6 斜坡爬行--P42 3.7 上下階梯運動--P44 3.8 兩側同動步態運動--P45 3.9 動步態運動--P47 第四章 運動分析--P49 4.1自由度--P49 4.2階梯攀爬範圍--P49 4.3關節角度之控制--P50 4.3.1馬達旋轉角度與各關節角度之關係--P50 4.4速度--P52 4.5動作分析--P54 4.5.1舉撐腰節--P54 4.5.2腿節--P55 4.6輸入轉速與關節角速度關係--P56 4.7機器人輪椅運動學--P59 第五章 運動測試分析--P64 5.1輪子與履帶之切換--P64 5.2身體高度之改變及站立姿態--P64 5.3平地移動--P66 5.3.1兩側同動步態--P65 5.3.2平地類四足步行--P67 5.4斜坡爬行--P71 5.5上下階梯運動--P77 第六章 結果與討論--P81 第七章 結論--P85 參考文獻--P86

REFERENCES

- [1] WATKINS, J & WATKINS,STAIR VEHICLE,1983.
- [2] BIHLER & ABELE, STAIR-CLIMBING APPARATUS FOR WHEELCHAIR,1985 [3] 陳國全, 中華民國專利, 1997.
- [4] 賴耿陽, 新機械人設計製造, A NEW INDUSTRIAL ROBOTS CONTROLLED MANIPULATOR,MECHANISM MECHINE,DESIGN AND MANUFACTURING, 復漢出版社。
- [5] M.VUKOBRATOVIC, 步行機械人與人工腳, 臺隆出版。
- [6] 金田周平、木下源一郎, 機械人工程學, 臺隆出版。
- [7] 林崇賢, 江耀宗, 機器人應用實務, 1989.
- [8] J. D. MARTENS, WS. NEWMAN, "STABILIZATION OF A MOBILE ROBOT CLIMBING STAIRS," IN PROCEEDINGS OF THE IEEE INTERNATIONAL CONFERENCE ON ROBOTICS & AUTOMATION, PP2501~ 2507, 1994.
- [9] 日本工業調查會, "A NEW INDUSTRIAL ROBOTS, CONTROLLED MANIPULATOR, MECHANISM MACHINE, DESIGN AND MANUFACTURING,".
- [10] S.HIROSE, K. YONEDA, K. ARAI AND T. IBE, "DESIGN OF A QUADRUPED WALKING VEHICLE FOR DYNAMIC WALKING AND STAIR CLIMBING",1995.
- [11] T.KAGIWADA, ""STABILIZATION OF A MOBILE ROBOT CLIMBING STAIRS," IN ROBOT DESIGN FOR STAIR NAVIGATION," JSME INTERNATIONAL JOURNAL, SERIES C: DYNAMICS, CONTROL, ROBOTICS, DESIGN AND MANUFACTURING, V39, NO3, 1996.

[12] JOHN J.CRAIG,INTRODUCTION TO ROBOTICS,ADDISON-WESLEY PUBLISHING COMPANY.

[13] 宮城政雄, 内田干城, 米田隆志, 小山浩幸, 舟久保熙康, "DEVELOPMENT OF STAIR CLIMBING WHEELCHAIR WITH LEGS AND WHEELS SYSTEM (1ST REPORT)-DEVELOPMENT OF STAIR CLIMBING MECHANISM,"精密工學會誌,VOL.64, NO.3, 1998.

[14] G.WIESSPEINER,E. WINDISCHBACHER, "DISTRIBUTED INTELLIGENCE TO CONTROL A STAIR-CLIMB -ING WHEELCHAIR," IN PROCEEDINGS OF THE IEEE INTERNATIONAL CONFERENCE ON ROBOTICS AND AUTOMATION, PP1173~1178, 1997.

[15] S.HIROSE, K. YONEDA, K. ARAI AND T. IBE, "DESIGN OF A QUADRUPED WALKING VEHICLE FOR DYNAMIC WALKING AND STAIR CLIMBING," ADVANCED ROBOTICS, VOL. 9, NO. 2, PP107~124, 1995.

[16] N.KOYACHI, H. ADACHI, T. NAKAMURA, E. NAKANO, "S MOTION SWITC ENSOR-BASED HING CONTR -OL IN STAIR-CLIMBING OF HEXAPOD," PROCEEDINGS OF THE JAPAN - USA SYMPOSIUM ON FLEXI -BLE AUTOMATION, 1992.

[17] D.J. PACK, "PERCEPTION-BASED CONTROL FOR A QUADRUPED WALKING ROBOT," IN PROCEEDINGS OF THE IEEE INTERNATIONAL CONFERENCE ON ROBOTICS AND AUTOMATION, PP 2994~3001, 1996.

[18] N.G. BOURBAKIS, "KYDONAS-AN AUTONOMOUS HYBRID ROBOTS: WALKING AND CLIMBING," IEEE RO -BOTICS & AUTOMATION MAGAZINE, JUNE, 1998.

[19] G.WIESSPEINER AND E. WINDISCHBACHER, "DISTRIBUTED INTELLIGENCE TO CONTROL A STAIR-CL -IMBING WHEEL CHAIR," PROCEEDINGS OF THE IEEE ENGINEERING IN MEDICINE AND BIOLOGY, VOL2, PP1173~1174, 1995.

[20] K.TAGUCHI, "ENHANCED WHEEL SYSTEM FOR STEP CLIMBING," ADVANCED ROBOTICS, VOL. 9, NO. 2, PP137~147, 1995.

[21] P.WELLMAN, V. KROVI AND V. KUMAR, "AN ADAPTIVE MOBILITY SYSTEMFOR THE DISABLED," IN PROCEEDINGS OF THE IEEE INTERNATIONAL CONFERENCE ON ROBOTICS & AUTOMATION, PP2006~ 22011, 1994.

[22] SHUE-SHU WU, CHING-SHIOW TSENG, CHENG SAN CHENG, "GAIT PATTERN ANALYSIS OF A QUADRUP -EDAL JOINTED WALKING ROBOT" JOURNAL OF TECHNOLOGY, VOL. 13, NO. 1,PP. 49~57, 1998.