DYNAMICS SIMULATION AND CONTROL FOR MOTORCYCLE RIDING

姚良駿、陳志鏗

E-mail: 9126579@mail.dyu.edu.tw

ABSTRACT

THIS THESIS IS TO DEVELOP THE EQUATIONS OF MOTION OF RIDER-MOTORCYCLE SYSTEM BY USING THE LAGRANGE'S EQUATION WITH NINE DEGREES OF FREEDOM. THE SIX COORDINATES FOR THE POSIT -ION AND ORIENTATION OF THE REAL WHEEL, THE ROLLING OF REAR WHEEL, THE FORK'S STEERING ANGLE AND THE RIDER'S LEAN ANGLE ARE USED. THE PURE ROLLING CONSTRAINS BETWEEN GROUND AND WHEELS ARE ALSO CONSIDERED IN THE DYNAMICAL EQUATIONS OF THE RIDER-MOTORCYCLE SYSTEM. WE USE THE SYMBOLICAL MATHEMATIC SOFTWARE MAPLE TO DERIVE THE THREE-DIMENSIONAL RIDER- MOTORCYCLE DYNAMICAL MODEL. THE C PROGRAMS ARE WRITTEN TO SOLVE THE DIFFERENTIAL-ALGEBRA EQUATIONS. THE SIMULATION STUDIES ARE DIVIDED INTO TWO PARTS.THE FIRST PART IS ON THE ST -EADY-STATE CONDITIONS. FROM THE EQUATIONS OF MOTION, WE SOLVE THE SYSTEM EQUILIBRIUM PO -INTS TO VERIFY THE STEADY BEHAVIOR IN COMPUTER SIMULATION.THE SECOND PART IS THE STABIL -IZING CONTROL UNDER DIFFERENT SPEED, STEERING ANGLE AND SIDE DISTURBANCE. THE FORCES OF THREE DIRECTIONS ARE INVESTIGATED DURING THE MOTORCYCLE CHANGING ITS DIRECTION OF MOTION. THE EQUATIONS OF MOTION DEVELOPED ARE VERIFIED BY ENERGY CONSERVATION AND EQUILIBRIUM PO -INTS.BY CHANGING THE PARAMETERS IN THE MODEL,THE DYNAMIC BEHAVIOR OF THE MOTORCYCLE IS STUDIED AND THE RESULT CAN BE USED TO IMPROVE THE MOTORCYCLE DESIGN.

Keywords : RIDER-MOTORCYCLE SYSTEM, LAGRANGE EQUATION, MOTORCYCLE HANDLING, EQUILIBRIUMS ANALYSIS, MOTORCYCLE SIMULATION DYNAMIC.

Table of Contents

REFERENCES

[1]R. S. SHARP, "THE STABILITY AND CONTROL OF MOTORCYCLE," J.MECH. ENG.SCI.,VOL.13, NO.5, PP. 316-329, 1971.

[2]R. S. SHARP, "THE INFLUENCE OF THE SUSPENSION SYSTEM ON MOTORCYCLE WEAVE-MODE OSCILLA -TIONS," VEHICLE SYSTEM DYNAMICS, VOL. 5, PP. 147-154, 1976.

[3]R. S. SHARP, "THE DYNAMICS OF SINGLE TRACK VEHICLES," VEHICLE SYSTEM DYNAMICS, VOL. 5, PP. 67-77, 1975/76.

[4]R. S. SHARP, C. J. ALSTEAD? "FREQUENCY RESPONSES OF MOTORCYCLE TO STEERING TORQUE INP -UT AND TO FRONT WHEEL AND TYRE IMPERFECTIONS," I. MECH. E., C129, PP. 193-200, 1983.

[5]葉莒和莊健弘, "機車飛越落地時之運動模擬與分析," 機械工業, PP. 74-82, 1985年8月.

[6]古有彬, 機車轉向機構對操安性之研究, 中山大學碩士論文, , 1989年6月.

[7]TSUYOSHI KATAYAMA AND TOMOO NISHIMI, "ENERGY FLOW METHOD FOR THE STUDY OF MOTORCYCLE WOBBLE

MODE," VEHICLE SYSTEM DYNAMICS, VOL.19, PP. 151-175, 1990.
[8]游凱程, 電動機車穩定性分析及最佳化設計, 台灣大學碩士論文, 1986年6月.
[9]陳志鏗, 許惠琳, 機車三維動態模擬之研究, 大葉大學碩士論文, 2001年7月.
[10]蕭印宏, 機車穩定性之研究, 交通大學碩士論文, 1990年6月.
[11]陳俊賢, 機車-人系統之實驗設計與穩定分析, 交通大學碩士論文, 1991年6月.
[12]K. GUO, H.GUAN, "MODELING OF DRIVER/VEHICLE DIRECTIONAL CONTROL SYSTEM," VEHICLE SYST -EM DYNAMICS, VOL. 22, PP. 141-184, 1993.
[13]FARSHID FOROUHAR, ANDREW PACKARD, "ROBUST STABILIZATION OF HIGH SPEED OSCILLATIONS IN SINGLE TRACK VEHICLES," AMERICAN CONTROL CONFERENCE, VOL. 1, PP. 26~30, 1994.
[14]吳仁琛, 騎士-機車系統運動控制:模糊控制方法, 交通大學博士論文, 1995年6月。
[15]YOUNG H. CHO. AND J. KIM, "STABILITY ANALYSIS OF THE HUMAN CONTROLLED VEHICLE MOVING ALONG A CURVED PATH ," VEHICLE SYSTEM DYNAMICS, VOL.25, PP.51-69, 1996.
[16]MOTOMU YOKOMORI, TAKIO OYA, AKIRA KATAYAMA, "RIDER CONTROL BEHAVIOR TO MAINTAIN STABL -E UPRIGHT," JSAE REVIEW, VOL. 21, PP. 61-65, 2000.
[17]R. S. SHARP, "STABILITY, CONTROL AND STEERING RESPONSES OF MOTORYCLE," VEHICLE SYSTEM DYNAMICS, VOL. 35, NO. 4-5, PP. 291-318, 2001.
[18]BENGT BRORSSON AND JAN IFVER, "WOBBLING IN MODERN MOTORCYCLES," ACCID. ANAL. & PREV., VOL. 16, PP. 451-456 , 1984.
[19]賴耿陽, 車輛驅動及控制, 復漢出版社, PP.5-50, 1993年, 11月.
[20]J. Y. WONG, THEORY OF GROUND VEHICLE, JOHN WILEY & SON, SECOND EDITION, PP. 3-72,1993.
[21]VITTORE COSSALTER, ALBERTO DORLA AND ROBERTO LOT, "STEADY TURNING OF TWO-WHEELED VEHI -CLES," VEHICLE SYSTEM DYNAMICS, VOL. 31, PP. 157-181, 1999.
[22]DONALD T. GREENWOOD, PRINCIPLES OF DYNAMICS, PRENTICE-HALL, SECOND EDITION, 1988.
[23]FARID M. L. AMIROUCHE, COMPUTATIONAL METHODS IN MULTIBODY DYNAMICS, PRENTICE-HALL, PP. 424-461, 1992.